

# Implementation of physiotherapeutic methods utilizing forces and pressures

*Ivana Vrdoljak*

University of Applied Health Sciences

*Tomislav Šipraga*

University of Applied Health Sciences

## Abstract

The field of physics, particularly medical physics, plays a crucial role in physiotherapy and medicine in general. Forces and pressures are crucial factors that physiotherapists and other healthcare professionals consider when treating patients. In physiotherapy, these forces can aid rehabilitation and pose challenges. This paper explains the principles of manual muscle testing (MMT) and its relation to physics, specifically the use of gravitational force to assess the muscle condition of patients. It also explores the effects of physics on the human body, focusing on fluid circulation and the musculoskeletal system. Additionally, the paper discusses how forces and pressures are integrated into therapeutic exercises while comparing concentric and eccentric movements. The role of buoyancy, hydrostatic pressure, and water viscosity in hydrotherapy is also covered, as well as the use of electromagnetism in specific therapies, such as electrotherapy, magnetotherapy, and laser treatments. The paper aims to highlight the significant impact of physics on cardiopulmonary functions and to raise awareness among physiotherapists and healthcare professionals about the importance of understanding the role of physics in medical interventions. Educating patients about the effect of applied forces and pressures on therapy outcomes is also a topic addressed, which can ultimately help them perform movements correctly and maintain proper posture.

**Keywords:** physics; medical physics; force; pressure; emergency physiotherapist

**Paper type:** Research article

**Received:** 20 Mar 2024

**Accepted:** 30 Jun 2024

**DOI:** <https://doi.org/10.2478/crdj-2024-0007>

## Introduction

Physics, as a fundamental science concerned with the interactions of forces, motion, matter, and energy, is integral to physiotherapy. The human body is constantly subjected to forces such as gravity, buoyancy, hydrostatic pressure, surface tension, water viscosity, and electromagnetism, all of which have a direct impact on physiotherapeutic interventions. Medical physics, a specialized field of physics, applies these principles within medicine, contributing to preventing ailments in patients, diagnosis, and rehabilitation. Medical physicists collaborate with healthcare professionals to ensure the safe and effective use of radiation in diagnostic and therapeutic procedures, including X-rays, CT scans, radiotherapy for cancer treatment, and nuclear medicine. They also play a key role in advancing medical technologies and techniques (Maqbool, 2017; Beyer et al., 2021). Physiotherapy, a branch of medicine focused on the rehabilitation of the musculoskeletal system, employs therapeutic exercises, manual therapy, massage, and other methods to treat injuries and restore function. Physiotherapists work independently or as part of multidisciplinary teams comprising doctors, nurses, and radiologists to enhance mobility, reduce pain and inflammation, and promote tissue healing following injury or surgery. Physics is deeply embedded in physiotherapy, shaping the assessment process, influencing rehabilitation strategies, and contributing to patient outcomes.

Physics influences physiotherapy through various approaches:

- **Biomechanics:** Mechanics and dynamics are applied to analyze gait, posture, movements, and flexibility, helping to diagnose musculoskeletal conditions and develop rehabilitation plans.
- **Therapeutic modalities:** Techniques like ultrasound, electrical stimulation, and heat/cold therapy use acoustic waves, electrical currents, and thermodynamics to relieve pain, promote healing, and relax muscles.
- **Exercise prescription:** Physiotherapists use principles like resistance, leverage, and moment of force to design rehabilitation programs that target specific muscles, improve strength and flexibility, and restore functional movement.
- **Mobilization techniques:** Joint and soft tissue mobilization involves applying forces based on physical principles to ensure safe and effective therapeutic outcomes.
- **Orthoses and aids:** Physical principles guide the design and customization of orthopedic aids (braces, crutches, and walkers), enhancing comfort and function for patients with mobility disorders or musculoskeletal impairments. Understanding physical principles enables physiotherapists to assess movement, apply interventions, and promote optimal recovery (Sacco et al., 2023).

## Impact of forces and pressure on the human body

Forces and pressures exert a significant and complex influence on the human body, both positively and negatively, depending on the environment and intensity, and a balance between the two is essential for maintaining the health and overall well-being of the human body, as well as planning and outcomes of physiotherapeutic interventions.

Prolonged exposure to excessive gravity, such as when standing in general or prolonged standing during work, can cause problems such as back and leg pain, swelling of the extremities (edema) and reduced blood circulation. Mechanical forces such as blows or pressure can cause injury or damage tissues and organs. For example, a blow to the head can result in a concussion, a skull fracture or a contusion of the brain tissue, while long-term pressure on the tissue can cause scarring. The force of buoyancy opposes the force of gravity. It cancels out the influence of gravity, allowing objects or bodies to float on the surface of the water. In the context of physiotherapy, buoyancy is often a key component of hydrotherapy and balneotherapy.

Atmospheric pressure is the force exerted by the atmosphere on the Earth's surface. Changes in atmospheric pressure can affect the human body, especially when occurring suddenly, such as when climbing high altitudes or diving. It can lead to problems such as hypoxia (lack of oxygen) or decompression sickness. Air pressure varies depending on altitude and weather conditions. High air pressure causes increased air density, making breathing easier, while low pressure can bring on a feeling of heaviness in the chest and make breathing difficult (dyspnea). Fluid pressure, like blood pressure, is important for the normal functioning of the body. An imbalance in blood pressure can lead to problems such as hypertension (high blood pressure) or hypotension (low blood pressure), which in turn has a negative impact on blood circulation and exerts a general strain on the cardiorespiratory system.

## Manual muscle test

The manual muscle test (MMT) is indispensable in the field of physiotherapy. Physiotherapists use it to assess the strength and mobility (range of motion) of patients and to further plan, implement and evaluate the rehabilitation process for various diseases and conditions. Besides strength and mobility, it also assesses gait, neurological damage and various types of damage to and fractures of the locomotive system. The manual muscle test uses a grading scale from 0 to 5 (Tbl. 1), is easy to perform and is based on resisting the force of gravity.

Although the test is objective, the limitations of the manual muscle test are that there may be some subjectivity during testing—clothing and shoes that may affect the manual muscle test should be removed, or two or more physical therapy examiners may subjectively give the patient a lower or higher rating. The patient may also be subjective when performing the manual muscle test, given that physiotherapists need to eliminate possible compensation with other muscles that the patient can use. Therefore, the physiotherapist requires expertise and professionalism when

conducting a manual muscle test so that the ongoing rehabilitation process is as objective as possible. A manual muscle test can also be performed by any healthcare professional to assess a patient's muscle condition.

*Table 1*

Presentation of grading of the manual muscle test

<b>Grade</b>	<b>Description</b>
<b>0</b>	No visible or palpable contraction
<b>1</b>	Visible or palpable contraction without motion
<b>2</b>	Full range of motion, gravity eliminated
<b>3</b>	Full range of motion against gravity
<b>4</b>	Full range of motion against gravity, moderate resistance
<b>5</b>	Full range of motion against gravity, maximal resistance

### **The role of gravity in therapeutic exercises**

Therapeutic exercises in physiotherapy are categorized into concentric (anti-gravity), eccentric (gravity-assisted), and isometric exercises, each involving different interactions with gravitational force. During concentric exercises, muscle fibers shorten, while in eccentric exercises, they elongate; in isometric exercises, muscle fibers remain static without changing length. Physics plays a crucial role in the resistance and movement of muscles from their proximal to distal attachments (Naqvi & Sherman, 2023). Concentric exercises involve muscles working against gravitational resistance to produce movement, known as the "positive" phase, in contrast to eccentric exercises, which are the "negative" phase. Examples include bench presses, squats, and bicep curls, where muscles must overcome gravity to lift a weight. Control and proper execution are essential to prevent injury, and exercise intensity can be adjusted by altering body position or the weights. Concentric exercises are often combined with eccentric and isometric exercises to maximize therapeutic outcomes, especially during rehabilitation after injury or surgery (Ansari et al., 2023). Eccentric exercises lengthen muscles while resisting gravitational force and weight, as the "negative" phase of movement. These exercises, such as lowering a bench press bar or descending in a squat, are essential for building strength as well as improving endurance and locomotor function. Eccentric exercises are particularly effective for enhancing flexibility, mobility, and balance, making them safer for persons with cardiovascular issues and the elderly. Controlled muscle stretching under load promotes muscle hypertrophy and plays a key role in both injury rehabilitation and muscle mass development during training (Ansari et al., 2023). Isometric exercises involve muscle contractions without change in muscle length or movement of the joint, with gravity acting as a stabilizing force. Examples include planks or holding the body in a push-up position, where muscles contract to maintain a static position. These exercises are widely used in rehabilitation to strengthen muscles and improve stability

without requiring movement, making them safe for individuals recovering from injuries and easy to perform without equipment (Vang & Niznik, 2021; Kangeswari et al., 2021; Sadeghi et al., 2022).

### **The physics behind thermotherapies and cryotherapies**

Thermotherapy relies on the physical principles of heat transfer, such as conduction, convection, and radiation, to properly deliver heat to the body. The thermal properties of materials, like thermal conductivity (Fig. 1), are crucial in selecting which materials to use for thermotherapy and cryotherapy devices or wraps. Understanding these physical principles helps optimize therapeutic procedures to achieve desired effects while minimizing side effects. Thermal conduction refers to heat transfer through a material or between materials in contact due to temperature differences. This process is important in thermotherapy, where heat from hot packs or thermal massages is transferred to the skin, relaxing muscles, improving circulation, and reducing pain. Materials with high thermal conductivity, such as metals, transfer heat quickly, while those with low conductivity, like glass or wood, transfer it more slowly. Materials with good thermal conductivity for effective heat transfer are essential in thermotherapy. For example, hydrotherapy uses thermal convection to transfer heat from hot water to the body. Convection occurs when warm substances move, causing heat circulation and distributing it evenly, like in water or air (Fig. 2). This method promotes uniform heating of the body, enhances circulation, and contributes to therapeutic outcomes such as muscle relaxation and pain relief. The heat capacity of a material is the amount of heat it can store. Materials with high heat capacity retain more heat and cool down more slowly, making them valuable in thermotherapy for maintaining consistent temperatures. Thermotherapy works by inducing vasodilation, where blood vessels widen, while cryotherapy relies on vasoconstriction, or the narrowing of blood vessels. Understanding the temperature thresholds of the human body is crucial in avoiding injuries. Excessive heat may cause burns or tissue damage, whereas insufficient cold may not provide the desired effect. Therefore, both therapies are applied within safe temperature ranges.

Various types of tissues respond to heat and cold differently. Heat can relax muscles, increase blood flow, and improve flexibility before therapeutic exercises, while cold can reduce inflammation and relieve pain. Recognizing these biological responses helps tailor thermotherapy and cryotherapy to specific health conditions. Individual sensitivity to temperature varies, so therapy should be adjusted according to each person's comfort and tolerance.

The use of thermotherapy in clinical settings has expanded, with hydrothermal baths incorporating minerals to enhance therapeutic outcomes by promoting not only muscle relaxation but also skin rejuvenation. In contrast, cryotherapy has moved beyond conventional ice packs. Whole-body cryotherapy chambers, reaching temperatures as low as  $-110^{\circ}\text{C}$ , are now popular in sports medicine for their ability to

reduce recovery time post-exercise by constricting blood vessels and reducing inflammation on a systemic level.

Further studies on the body's thermal response show that localized heat application can help modulate the inflammatory response by increasing cytokine activity, which plays a role in cellular repair mechanisms. In addition, cryotherapy has been found to influence metabolic rates by stimulating brown adipose tissue (BAT) in the body, which increases calorie expenditure and has potential implications in weight management.

Both therapies closely monitor temperature thresholds to prevent adverse effects. Modern devices now include embedded sensors to track real-time skin and core temperatures, ensuring that both thermotherapy and cryotherapy remain within therapeutic safety limits. These technologies enhance the personalization of therapy, taking into account factors like age, body composition, and pre-existing health conditions. As understanding of tissue-specific responses to heat and cold continues to evolve, both thermotherapy and cryotherapy are becoming increasingly tailored to individual therapeutic goals and physiological needs (Elfahem et al., 2023).

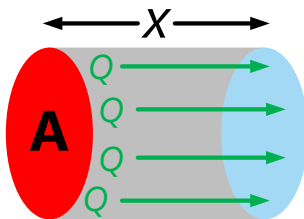


Figure 1. Schematic display of thermal conduction (illustration by the author)

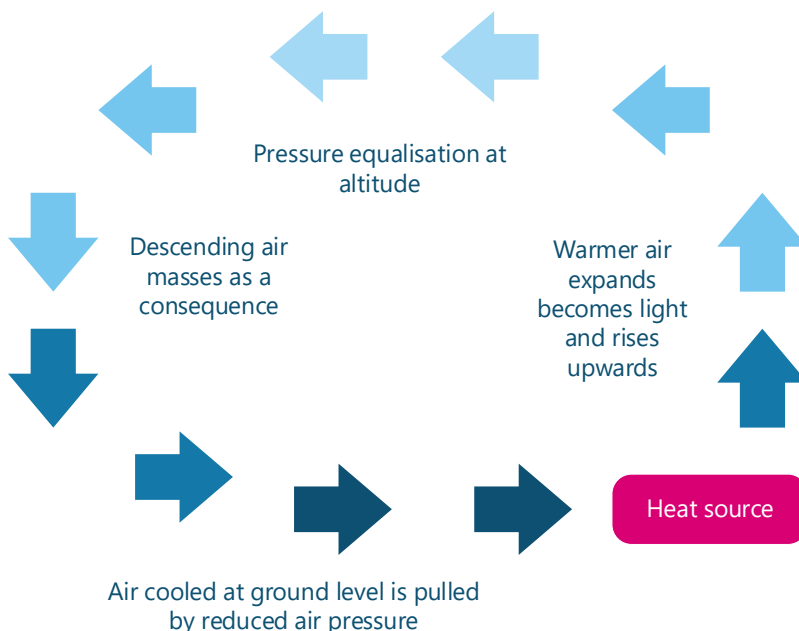


Figure 2. Schematic display of thermal convection (illustration by the author)

## The role of physics in hydrotherapy

Hydrotherapy is a physiotherapy intervention that uses water as a physical agent to treat and prevent various musculoskeletal and neurological conditions, reduce pain and muscle spasms, decrease swelling, and improve posture, gait, and psychological well-being by lowering depression and anxiety. It is suitable for all age groups, from children to the elderly, as the use of water is generally well-received and comfortable for patients.

The primary physical force in hydrotherapy is buoyancy, which counteracts gravity, making it easier for patients to perform therapeutic exercises, move, and feel more at ease. Hydrostatic pressure improves cardiovascular and respiratory function, which is particularly beneficial for patients with heart conditions. Surface tension assists with movement at the water's surface, while water viscosity provides resistance, enhancing muscle strength. Hydrotherapy is widely recommended for treating musculoskeletal conditions and as a preventative measure for the elderly, improving posture and reducing the risk of falls. However, it is contraindicated for patients with skin issues, infections, or fever, and its high cost can be a limitation factor. When immersed, body weight is reduced, lowering strain on joints, muscles, and the spine, which alleviates pain and makes exercising easier. Water resistance boosts muscle strength, while warm water promotes blood circulation, improving joint mobility and range of motion—particularly useful for those with injuries or arthritis. Hydrotherapy also aids balance and coordination, making it a key component of rehabilitation after injuries or surgeries.

Physiotherapy combined with hydrotherapy integrates traditional physiotherapy techniques with water-based therapeutic approaches, offering additional benefits by harnessing the physical properties of water. For instance, physiotherapists can design specific exercises to be performed in water to improve strength, flexibility, balance, and coordination. The resistance provided by water enhances muscle engagement while reducing stress on joints and the spine. Water-based massages and therapeutic swimming can also be incorporated into hydrotherapy, helping reduce muscle tension, improve circulation, and relieve pain. Warm water relaxes muscles, increases blood flow, and provides a calming effect, reducing stress and enhancing therapy outcomes. Cold-water therapy, on the other hand, helps reduce swelling, inflammation, and pain from injuries. Hydrotherapy is frequently used in injury rehabilitation, such as sports injuries, joint damage, or post-surgery recovery. It decreases stress on injured areas, enhances mobility, and reduces pain. Cold water can slow blood flow and metabolic activity, easing injury symptoms. Thalassotherapy, using seawater and marine environments, can also improve circulation, reduce inflammation, and alleviate pain in patients with orthopedic, neurological, and cardiovascular conditions. Integrating hydrotherapy into a physiotherapy plan accelerates healing and improves patient quality of life. The therapy plan is always tailored to individual needs and goals (McIntyre, 2017).

## Physics and pulmonology

Physics plays a key role in understanding pulmonary pressures and related phenomena, which are crucial for diagnosing and monitoring lung and heart diseases. Pulmonary pressures, primarily influenced by diaphragm and intercostal muscle contractions during breathing, are vital for air exchange. High pulmonary pressure may indicate conditions like pulmonary hypertension, often caused by heart, lung, or vascular diseases. These pressures can be measured invasively using a catheter or using non-invasive methods like ultrasound or MRI.

Pulmonary volumes and capacities, such as tidal volume, inspiratory and expiratory reserve volumes, and residual volume, measure the air lungs inhale and exhale at different stages. These metrics help diagnose conditions like asthma or COPD and track treatment progress. Lung capacity is influenced by factors like age, gender, physical fitness, and smoking and can be assessed using spirometry, which is essential in both medical diagnoses and sports performance enhancement.

Lung capacity may decline with age, but regular physical activity and a healthy lifestyle can help maintain lung function. Monitoring lung capacities aids in the early detection and management of respiratory conditions.

### Respiratory exercises in physiotherapy

Respiratory exercises are an essential component of physical therapy, particularly for patients with respiratory issues or undergoing post-operative recovery. These exercises enhance lung capacity, improve breathing, reduce dyspnea, and promote mucus clearance and overall respiratory function.

The key techniques include:

- Diaphragmatic breathing focuses on activating the diaphragm to improve breathing efficiency and reduce the effort required.
- Deep breathing exercises involve inhalation through the nose, brief breath-holding, and slow exhalation through the mouth, which help expand the lungs and improve airflow.
- Pursed-lip breathing, which involves exhaling through a resistance device, strengthens respiratory muscles and enhances breath control.
- Huffing, or forceful exhalation through open lips, helps clear excess mucus from the lungs and airways.
- Postural drainage, where therapists position patients to leverage gravity in facilitating mucus clearance.

Before starting any respiratory exercises, it is crucial to consult with a qualified physical therapist or healthcare professional to ensure the exercises are tailored to the patient's needs. Physical therapists also monitor symptoms such as dyspnea, fatigue, chest pain, dizziness, and fainting, as these may indicate serious conditions requiring medical attention.



## Physics and cardiology

The connection between physics and heart function can be examined from several perspectives. The structure and electrophysiology of the heart show that it is a muscular organ that generates electrical impulses, pumping blood throughout the body, as well as creating specific forces and pressures within blood vessels. This electrophysiological function can be described using the principles of electromagnetism, electrical circuit physics, hydrodynamics (blood flow), and mechanics (muscle contraction). The heart contracts in a process known as systolic contraction, initiated by electrical signals generated within the heart. The cardiac impulse begins in the sinoatrial (SA) node in the right atrium and spreads through a specialized conduction system, including the atrioventricular (AV) node and the His bundle. The impulse reaches the atria and ventricles, causing their contraction and initiating the blood circulation cycle. After contraction, the heart muscle relaxes to allow for refilling with blood before the next contraction, as a continuous process, ensuring adequate oxygen and nutrient supply to all tissues and organs (Buckberg et al., 2024).

## The role of physiotherapy in cardiology

Physical therapy plays a crucial role in cardiology as part of a comprehensive medical approach to treating heart diseases and improving overall cardiovascular health. Physiotherapists implement cardiac rehabilitation in various healthcare settings, including clinics and wellness centers. They develop individualized exercise programs tailored to each patient's needs and abilities, incorporating aerobic exercises, strength training, and flexibility exercises to enhance cardiac function and physical fitness. Following a heart attack, surgery, or other cardiac issues, physiotherapists run rehabilitation programs that help patients regain strength, endurance, and independence through a gradual increase in supervised physical activity. Physiotherapists monitor vital signs such as blood pressure, heart rate, and cholesterol levels, offering medical advice on how to manage them through exercise and lifestyle modifications. Education on healthy living, including dietary guidance, weight management, stress management, and smoking cessation, is also provided, as lifestyle changes are key to preventing heart diseases and improving cardiovascular health. They assess the functional status of patients to identify capabilities and limitations related to physical activity, creating personalized treatment and rehabilitation plans. Breathing techniques can help reduce stress and anxiety and enhance cardiac function. Physiotherapists can teach patients deep breathing, relaxation, and controlled breathing techniques for symptom management. Collaborating with other healthcare professionals in multidisciplinary teams provides a holistic approach to patient care, addressing all aspects of patient health and well-being. Ultimately, physiotherapy utilized in cardiology aims to improve heart function, alleviate symptoms of heart disease, and enhance the quality of life for patients, significantly impacting their long-term health and recovery.

Physical therapy in cardiology has increasingly integrated technology to personalize and optimize rehabilitation, using wearable devices to track heart rate, oxygen levels, and other vital signs in real-time. These tools enhance patient safety and allow for data-driven adjustments during exercise sessions, facilitating remote monitoring and telehealth options for patients in rural or underserved areas. Additionally, high-intensity interval training (HIIT) has gained recognition as an effective method for cardiac rehabilitation, shown to improve  $VO_2$  max and cardiac output more efficiently than traditional steady-state exercises, under controlled supervision. Advances in virtual reality (VR) have also allowed cardiology patients to engage in immersive, low-impact exercises that improve cardiovascular health and reduce sedentary behavior. Furthermore, physiotherapists focus on balance training, particularly for elderly cardiac patients, to decrease fall risks, which are higher in this population due to medication side effects or muscle weakness.

Collaboration within cardiology and mental health teams has highlighted the importance of addressing mental well-being alongside physical recovery. Stress management, breathing techniques, and biofeedback help manage anxiety, which has been shown to significantly impact heart health and recovery rates. By promoting a holistic approach and continuous education on heart-healthy habits, physiotherapists play a pivotal role in reducing cardiac event recurrence, boosting patient autonomy, and enhancing long-term heart health and quality of life (Aamot et al., 2020).

## Phototherapy and physics

Phototherapy, or light therapy, utilizes natural light sources like the sun or artificial light sources, such as lasers and infrared or ultraviolet rays, to treat various medical conditions. This form of therapy positively affects a range of diseases, including dermatological conditions (e.g., psoriasis and atopic dermatitis), neurological disorders (such as multiple sclerosis, Parkinson's disease, traumatic brain injury, and clinical depression), as well as issues related to orthopedics, rheumatology, and cardiology. Phototherapy can also help alleviate chronic nonspecific pain in the lumbar region and reduce pain associated with fibromyalgia. The use of light therapy for therapeutic purposes dates back to ancient cultures, including those of Greece, Egypt, and India. Hippocrates wrote about the positive effects of sunlight on mood and mental well-being, coining the term "heliotherapy." Today, phototherapy is defined as the use of light sources—such as sunlight, infrared rays, ultraviolet rays, and laser therapy—for therapeutic applications (Liebert & Kiat, 2021).

## Heliotherapy

Heliotherapy, the therapeutic use of sunlight, has been practiced since ancient times. Civilizations like the Egyptians, Greeks, and Romans recognized the beneficial effects of sunlight on the human body for therapeutic purposes. The modern understanding and development of heliotherapy began in the 19th and 20th centuries when physicians started investigating the therapeutic effects of sunlight, particularly its role

in synthesizing vitamin D and producing neurotransmitters like serotonin, which influence mood. Exposure to sunlight improves overall health, reduces inflammation, extends lifespan, and mitigates cognitive impairments, especially during winter months when sunlight exposure is limited. It also helps stimulate the immune system to resist various diseases, including influenza and coronavirus. Additionally, sunlight has bactericidal properties and can reduce fungal contamination on infected clothing. Light therapy is effective for treating seasonal affective disorder (SAD), depressive disorders, and bipolar depression. It also improves sleep-wake cycles in individuals with Parkinson's disease and alleviates fatigue associated with multiple sclerosis (39, 40). Furthermore, heliotherapy is beneficial in dermatology, enhancing the quality of life for patients with psoriasis or atopic dermatitis (Karppinen et al., 2015).

### **Laser therapy**

In medicine, the term "laser" is an acronym for "light amplification by stimulated emission of radiation." It is a device that produces light (photons) and has a well-documented impact on patients undergoing physical therapy. Laser therapy is a non-invasive therapeutic intervention used by physiotherapists who apply both low-level laser therapy (LLLT) and high-power laser therapy (HPLT). The main difference between these types of therapies lies in their output power: LLLT generates up to 500 mW, while high-power lasers produce over 500 mW. Laser therapy involves directing a precisely focused beam of laser light onto the targeted area of the musculoskeletal system. Both the therapist and the patient must avoid looking at the laser light and should wear appropriate protective eyewear or keep their eyes closed and away from the laser source. This therapy stimulates body tissue, accelerating regeneration, reducing pain, and alleviating inflammation. Lasers operate at wavelengths ranging from 632 nm to 904 nm, which physiotherapists utilize for various musculoskeletal disorders, including rheumatoid arthritis, osteoarthritis, tendinitis, bursitis, and conditions affecting the back, such as sciatica, herniated discs, and chronic lumbar pain. It also addresses overuse syndromes like plantar fasciitis, tennis elbow, and frozen shoulder, and helps reduce lymphedema-related pain.

### **Infrared therapy**

Infrared therapy, also known as infrared light therapy or infrared radiation therapy, utilizes infrared light to apply heat to the body. As a form of phototherapy and thermotherapy, it offers various health benefits, including pain relief, improved circulation, reduced inflammation, and relaxation. Infrared therapy works by penetrating the skin and stimulating mitochondrial activity, which is crucial for energy production in the body. This stimulation enhances cellular repair and regeneration processes, leading to multiple health benefits. The methods of applying infrared therapy include:

- Infrared lamps: Devices that emit infrared light, which can be directed at specific body areas to relieve pain, reduce inflammation, or warm tissues. For

example, muscles are heated before spinal traction to enhance flexibility and improve therapeutic outcomes.

- Infrared heating pads: Cushions or mats equipped with infrared technology that can be placed on specific body parts to provide thermal therapy.

Infrared therapy is frequently employed for various musculoskeletal conditions, including muscle spasms, joint pain, arthritis, and certain skin disorders.

### **Patient education about medical physics**

Educating patients on the importance and impact of medical physics is crucial for enhancing their understanding of medical procedures and improving their healthcare experience. This education can be achieved using several key concepts, including:

- Fundamentals of medical physics: Understanding the effects of forces, pressures, radiation, energy, and waves on the human body.
- Types of radiation: Knowledge of different radiation types, such as X-rays, gamma rays, and ionizing radiation, and their role in radiotherapy, especially for oncology patients.
- Applications in diagnostics: Recognizing how medical physics principles are utilized in diagnostic procedures like X-rays, MRI, CT scans, and ultrasound, ensuring accuracy and precision that enhance diagnosis, treatment success, and overall rehabilitation.
- Patient experience: Understanding medical physics can reduce anxiety and fear during diagnostic tests and improve cooperation during therapeutic procedures.
- Future developments: Informing patients about the latest technological innovations in medical physics that may enhance the healthcare provided to them in the future.
- Resources for information: Encouraging patients to ask questions and seek additional information about medical physics from healthcare professionals or reliable online sources.
- Accessible and informative education empowers patients with a better understanding of medical procedures, resulting in greater cooperation and improved treatment outcomes (Brown et al., 2024).

### **Conclusion**

Physiotherapy and, in general, all medical professions must more intensively consider the effect of physics or medical physics in their diagnostic and therapeutic procedures. Better education of medical professionals and patients is needed regarding the influence of physics on the human body and the surrounding nature. A better

understanding of the influence of physics can significantly contribute to a better understanding of the world in which humans live. Physics is not given much attention, even though it is ubiquitous in medicine. Physiotherapists should gain a deeper understanding of physical principles and apply them in physiotherapeutic interventions—given the various pathologies that patients may suffer—in order to ensure the most professional and high-quality rehabilitation process and the outcome of the therapeutic procedure.

## References

1. Aamot, I. L., Forbord, S. H., Gustad, K., Løckra, V., Stensen, A., Berg, A. T., Dalen, H., Karlsen, T., and Støylen, A. Home-based versus hospital-based high-intensity interval training in cardiac rehabilitation: a randomized study. (2020). *EPJC*, 21(9), 1070-1078.
2. Ansari, M., Hardcastle, S., Myers, S., and Williams, A. D. (2023). The health and functional benefits of eccentric versus concentric exercise training: A systematic review and meta-analysis. *J Sports Sci Med*, 22(2), 288-310.
3. Beyer, T., Bailey, D. L., Birk, U. J., Buvat, I., Catana, C., and Cheng, Z., et al. Medical physics and imaging—A timely perspective. *Frontiers*, 9.
4. Brown, D. W., Atwood, T. F., Moore, K. L., MacAulay, R., Murphy, J. D., and Mundt, A. J., et al. (2018). A program to train medical physicists for direct patient care responsibilities. *J Appl Clin Med Phys*, 19(6), 332–5.
5. Buckberg, G., Nanda, N., Nguyen, C., and Kocica, M. (2018). What is the heart? Anatomy, function, pathophysiology, and misconceptions. *J Cardiovasc Dev Dis*, 5(2), 33.
6. Elfahem, R., Abbes, B., Bouchet, B., Murer, S., Bogard, F., Moussa, T., Beaumont, F., and Polidori, G. (2023). Whole-Body Cryostimulation: New Insights in Thermo-Aeraulic Fields inside Chambers. *Inventions*, 8(4), 81.
7. Kangeswari, P., Murali, K., and Arulappan, J. (2021) Effectiveness of Isometric exercise and counseling on level of pain among patients with knee osteoarthritis. *SAGE Open Nurs*, 7.
8. Karppinen, T., Ylianttila, L., Kautiainen, H., Reunala, T., and Snellman, E. (2015). Empowering heliotherapy improves clinical outcome and quality of life of psoriasis and atopic dermatitis patients. *Acta Derm Venereol*, 95(5), 579–82.
9. Liebert, A., and Kiat, H. (2021). The history of light therapy in hospital physiotherapy and medicine with emphasis on Australia: Evolution into novel areas of practice. *Physiother Theory Pract*, 37(3), 389–400.
10. McIntyre D. (2017). Aquatic therapy and pain in the rehabilitation patient. In: *Comprehensive Pain Management in the Rehabilitation Patient*. Cham: Springer International Publishing, 347–55.

11. Maqbool, M. (2017). Introduction. In: *An Introduction to Medical Physics*. Cham: Springer International Publishing.
12. Naqvi, U., and Sherman, A. I. (2023). *Muscle Strength Grading*. StatPearls Publishing.
13. Sacco, I. C. N., Trombini-Souza, F., and Suda, E. Y. (2023) Impact of biomechanics on therapeutic interventions and rehabilitation for major chronic musculoskeletal conditions: A 50-year perspective. *J Biomech*, 154, 111604.
14. Sadeghi, A., Rostami, M., Ameri, S., Karimi Moghaddam, A., Karimi Moghaddam, Z., and Zeraatchi, A. (2022). Effectiveness of isometric exercises on disability and pain of cervical spondylosis: a randomized controlled trial. *BMC Sports Sci Med Rehabil*,14(1).
15. Vang, C., and Niznik A. (2021). The effectiveness of isometric contractions compared with isotonic contractions in reducing pain for in-season athletes with patellar tendinopathy. *J Sport Rehabil*, 30(3), 512-515.

## About the authors

Ivana Vrdoljak graduated from the Faculty of Physics, University of Rijeka, with a Master of Education in mathematics and physics. She acquired her PhD in lifelong learning at the Faculty of Economics and Business, University of Zagreb. Ivana works at the University of Applied Health Sciences, Zagreb. Currently, she is chair of the Department of Informatics in Health Care. Her research interests are lifelong learning, education, and information technologies. She has participated in several research conferences and published scientific papers. The author can be contacted at [ivana.vrdoljak@zvu.hr](mailto:ivana.vrdoljak@zvu.hr)

Tomislav Šipraga enrolled in the University of Applied Health Sciences in Zagreb, completing the program within the prescribed time and gaining a Bachelor of Physiotherapy. He is currently seeking an institution to undertake his traineeship. After completing the traineeship, he plans to continue his studies. The author can be contacted at [tsipraga2@gmail.com](mailto:tsipraga2@gmail.com)