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CK4Stim

# Clinical Key for Electrical Stimulation in Physiotherapy and Rehabilitation

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Türkiye  
Fizyoterapistler  
Derneği



COLEGIUL  
FIZIOTERAPEUȚILOR  
DIN ROMÂNIA



LIETUVOS  
KINEZITERAPEUTŲ  
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## Preface

**Ahmet KUTLUHAN, M.D.Prof.**

Rector of Pamukkale University

A project titled “Clinical Key for Electrical Stimulation in Physiotherapy and Rehabilitation (CK-4Stim)” was carried out within the scope of ERASMUS+ Program Partnerships for Cooperation in Vocational Education (KA220) under the coordination of Pamukkale University. Cooperation partnerships in vocational education and training under the Erasmus+ project are instrumental in enhancing the quality, relevance, and attractiveness of vocational education and training (VET) across Europe. This cooperation partnership brought together universities, researchers and associations regarding physiotherapy and rehabilitation in Türkiye, Romania and Lithuania. This collaboration fostered the exchange of knowledge, expertise, and best practices in vocational education and training of physiotherapy and rehabilitation. It is very important for the future of science that European projects are carried out in more than one university environment through partners. One of the most prominent policies of the European Union is to ensure the emergence of more effective practices by revealing the local differences in the practices performed and to share knowledge and skills. On this occasion, the Romanian, Lithuania and Turkish partners of our CK4Stim project have carried out very successful work. The resulting project results show that it was realized in accordance with its intended purpose. Therefore, as Pamukkale University, we are very happy that such a project is supported by the European Union and accepted

and carried out by Romania, Lithuania and other universities in our country.

Clinical keys handled in CK4Stim project is a comprehensive online platform that provides physiotherapists and other healthcare professionals with access to a vast array of information about electrical stimulation approaches in physiotherapy and rehabilitation.

Electrical stimulation is a valuable modality in physiotherapy and rehabilitation with various applications and benefits such as pain management, muscle strengthening, muscle re-education, neuromuscular rehabilitation, functional rehabilitation, wound healing, edema reduction, and improved range of motion, nerve regeneration, motor re-learning and plasticity. Overall, electrical stimulation is a versatile and effective modality in physiotherapy and rehabilitation, offering multiple therapeutic benefits across a wide range of clinical conditions and patient populations. When used judiciously and in conjunction with other treatment modalities, electrical stimulation can play a valuable role in optimizing patient outcomes and promoting recovery and rehabilitation. However, in order to obtain the most appropriate treatment result, electrical stimulation parameters must be selected and applied in the most appropriate way. CK4Stim’s project results are a valuable resource for physiotherapists. CK4Stim project provides access to rich medical information, evidence-based resources, multimedia content, and clinical keys

to support clinical practice, education, and professional development in electrical stimulation approaches.

CK4Stim project is based on lifelong learning which is crucial in professional life. Lifelong learning ensures physiotherapists stay updated and adaptable to new developments and changes in electrical stimulation. Continuous learning enables physiotherapists to acquire new skills and enhance existing ones, keeping them competitive in physiotherapy and rehabilitation applications. By integrating this knowledge into their clinical practice, they can provide treatments that are supported by scientific evidence, ensuring the highest standards of treatment, rehabilitation and patient safety. Open access education materials play a significant role in professional life and lifelong learning. Open access materials of CK4Stim project re-

sults are freely available. This accessibility enables physiotherapists to access high-quality open access educational resources to improve their knowledge and skills regarding electrical stimulation approaches in physiotherapy and rehabilitation, regardless of their financial situation or geographical location, without the waste of time required to travel to national / international courses, seminars, conferences and events.

“Clinical Key for Electrical Stimulation in Physiotherapy and Rehabilitation” project aimed lifelong learning in vocational education with open access education materials based on exchange of knowledge, expertise, and best practices in electrical stimulation approaches. I wish the project results of CK4Stim will support the lifelong professional development of physiotherapists around the world.



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## Preface

**Nuray KIRDI, PT.PhD.Prof.**

Electrical therapy is a treatment approach that has been used to treat various diseases since ancient times and still continues to be applied. Electrical stimulation therapy helps patients improve functionality and improve quality of life in their normal lives. As a therapeutic approach, electrical stimulation can be widely used as an alternative to conventional treatments in target tissues or in patients who are drug-resistant or unsuitable for the purpose of eliciting target effects. Electrical stimulation can be applied to certain tissues to modulate electrophysiological mechanisms, especially in triggering the target tissue.

Electrical stimulation has big importance not only for its effect in relieving pain, but also for purposes both in the treatment of central and peripheral nervous system diseases such as strengthening or retraining the muscle, increasing joint range of motion, regulating circulation, reducing edema and spasticity, and its effects on healthy muscles. Additionally, in controlled clinical studies, electrical stimulation has been shown to be effective against sarcopenia, especially in patients with chronic congestive heart disease, diabetes mellitus, chronic obstructive pulmonary disease and advanced renal failure.

In today's technology, new devices, new techniques, new terminology and new indications are emerging, and as the demand for healthcare services where the product is personalized increases with the contribution of advantages such as small

size, light weight, wireless, battery-free, easy to use in practice and less perceived discomfort, regulations regarding stimulators are gaining momentum.

It is important to combine electrical stimulation with neurorehabilitation to improve motor functions and enhance performance to maximize potential synergy.

In your ERASMUS+ Project; The project content is organized in 5 modules: "Physiology of Healthy and Denervated Muscles", "Currents Used in Electrical Stimulation", "Electrical Stimulation for Healthy Muscles", "Electrical Stimulation for Denervated Muscles" and "Electrical Stimulation for Reinnervated Muscles" is important for students and also physiotherapists working in the field. In muscle-nerve injuries that occur or may occur due to various factors throughout life, correct planning, timing and correct implementation of the treatment with appropriate physiotherapy and rehabilitation approaches are very important during the healing process. Incorrect practices and guidance may affect the functionality of the person and may lead to lifelong disability.

I believe that the international knowledge and experience sharing of physiotherapists in this project will lead to the standardization of professional practices on electrical stimulation and will contribute to the continuity of up-to-date information in the quality of education in parallel with the developing technology.

I congratulate my very valuable BSc, MSc and PhD student and dear colleague Prof. Dr. Nilufer CETISLI-KORKMAZ for her success in the project and hope that she will achieve many more successes.

I know that Prof. Dr. Nilufer CETISLI-KORKMAZ will continue to make scientific contributions

to her students and colleagues as a very successful academician, and I believe that my young colleagues will improve themselves with determination on this path.

Wishing you success in your work, with love and respect.





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## Preface

**Nilufer CETISLI-KORKMAZ, PT.PhD.Prof.**

Project Coordinator

This guidebook is the outcome of the project titled with “Clinical Key for Electrical Stimulation in Physiotherapy and Rehabilitation (CK4Stim)” developed by the project partners in collaboration with Pamukkale University-TÜRKİYE (PAU) (Coordinator), University of Craiova-ROMANIA (UCV), Başkent University-TÜRKİYE (BU), Süleyman Demirel University-TÜRKİYE (SDU), Šiauliai State University of Applied Sciences-LITHUANIA (SVK), Hatay Mustafa Kemal University-TÜRKİYE (HMKU), and Burdur Mehmet Akif Ersoy University-TÜRKİYE (MAKU). Additionally, Tartu Health Care College was partner just between 28 February 2022 and 22 February 2023. The associated partners are Turkish Physiotherapy Association, Order of Physiotherapists in Romania, Lithuanian Physiotherapy Association and Estonian Association of Physiotherapists.

The principle goal of this guidebook is to present the information about the knowledge, attitude and skill status of the physiotherapists in partner countries in integrating electrical stimulation approaches to physiotherapy and rehabilitation programs. Through this guidebook and other project results such as presentations and video presentations, the aim is to improve awareness and knowledge about electrical stimulation, model the electrical stimulation training and to assist to optimize the physiotherapy and rehabilitation programs in Türkiye, Romania and Lithuania. We hope that, this will be a valuable step in the development and dissemination of life-long learning and vocation-

al/professional training for all physiotherapists worldwide, especially in these countries.

Electrical stimulation involves the application of electrical current for the generation of muscle contraction, sensation, and circulation, usually using adhesive or rubber electrodes placed on the skin. Over the past few years, there has been a growth in the application of exogenous electrical stimulation to modulate neuronal cell behavior for regenerative and therapeutic applications. Bioelectric communication between neurons and stimulation of cells for good function and wound healing has the great potential to aid recovery and regeneration, however significant challenges remain to realize the success of the treatment. Meanwhile, the mechanisms associated with its effects are not recognized and generally understood.

Electrical stimulation protocols to improve the performance of both healthy and dysfunctional skeletal muscle are widely accepted and routinely demonstrated in research studies as well as in clinical practice. It is first important to know that parameters of stimulation and placement of electrodes influence the neuromuscular response to electrical stimulation. Commercially available products often have a pre-programmed stimulation protocol tuned to the parameters of the electrical current. Meanwhile, these protocols are designed to offer a variety of treatment options that physiotherapists can easily decide on. However, these options may not always be appropriate and physiotherapists need to understand how each pa-

parameter may affect treatment. Stimulation parameters have serious effects.

The first thing you notice when you search for information on electrical stimulation is the wide variety of names [e.g. Electrical Muscle Stimulation (EMS), Electro-Motor Stimulation, Electrical Nerve Stimulation (ENS), Functional Electrical Stimulation (FES), Functional Electrical Therapy (FET), Transcutaneous Electrical Stimulation (TES), Transcutaneous Electrical Nerve Stimulation (TENS), and Neuromuscular Electrical Stimulation (NMES)], types, methods, and parameters (e.g. current, duration, ramp-up and down, frequency, pulse width, and intensity/amplitude). Arguably, the diversity of terminology confuses physiotherapists and makes them reluctant to conduct further research. However, approaches named above (and many others) all share the same basic background and rely on the same physiological processes to function effectively.

The electrical stimulation approaches in physiotherapy and rehabilitation studies are available with different methods and treatment techniques, different current models, and different patient populations, due to different levels of severity and factors. Decision must be made carefully in these multivariate situations. The specifics of current format and implementation process are often missing in published articles. It is not yet understood that there are many combinations of electrical stimulation current models and techniques for all applications. Physiotherapists need to know which techniques are more effective under which conditions. Because of all these, physiotherapists need to be confident in the manipulation of these parameters in order to use electrical stimulation effectively. Without comparable information, it is not possible for physiotherapists to fulfill their responsibility to provide the most effective treatment to their patients.

In this project, we have used the evidences in the literature to recommend specific parameters and techniques to optimize efficiency. The alteration in electrical stimulation protocol is the result of the manipulation of the available electrical stimulation parameters those the physiotherapist

can control. We hope that this guidebook, recommending treatment protocols that are most likely to produce improvements in patients, will be useful to physiotherapists and clinicians. Ultimately, we focused on promoting awareness and practice of effective and safe electrical stimulation among physiotherapists based on literature, knowledge, and clinical practice.

The aim of this project is to provide physiotherapists with an evidence-based clinical key that can guide clinical decision making and thus enable physiotherapists to use electrical stimulation effectively in physiotherapy and rehabilitation.

The specific objectives of this CK4Stim project are to

1. Increase awareness of various applications for electrical stimulation,
2. Demonstrate how electrical stimulation protocols can designed to meet different treatment goals (e.g., strengthening, endurance training, sensation, pain) and adjusted to the specific clinical situation (e.g. stage of recovery),
4. Provide comprehensive clinical key recommendations that will promote best practices in the use of electrical stimulation to ensure safety and effectiveness,
5. Recommend terminology that should be used to describe electrical stimulation parameters to facilitate communication among physiotherapists, equipment suppliers, and other members of the clinical and rehabilitation communities.

This guidebook, one of the outputs of project, describes the evidence-based clinical practice recommendations for optimal use of electrical stimulation through lifelong continuing learning in professional life. This guidebook is intended to provide information to all stakeholders, including physiotherapists who use electrical stimulation, those who may benefit from electrical stimulation, and those who have strategic and/or leadership roles, distribute, provide, teach, research and develop electrical stimulation approaches in physiotherapy and rehabilitation. The partners believe they have offered the optimal approaches after rigorous review of the literature and clinical experiences.





The guidebook of clinical key for electrical stimulation in physiotherapy and rehabilitation has been reviewed and approved by the project partners. It will encourage physiotherapists to apply electrical stimulation using their professional autonomy when engaging in patient-centered physiotherapy and rehabilitation programs. Responsibility for clinical key implementation of electrical stimulation approaches lies with physiotherapists.

Guidebook, prepared as a clinical key, is synthesized to provide guidance on optimal design and delivery of electrical stimulation approaches, including safe and effective treatment and ongoing support and monitoring, with appropriate training of physiotherapists using electrical stimulation. We believe that synthesis of published literature in this guidebook will help make clinical decisions in collaboration with the potential/actual user of electrical stimulation, taking full account of their views and preferences.

The stages of developing this guidebook included:

1. Rigorous consultation were held with partners using survey and qualitative methods to find out whether physiotherapists thought this guidebook was needed and what it should address.
2. Evidence was searched by reviewing literature on use of electrical stimulation in physiotherapy and rehabilitation.
3. A pilot course approach was conducted with physiotherapists working in different clinics, universities and countries to obtain opinions and suggestions about the draft online education materials. They reviewed and rated the guidebook and presentations on clinical key of electrical stimulation in physiotherapy and rehabilitation.

It is important to note that this guidebook is not a legally binding document. Please use this guidebook in conjunction with all professional standards and clinical guidelines relevant to your profession and workplace. Like with other interventions, electrical stimulation can be prescribed and administered by qualified physiotherapists

who are competent in its use and who consider electrical stimulation to be within their scope of physiotherapy and rehabilitation program. Although training is required at university, physiotherapists can gain qualifications by attending a postgraduate course or by undertaking on-the-job workplace learning. Proficiency checks through quizzes at the end of the chapters can help physiotherapists recognize gaps in their knowledge and skills need to be acquire before using electrical stimulation.

Cooperation partnerships in vocational education and training (VET) projects under the Erasmus+ program, helps to improve the quality, accuracy, and effectiveness of education and training in professional field. Our cooperation partnership facilitated the exchange of best practices between universities and physiotherapy associations, across Türkiye, Romania and Lithuania. This exchange has allowed us to learn from each other's experiences, methodologies, and approaches, thereby constantly improving the quality of education and training for lifelong professional learning. The CK4Stim project's open access education materials incorporate the latest research findings and best practices, aiming to ensure that physiotherapists may be well-prepared to meet the changing needs of patients and application of electrical stimulation. Besides, as a partner we gained valuable international experience, cultural awareness, and language skills, which have become important in a globalized healthcare landscape with the enhanced mobility opportunities, meetings, training workshops, seminars, and conferences. Meanwhile, our cooperation partnership has strengthened interdisciplinary learning and collaboration by bringing together us from different disciplines such as physiotherapists, doctors, engineers, and philologist.

CK4Stim Project aimed to serve lifelong learning for physiotherapist about electrical stimulation in physiotherapy and rehabilitation. Lifelong learning is especially crucial for physiotherapists due to the dynamic nature of healthcare and the evolving needs of patients. Because, lifelong learning ensures that physiotherapists stay updated on

the latest evidence-based practices to deliver the best possible physiotherapy and rehabilitation to their patients. This project's open access online education materials based on lifelong learning in specific areas of interest such as electrical stimulation. By continuously acquiring knowledge and skills in this area, physiotherapists can become experts and provide specialized care tailored to the needs of different patient populations. CK4Stim offers opportunities for continuing education, advanced certifications, and participation in professional development activities. Therefore, we believe that CK4Stim not only may enhance clinical skills but also may open up opportunities for leadership roles, teaching positions, and research opportunities within the electrical stimulation field. CK4Stim online education materials may guide physiotherapist in integrating electrical stimulation approaches into their practice, and assist with treatment planning, patient assessment, and decision-making at the point of physiotherapy and rehabilitation.

Open access education materials play a significant role in professional life. CK4Stim project's open access materials are free for all physiotherapist to improve their knowledge and skills about electrical stimulation in physiotherapy and rehabilitation by eliminating financial barriers to lifelong professional continuing education. Our open access educational resources enable physiotherapists to engage in continuous learning and professional development without the need for classroom training. Our materials include guidebook, presentations and video presentations. This flexibility will allow physiotherapists to choose the format that best suits their learning preferences and schedules, allowing them to learn and remember easily at their own pace and convenience without language barriers. Therefore, we believe that the CK4Stim project's open access materials may increase the access to information and knowledge, to enable physiotherapists to participate in continuing education and professional development about electrical stimulation approaches.

In conclusion, physiotherapists' awareness and knowledge regarding the electrical stimulation ap-

proaches used, their compliance with guidelines, their ability to diagnose disorders and operate electrotherapy and electrostimulation devices, their manners and ethical principles that guide them in work should be considered. These factors ultimately help achieve therapeutic goals. Frequency, pulse width/duration, duty cycle, intensity/amplitude, ramp time, pulse pattern, program duration, program frequency, and muscle group activated must be decided correctly. Lack of clear parameters makes comparisons between studies and the use of general protocols difficult. Additionally, a lack of established protocols may pose a risk to patients, as excessive electrical stimulation may reduce the potential benefit of electrical stimulation, aggravate nerve damage, or be harmful. At the same time, the possibility of tissue damage caused by the passage of electrical current should be carefully evaluated.

Before optimizing and improving the use of electrical stimulation in the clinic application, it is necessary to improve our knowledge of the physiological properties, effects and parameters (methodology) of electrical stimulation. We hope that physiotherapists in the countries of project partners will be willing to contribute to the topic of electrical stimulation issue, where standardization has not been achieved and is still unclear, and will accept this guidebook as a model for sharing and delivering knowledge and experiences with best practices in electrical stimulation in physiotherapy and rehabilitation science.

Printed materials as well as webpages, social media pages and dissemination activities are very important for the sustainability of any project. This guidebook is an example. We also organized conference and meetings, participated congresses, conferences and seminars. You may find open access education materials in our website "<https://ck4stim.eu/>".

I had the pleasure of working with our partners as well as physiotherapists associations and orders from Türkiye, Romania and Lithuania.

I would especially like to thank to our partner universities members Prof. Dr. Ahmet KUTLUHAN, Prof. Dr. Fatih CETISLI, Assoc.Prof. Dr. Arzum ISI-



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TAN and Assoc.Prof. Furkan BILEK from PAU/TÜRKİYE; Prof. Ligia RUSU, Assist.Prof. Dr. Eva ILIE and Assist.Prof. Dr. Mihai RUSU from UCV/ROMANIA; Assoc.Prof. Dr. Esra DOGRU-HUZMELI and Assoc.Prof. Dr. Yasemin KARAASLAN from Hatay MKU/TÜRKİYE; Assoc.Prof. Dr. Mehmet DURAY from SDU/TÜRKİYE; Prof. Dr. Zeliha Ozlem YURUK from BU/TÜRKİYE; Assoc.Prof. Dr. Vaida ALEKNAVIČIŪTĖ-ABLONSKĖ and PT.MSc. Dovydas GEDRIMAS from SVK/LITHUANI; PT.MSc. Fatma Nur ALCIN and PT.MSc. Betül SOYLEMEZ from Burdur MAKU/TÜRKİYE for their admirable efforts and diligence, their friendship and hospitality, and sharing their valuable time, experience and knowledge. On their behalf, I would like to express my gratitude to their team for their academic and social activities such as transnational meetings and on-line meetings, but also sensitivity in fulfilling. Because the requirements of this project required completion of all project activities, outputs and this transnational guidebook in a timely manner.

I am also very grateful to the members and leaders of our associated partners. Prof. Dr. Tülin DÜĞER (head of Turkish Physiotherapy Association), Assist.Prof. Alin BURILEANU, (Order of Physiotherapists in Romania), Prof. Dr. Inesa RIMDEIKIENĖ (Lithuanian Physiotherapy Association) supported us from the beginning in disseminating our goals and outputs of our project to our national physiotherapists. Since they are our associated partners, they are willing to support us in realizing our project and reaching physiotherapists. Our colleagues and physiotherapists in

our country encouraged us, shared their opinions with us to identify the gaps in the use of electrical stimulation applications, and encouraged us with the pilot course of our online education materials. That's why I am grateful to them. I grateful to Prof. Dr. Nuray KIRDI, not only for her support during the project, but also for her constant guidance and pure motivation in the use of electrical stimulation application.

I would also like to express my gratitude to the Turkish National Agency for guiding and helping us to reach the project to this point. We were able to realize this successful project with full the support and grant provided to fulfill the requirements of this project according to its framework.

This project titled with "Clinical Key for Electrical Stimulation in Physiotherapy and Rehabilitation (CK4Stim)" carried out by project partners from Türkiye, Romania and Lithuania and aimed to create open access education materials for life-long professional learning about electrical stimulation approaches. It is not only about education, but also about the use electrical stimulation in their professional life, by offering a clinical key for physiotherapists in Türkiye, Romania and Lithuania. We hope, this will be the first step in improving electrical stimulation use in these countries. It is hoped that physiotherapists in other countries will be willing to contribute to this unfortunately neglected approach and accept this clinical key guidebook as a model for sharing and delivering the knowledge and experiences in best practices of electrical stimulation approaches in physiotherapy and rehabilitation.



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# Preface



## PROJECT PARTNERS

### Fatih CETISLI, C.Eng.PhD.Prof.

Nowadays, the possibility to access, to improve, and to develop knowledge is increasing day by day. Within the scope of this project, which was initiated with this basic idea, the existing information on electrical stimulation in physiotherapy was compiled. Through the conducted study and with regarding the improvement suggestions a clinical key was prepared. As an engineer, it is a source of pleasure to have taken part in the preparation of an online open access guidebook within the scope of this project. The most prominent feature of this project, which has yielded its main fruit with a comprehensive, compiled, and developed guidebook for physiotherapists who are using electrical stimulation, is that it allows interdisciplinary interaction and is international in nature. I am hoping that the CK4Stim project, in which the project outputs are published in three different languages and is enriched with studies that are conducted in three different countries, will guide physiotherapists within the scope of the philosophy of lifelong learning.

### Arzum ISITAN, M.Eng.PhD.Assoc.Prof.

Vocational education and training is undergoing a transformation with Industry 4.0 and Education 4.0. CK4STIM project combines distance education and vocational training tools with accessible and sustainable education and training. For this purpose, I am very pleased and honored to take part in this project prepared for vocational education and development in the field of Physical Therapy and Rehabilitation.

### Furkan BILEK, PT.PhD.Assoc.Prof.

Electrical stimulation modalities have become an important tool, especially in supporting the physical recovery process and accelerating the rehabilitation process. This guidebook aims to provide a comprehensive resource for anyone interested in understanding the critical role of electrical stimulation in physiotherapy and rehabilitation practice and to establish a common language in this field. Covering a wide range of topics from the basic principles of electrical stimulation to clinical applications, this guidebook contains useful information for both beginners and experienced professionals. I hope that while reading this guidebook, you will gain a deeper understanding of the potential of electrical stimulation and be able to apply new ideas to enrich your treatment strategies. Best regards.



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## **Ligia RUSU, M.D.Prof.**

The project Clinical Key for Electrical Stimulation in Physiotherapy and Rehabilitation / CK4Stim, creates a space for debate an interesting subject regarding how is the way for prescription and apply the electrical stimulation.

From my point of view this project designs the best approach of electrical stimulation application and helps the physiotherapist in their practice. On the other hand, this project creates for me an opportunity for communication, for met new and friendly people and hope that open a new way for cooperation.

## **Eva ILIE, PT.PhD.Assist.Prof.**

As a dedicated physiotherapist and academic in the field of physical therapy and sports medicine, with high interest in learning, growth, and sharing knowledge, I wholeheartedly embraced the opportunity to join the CK4Stim project. This initiative, with its clear objective and pressing need, sought to standardize the diverse and widely used electrical stimulation (ES) techniques in physiotherapy and rehabilitation.

Our journey was both intense and rewarding. It provided me the privilege to collaborate with esteemed professionals whom I admire and respect, as well as my committed colleagues and advisor. I extend my deepest gratitude to them for their passion, hard work, and courage.

Through our collective efforts, we successfully compiled and adapted existing training content for ES approaches to meet the specific rehabilitation requirements within the European context. This project has significantly advanced the professional skills of physiotherapists by offering continuing vocational education and digital training. It has also arise awareness and understanding of ES protocols, thereby enhancing the quality of services provided to patients.

Moreover, we created a scientifically-grounded guideline accessible to all stakeholders, using every available tool to elevate our work in this field. I am immensely proud of our achievements and grateful for the CK4Stim family and project coordinators' patience and exceptional guidance.

Our hard work has paid off, and I am optimistic about continuing this impactful work in the near future.

## **Mihai RUSU, Phil.PhD.Assist.Prof.**

This project is the first experience in field of ERASMUS project and gives me the opportunity to improve my specific English terminology in field of physical therapy. In the same time, I want to mention that met a lot of new people, visit the universities and develop the new relationship. My contribution to translate the guidebook will open the new way of knowledges for the physiotherapists in Romania.

## **Esra DOGRU-HUZMELI, PT.PhD.Assoc.Prof.**

Reflecting on the journey that began with the acceptance of CK4Stim, I am filled with immense joy and pride. The inception of this project marked the beginning of a new era for us, one filled with frequent gatherings with our esteemed colleagues and opportunities for scientific retreats. As the years have swiftly passed, we now find ourselves at the culmination of this remarkable project.

Through CK4Stim, I have gained invaluable knowledge and experiences that I am eager to share through our project's findings. Acknowledging the scarcity of scientific resources on electrical stimulation, I believe our research has significantly contributed to bridging this crucial gap in the field.

I extend my deepest gratitude to Prof. Dr. Nilufer CETISLI-KORKMAZ for her unwavering support and leadership. My heartfelt thanks also go to all the partners and researchers whose dedication and hard work have been instrumental in the success of this project. It has been both an enjoyable and educational journey, enriched by the contributions of every individual involved, no matter how big or small.

Thank you to everyone who played a part in this endeavor. Your efforts have made this project an enriching experience, and I am confident that the results will provide valuable insights and advancements in the study of electrical stimulation.

### **Yasemin KARAASLAN, PT.PhD.Assoc.Prof.**

It is a great honor for me to take part in this project that provides rich content to the literature on the use of electrical stimulation. I would like to thank all our instructors, especially our coordinator Prof. Dr. Nilufer CETISLI-KORKMAZ, who brought us together in this very devoted and labor-filled project. I hope this guidebook will be a guiding resource for all physiotherapists. In addition, this project was one of the things that helped me re-adapt to science when I was going through one of the hardest times of my life during the February 6 earthquake.

### **Mehmet DURAY, PT.PhD.Assoc.Prof.**

While I am happy to take part in the CK4Stim project, I am also happy to be a part of the team that brought this guidebook to the national and international arena. Our guidebook is an outcome of our project, and the surveys and evaluations we made before we started writing our guidebook showed how many deficiencies we have in the field of electrotherapy as a physiotherapy community and how low our awareness in this field is. In order to both identify deficiencies and eliminate target deficiencies, we, as the project team, have not only worked hard since the first day, but also updated ourselves with the latest information, and we present this information to you in this guidebook. I wish you a pleasant reading with the joy of sharing this most up-to-date work on electrical stimulation applications with valuable readers.

### **Zeliha Ozlem YURUK, PT.PhD.Prof.**

Treatments using electricity constitute one of the first applications of physiotherapy. Electrical stimulation became one of the methods systematically used in physiotherapy and rehabilitation after the Second World War. Electrical stimulation is used primarily in neurology, orthopedics, and geriatrics physiotherapy and is applied with many different methods with the development of technology in recent days.

This guidebook is a valuable output of the CK4Stim project, which started in 2022. In this guidebook, we have covered many issues that are still not explained clearly in electrical stimulation applications. By researching both national and international literature, we shared the latest updated information and created a guide in the areas where electrical stimulation is used.

We hope it will be beneficial for all our colleagues.

### **Vaida ALEKNAVIČIŪTĖ-ABLONSKĖ, PT.PhD.Assoc.Prof. and Dovydas GEDRIMAS, PT.MSc.**

We are incredibly proud of the hard work and dedication that went into creating this project. The project goal was to develop a comprehensive guidebook, slides, and video materials that showcase the innovative application of electrotherapy in physiotherapy and rehabilitation. These meticulously crafted resources provide detailed insights into essential electrical current parameters such as frequency, amplitude, etc. They offer expert guidance on their effective use across pediatric, orthopaedic-traumatological, neurological, and sports physiotherapy. Developed through dedicated collaboration among all project partners, this high-quality educational material is exceptionally well-organized, covering critical aspects of physiotherapy treatment.



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We are confident that this resource will greatly benefit practitioners by saving them valuable time and eliminating the need to search for information across multiple sources. Throughout the project, partners from Türkiye, Lithuania, and Romania worked seamlessly together, fostering professional relationships and warm and respectful bonds that we cherish. Achieving our ambitious project goals required unwavering commitment to deadlines and meticulous planning during TPM meetings. These sessions were not only productive with in-depth discussions and evaluations of our hard-earned results, but also moments of camaraderie filled with laughter, light-hearted jokes, and the formation of lasting international friendships.

We take immense pride in the collaborative spirit and mutual respect that defined this project, ensuring it was a truly enriching and successful experience for everyone involved.

### **Fatma Nur ALCIN, PT.MSc.**

The application principles of electrical stimulation therapy, which has gained a great place in the field of physiotherapy and rehabilitation for many years and can be used in many different patient groups, still contains some question marks for physiotherapists. This guidebook, which is one of the important results of our CK4Stim Project, has been written meticulously with the aim of eliminating question marks regarding electrical stimulation. I hope that our guidebook will contribute to all our colleagues and students who have or will include electrical stimulation in their clinical work. Being part of this project, where every moment is filled with hard work, will always be a source of pride for me. Sincerely.

### **Betul SOYLEMEZ, PT.MSc.**

Electrical stimulation is a technique that has been used in physiotherapy and rehabilitation for many years. However, due to the wide range of techniques and parameters, standardization has not been established in practices. After 2.5 years of intense work, this guidebook is one of the most important outcomes of our project CK4Stim and it contains detailed information for physiotherapists about which electrical stimulation method to apply in which situations and how. Hoping to help our patients and colleagues...

### **Kirkke REISBERG, PT.MSc.**

(as partner between 28/02/2022 and 22/02/2023)



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## Preface



### PROJECT ASSOCIATED PARTNERS

#### Turkish Physiotherapy Association

#### Tülin DÜGER, PT.PhD.Prof.

#### President of Turkish Physiotherapy Association

Physiotherapists; are autonomous health professionals who evaluate individuals, reveal their physiotherapy and rehabilitation needs in the light of their evaluation, plan and treat the treatment, evaluate the effects of the treatment, and are responsible for their own actions.

The physiotherapist profession is a science-based profession; it adopts a “holistic” approach to health and well-being, which includes the patient’s general lifestyle. Being a physiotherapist requires professionalism.

Physiotherapists’ contributions to rehabilitation practices in our country, as well as all over the world, are made with evidence-based approaches. For this reason, it is extremely valuable to introduce approaches that will contribute to the development of physiotherapy and rehabilitation science in our country, with evidence-based practices.

Due to the diversity of electrotherapy methods, which is one of the physiotherapy and rehabilitation approaches, and the emergence of new applications with technology, there is a great need to reveal the evidence levels and to shed light on the clinic. The project titled “Clinical Key for Electrical Stimulation in Physiotherapy and Rehabilitation”, which is a guide for physiotherapists and physiotherapy students about the place and therapeutic effects of electrical stimulation applications in physiotherapy and rehabilitation practices has been completed under leadership of Dear Nilufer CETISLI-KORKMAZ, PT.PhD.Prof., one of the most valuable faculty members of our profession, in partnership with Turkey, Romania and Lithuania, and supported within the scope of the European Union-Erasmus + KA220-VET Cooperation Partnerships in Vocational Education and Training. As our professional organization, the Turkish Physiotherapists Association, it is extremely valuable that the results of the project, in which we are honored to take part, shed light on all our colleagues and encourage them to new projects.

I would like to express my endless gratitude to Prof. Dr. Nilufer CETISLI-KORKMAZ, who led the project that required a long and great effort, brought together national and international partners in many meetings and ensured that the best results were achieved, project researchers and project partners.





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### Order of Physiotherapists in Romania

#### **Alin BURILEANU, PT.PhD.Assist.Prof.**

President of Order of Physiotherapists Dolj.

Congratulations to the entire team for making such a significant step in developing an improved curriculum for a well-known yet underutilized therapy. This initiative will greatly benefit many clinicians and, more importantly, enhance the quality of care for patients by ensuring better-prepared physiotherapists. It was a privilege to collaborate with such a professional and dedicated team. Your hard work and commitment have set a new standard in our field, and it was an honor to witness this great achievement.

### Lithuanian Physiotherapy Association

#### **Inesa RIMDEIKIENĖ, PT.PhD.Prof.**

President of Lithuanian Physiotherapy Association

The Clinical Key for Electrical Stimulation in Physiotherapy and Rehabilitation (CK4Stim) project was implemented according to the guidelines of the ERASMUS+ Program's Partnerships for Cooperation in Vocational Education (KA220).

The main goal of the CK4Stim project was to standardize the various and widely used electrical stimulation (ES) methods in physiotherapy and rehabilitation. The project partners, coordinated by Pamukkale University, from Türkiye, Lithuania, and Romania, analyzed, systematized, and presented ES protocols based on evidence-based practice, ensuring the highest rehabilitation treatment standards for various conditions. During the project, digital material was developed for practicing physiotherapists, expanding their knowledge and skills, and promoting lifelong learning principles.

We, the Lithuanian Physiotherapy Association, are pleased with the excellent work of all the project partners in creating methodological material that will enrich and further optimize the work of physiotherapists in Lithuania and throughout the European Union.







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## Partners of CK4Stim Project









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CK4Stim

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Turkish Physiotherapy Association	Order of Physiotherapists in Romania	Lithuanian Physiotherapy Association	Estonian Association of Physiotherapists





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## Project Partners and Resumes



### Pamukkale University

#### Ahmet KUTLUHAN, M.D.Prof.

##### Rector

Prof. KUTLUHAN has been rector of Pamukkale University since 2020. He is a medical doctor, academician, senior lecturer and researcher at Pamukkale University, Faculty of Medicine. He had his BSc and MSc from Ege University, PhD from Erciyes University (otolaryngology-head and neck surgery) and oral and maxillofacial surgery specialty in medicine from the Ministry of Health. He has been a professor since 2008. Prof. KUTLUHAN has several national and international projects, articles, abstracts, and book chapters in the otolaryngology-head and neck surgery sciences. He worked in Kafkas University Faculty of Medicine ENT Department and Hospital, Ankara Atatürk Hospital ENT Clinic and Hospital, Van Yüzüncü Yıl Medical Faculty, Hospital and ENT Clinic, Hakkari State Hospital ENT Department. Besides his academic experience, he held administrative positions such as Ankara Yıldırım Beyazıt University Vice Rector, Interuniversity Board Member (Ankara Yıldırım Beyazıt University Representative), Ankara Yıldırım Beyazıt University Faculty of Health Sciences Dean (by proxy), Ankara Atatürk Hospital Deputy Chief Physician, Ankara Atatürk Hospital Clinic Chief, Hakkari State Hospital Deputy Chief Physician, and Salur Health Center Presidency.

His professional affiliations include Turkish Otorhinolaryngology and Head and Neck Surgery Association, Ankara ENT and Head and Neck Surgery Association, Kayseri Ear Nose and Throat Association, Otolaryngologic Allergy Association, Turkish Rhinology Association, BIDDER, and among others.



**Nilufer CETISLI-KORKMAZ, PT.PhD.Prof.****Project Coordinator**

She is a physiotherapist, academician, senior lecturer and researcher at Pamukkale University, Faculty of Physiotherapy and Rehabilitation. She had her BSc, MSc and PhD degrees from Hacettepe University. Her PhD thesis was titled as “Effect of high voltage pulsed galvanic stimulation on strengthening and fatigue in patients with Multiple Sclerosis”. She has been a professor since 2021. Her research and teaching interests include electrotherapy, neurorehabilitation, geriatric rehabilitation, community-based and home-based physiotherapy and rehabilitation, evidence-based clinical decision making, and development of digital educational training materials in physiotherapy and rehabilitation. Prof. CETISLI-KORKMAZ has several national and international projects, articles, abstracts, and book chapters in the physiotherapy and rehabilitation sciences. She worked in Hacettepe University, Harvard University-MGH Institute of Health Professions (as observer), Hatay Mustafa Kemal University and Pamukkale University. In addition to her academic experience, she has been rolling as Deputy Dean of Faculty of Physiotherapy and Rehabilitation at PAU since 2020.

Prof. CETISLI-KORKMAZ has international research collaborations through Erasmus mobility and COST programs. Her professional affiliations include Turkish Physiotherapists Association, Turkish Geriatric Physiotherapists Association, Turkish Neurology Association, Turkish Elderly Issues Research Association, Türkiye Multiple Sclerosis Association, and some others.

**Fatih CETISLI, C.Eng.PhD.Prof.**

Fatih CETISLI has been a faculty member of Engineering Faculty at PAU since 2012. He earned his MSc and PhD degrees from Lehigh University (Bethlehem, PA, USA). He has been taking role as Erasmus Department Coordinator (at both Firat and Pamukkale University) since 2008. Besides his academic experience, he took role in organization of Firat University while adapting to Bologna Process, took role as chair and associate chair of Civil Engineering dept at Pamukkale University, took role as Associate Dean of Faculty of Engineering. Within in administrative duties he was responsible to prepare questionnaires to collect data, analyze the obtained data, and prepare the reports for quality assurance. Fatih CETISLI is professionalized in earthquake engineering and steel structures.





### **Arzum ISITAN, M.Eng.PhD.Assoc.Prof.**

Assoc. Prof. Dr. Arzum ISITAN graduated from Yıldız Technical University, Faculty of Mechanical Engineering. She completed her master's and doctoral studies at Pamukkale University, Institute of Natural and Applied Sciences, Department of Mechanical Engineering. Since 2002, she has been working at Pamukkale University and is currently a faculty member at the Department of Mechanical Engineering, Faculty of Technology.

Her research interests include machine elements, machine design, nanotechnology, biomaterials, nanotechnology, nanotechnology, biomaterials, digital education, and development of digital educational training materials. ISITAN is involved in 7 European Union projects and is the project coordinator in 4 of them. ISITAN has 3 patent applications and 2 patents have been awarded in international patent competitions. Since 2019, she has competed as a finalist with at least two teams every year in Teknofest competitions and received various awards.

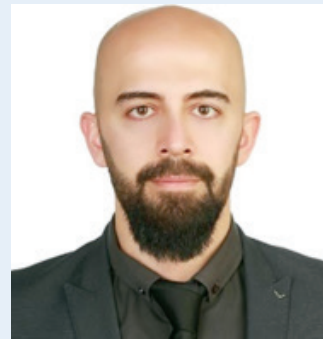
Between 2024-2025, ISITAN is conducting her post-doctoral study at the Bruno Kessler Foundation in Italy on bioplastic production from textile waste and investigating its usability as a machine material. ISITAN is the mother of 2 children.



### **Furkan BILEK, PT.PhD.Assoc.Prof.**

Muğla Sıtkı Koçman University

He is an academician at Muğla Sıtkı Koçman University Fethiye Faculty of Health Sciences, Department of Gerontology. He received his bachelor's degree from Pamukkale University in 2013. Then he received his master's degree from Muğla Sıtkı Koçman University in 2017. In his master's thesis, he investigated the acute effects of transcutaneous electrical nerve stimulation and high voltage pulsed stimulation on subacromial pain and shoulder movements. He received his PhD degree from Pamukkale University in 2021. During his master's and doctoral education, he had electrotherapy, neurological and geriatric rehabilitation courses. BILEK has been working at Muğla Sıtkı Koçman University since 2021. He received his associate professor degree in 2023 and has been continuing his research at Faculty of Medicine, Memorial University of Newfoundland for postdoctoral research since 2024. BILEK has national and international articles, papers, projects and book chapters in physiotherapy and rehabilitation discipline.



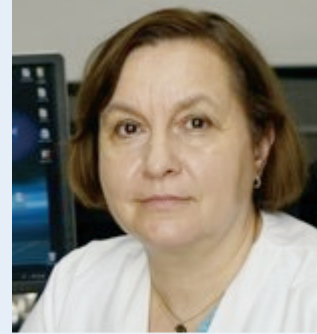
## University of Craiova

### Ligia RUSU, M.D.Prof.

She is a Professor at University of Craiova, in the Sport Medicine and Physical Therapy Department. She is a sport medicine physician and sport trauma rehabilitation.

Prof. RUSU is also a sport medicine physician at the Sport Medicine Department Emergency Hospital Craiova, Romania. Now she is head of Sport Medicine and Physical Therapy Department.

Prof. Ligia RUSU is involved in research in the field of physical activity prescription, sport trauma rehabilitation, musculoskeletal ultrasound, biomechanics, and sport medicine. She is also a PhD students coordinator. Further, Prof. Ligia RUSU is active within the research activities in the research laboratory of the research institute [www.incesa.ro](http://www.incesa.ro). and published a lot of papers.



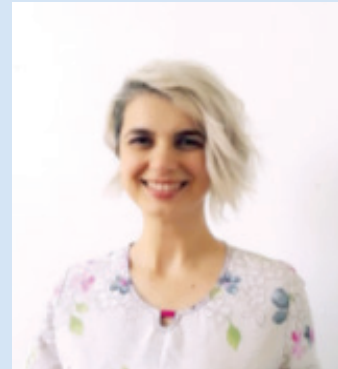
### Eva ILIE, PT.PhD.Assist.Prof.

She is an Assistant Professor at the Faculty of Physical Education and Sports, Sport Medicine and Physical Therapy Department of the University of Craiova, Romania. She studied physiotherapy and graduated both her bachelor's and master's at the same faculty, and received her PhD degree from the National University of Physical Education and Sports in Bucharest, Romania.

In her 14 years as a physiotherapist, she developed skills and expertise in the field of manual therapy, pain management, neurological recovery, but her main focus being on pediatric rehabilitation, pre and post-partum recovery, postural re-education, musculoskeletal disorders and the use of taping techniques.

Eva ILIE has also been interested in research and took part in several projects, in the field of physiotherapy, over the years, her main topic being the use of therapeutic techniques in postural rehabilitation.

In her role as an Assistant Professor over the last 10 years, she teaches bachelor's practical courses in the field of neurological rehabilitation, orthosis and prosthesis.





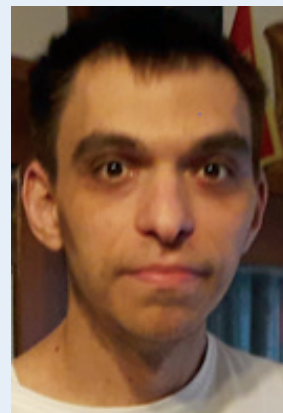


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### **Mihai RUSU, Phil.PhD.Assist.Prof.**

He is Assist. Professor at Faculty of Physical Therapy, University of Craiova. His main research interests lie in translation studies, medical translation, pragmatics and intercultural communication. His PhD thesis subject is focused on medical terminology and medical translation. He is member of the Romanian Society for English and American Studies (RSEAS). He has contribution to translate the courses and guidebook, development the medical specific terminology in field of physical therapy.



### **Hatay Mustafa Kemal University**

### **Esra DOGRU-HUZMELI, PT.PhD.Assoc.Prof.**

Dr. Esra DOGRU-HUZMELI, currently a Visiting Researcher at Queen's University, Kingston, On, Canada has a distinguished academic and professional background in the fields of physiotherapy. Dr. DOGRU-HUZMELI, holds a Ph.D. in Physical Therapy and Rehabilitation from Hacettepe University, with research on sensory training's impact on trunk control and upper extremity functions in stroke patients. She has served as an Associate Professor at Hatay Mustafa Kemal University since 2018, and has held various academic positions, including Assistant Professor and Lecturer.

Dr. DOGRU-HUZMELI's research interests include neurorehabilitation, the effects of exercise on neurological conditions, and the integration of new technologies in physiotherapy. She has been actively involved in numerous research projects and has received multiple grants for her work. Her career also includes extensive experience in supervising Master's theses and contributing to international research collaborations through Erasmus mobility and COST programs. Her professional affiliations include membership in the Turkish Physiotherapists Association and the Turkish Neurology Association, among others, underscoring her commitment to advancing the field of physiotherapy through both research and education.



**Yasemin KARAASLAN, PT.PhD.Assoc.Prof.**

She is a physiotherapist and academician at Hatay Mustafa Kemal University Faculty of Health Sciences Department of Physiotherapy and Rehabilitation. She has received a bachelor's degree from İstanbul University in 2013. She has taken her MSc degree from Gaziantep in 2015. In her MSc thesis, she evaluated upper extremity range of motion and respiratory functions in patients who had undergone thoracotomy. After that, she has taken Ph.D. degree from Ankara Yildirim Beyazit University in 2019. In her Ph.D. thesis, she investigated the effects of pelvic floor muscle training combined with connective tissue massage in women with overactive bladder. She worked at Beykent University for a long time. In 2024, she has taken the title of associate professor in physiotherapy and rehabilitation. She teaches many courses in the field of physiotherapy and rehabilitation at the university. Her areas of experience are pelvic health, physiotherapy and rehabilitation in women's health. She has also published manuscripts on electrotherapy in reputable journals.

**Süleyman Demirel University****Mehmet DURAY, PT.PhD.Assoc.Prof.**

Mehmet DURAY was born in Isparta in 1987. After completing his primary and secondary education in Adana and Konya, he graduated from Hacettepe University School of Physical Therapy and Rehabilitation in 2010. The researcher, who completed his master's degree at Dokuz Eylül University School of Physical Therapy and Rehabilitation in 2013, completed his doctorate at Pamukkale University in 2019 and received the title of doctor of science. The researcher started working as a Doctor Lecturer at Süleyman Demirel University in 2020 and received the title of Associate Professor in 2024. He has one child.





## Başkent University

### Zeliha Ozlem YURUK, PT.PhD.Prof.

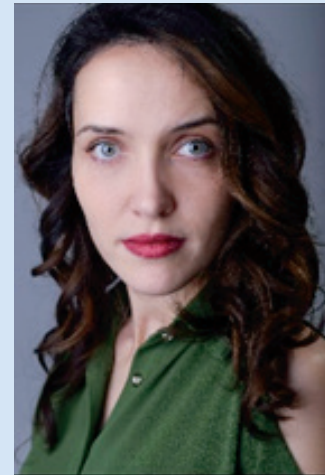
She is a physiotherapist and academician at Baskent University Faculty of Health Sciences Department of Physiotherapy and Rehabilitation. She has taken a bachelor's degree from Baskent University in 2004. After that, she has taken MSc degree from Baskent University in 2007. She applied electrotherapy and exercise to fibromyalgia patients in her MSc thesis. She has a Ph.D. degree from Hacettepe University in 2013. Prof. YURUK investigated the effectiveness of Extracorporeal shock wave therapy in her Ph.D. thesis. She studied electrotherapy, neurological, and geriatric rehabilitation courses during her MSc and Ph.D. education. Prof. YURUK has been working at Baskent Hospital and Baskent University since 2004. She had an associate professor degree in 2016 and she has been a professor since 2021. She has been giving electrotherapy, neurophysiological approaches, and neurological and geriatric rehabilitation courses at the university. Prof. YURUK has national and international articles, abstracts, and book chapters in the physiotherapy and rehabilitation discipline.



## Šiauliai State University of Applied Sciences

### Vaida ALEKNAVIČIŪTĖ-ABLONSKĖ, PT.PhD. Assoc.Prof.

She has PhD degree from Lithuania Sport University in 2017. She is a physiotherapist, academician, and researcher at Šiauliai University of Applied Sciences, Faculty of Health Sciences. She had her BSc, MSc, and PhD degrees from Lithuania Sport University. Her PhD thesis was titled "Longitudinal research of calf muscles functional changes after Achilles tendon rupture". She has been an Associate Professor since 2023. Her experience area neuromechanical and biomechanical characteristics and changes in muscles of individuals with orthopedic trauma. Also, scoliosis treatment using the Schroth method. Assoc. Prof. Vaida ALEKNAVIČIŪTĖ-ABLONSKĖ has national and international articles in the physiotherapy and rehabilitation sciences. She worked as a member of the National Health Council.



### Dovydas GEDRIMAS, PT.MSc.

He is a lecturer in Šiauliai State University of Applied Sciences Faculty of Health Care in Department of Rehabilitation and massage therapy instructor in Šiauliai Technology Training Center. He has taken a bachelor's degree in 2013 at Šiauliai State University of Applied Sciences. After that he received a master's degree in 2017 at the Lithuanian Sports University. In his practical and academical work he is interested in orthopaedical and sports rehabilitation, massage and manual therapy.



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Fatma Nur ALCIN was born in Ankara/Türkiye in 1996. She completed her BSc degree in 2018 at Kütahya Dumlupınar University and her MSc degree in 2020 at Hasan Kalyoncu University. She is currently continuing her doctoral education at Pamukkale University. After her BSc graduation, she worked as a clinical physiotherapist at Anamur/Mersin Private Anamed Hospital for 1 year. She has been working as a lecturer at Burdur Mehmet Akif Ersoy University, Gölhisar Vocational School of Health Services since 2021. She is interested in neurorehabilitation, geriatric rehabilitation, electrotherapy and occupational therapy subjects.



### Betul SOYLEMEZ, PT.MSc.

She was born in Denizli / Türkiye in 1996. She completed her BSc in 2019 and her MSc degree in 2021 at Pamukkale University. She is currently continuing her PhD education at the same university. She has been working as a lecturer at Burdur Mehmet Akif Ersoy University, Burdur Vocational School of Health Services since 2021. She is interested in neurological rehabilitation, geriatric rehabilitation, electrical stimulation, orthotics and prosthesis subjects.



### Tartu Health Care College

*(as partner between 28/02/2022 and 22/02/2023)*

### Kirkke REISBERG, PT.MSc.



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