Physical Activity, Exercise and Health Research Network: From Mechanisms to Practice

Collaborative network at the University of Jyväskylä (for updates, please, contact urho.m.kujala@jyu.fi).

The general aim of the Research Network is to present an evidence-based view of the beneficial and adverse effects of physical activity, exercise training and rehabilitation on health and function. We study both the role of physical activity in the prevention of diseases and the role of different exercise interventions in the treatment or rehabilitation of diseases and maintaining well-being and functioning. This includes in-depth investigations into the mechanisms that mediate the effects of exercise. The current physical inactivity and obesity epidemic, with the related increase in the risk of chronic diseases and disability, demonstrates the importance of this research. Loss of muscle mass and function by age, diseases and injuries is a field that has unmet need for research and practical applications. It is our vision that, by increasing physical activity and correcting eating habits, we are able to promote good health and physical function, which leads to a better quality of life and monetary savings in health care.

We use multiple research approaches to address the key issues in the focus area:

**Observational epidemiological research** focuses on different individual-based cohorts, and on twin and family studies, controlling for genetic background when investigating the associations between physical activity, physical fitness and health in the population.

**Intervention studies** concentrate on the effects of exercise on muscles and, furthermore, on the development of cardio-metabolic problems and cognitive decline and on the effects of exercise on bones, cartilage and brain.

Both human and experimental research also focuses on genetic and molecular mechanisms deepening our knowledge on the mechanisms through which exercise has its effects.

The network also carry out systematic reviews and meta-analyses as well as participate in developing and up-dating Finnish Current Care Guidelines which are evidence-based clinical practice guidelines. These national guidelines cover important issues related to Finnish health, medical treatment as well as prevention of diseases. The guidelines are intended as a basis for treatment decisions, and can be used by physicians, healthcare professionals and citizens.

The research network has regular scientific seminars including international invited speakers.

**Highlights of research projects of different collaborating team leaders**

**Professor of kinesiology Taija Finni** ([https://staff.jyu.fi/Members/finni](https://staff.jyu.fi/Members/finni)):
Prof. Finni’s research ranges from basic neuromuscular function to translational research related to physical activity and sedentary behavior. Regarding physical activity field we study the electromyographic activity patterns in antigravity muscles of adults and children that have the potential to short-circuits detrimental physiological processes of sedentary time resulting
in better cardio-metabolic risk profile. We gain accurate individual-level knowledge of the sedentary behaviour that is needed for designing effective interventions. Another research line focusing on muscle-tendon neuromechanics has provided fundamental information on tendon properties and muscle-tendon function for exercise training, rehabilitation and insight into age-related changes in mobility and neuromuscular performance.

**Professor Ari Heinonen** ([https://www.jyu.fi/sport/laitokset/terveys/en/staff/heinonen-ari](https://www.jyu.fi/sport/laitokset/terveys/en/staff/heinonen-ari)): Intervention studies test the effects of exercise training (plus nutrition), using randomized controlled designs in the treatment/rehabilitation of diseases and prevention of disability. Currently, we have studied, for example, the differently loaded exercise effects on bone and cartilage by looking at the effects of bone beneficial exercise loading and intensive aquatic training effects on knee cartilage. For measures, the bone and cartilage outcomes were used modern technologies such quantitative MRI for cartilage structure and biochemical composition. Postmenopausal women who may be at risk of osteoporosis (bone loss), as well as at risk of osteoarthritis, can carry out progressive high-impact training to maintain bone health and physical function.

**Juha Hulmi; PhD,** Academy of Finland Research Fellow ([https://staff.jyu.fi/Members/jjhulmi/main](https://staff.jyu.fi/Members/jjhulmi/main)), has a systems biology interest using different human and experimental studies and designs to understand physiology as a big picture, not just a single molecule approach. Main line of research is in muscle biology especially relating to muscle hypertrophy, atrophy and energy metabolism and their regulation in health and disease. Currently the main focus of the research is the extent and mechanisms how adequate muscle mass and physical fitness/activity can prolong survival from a catastrophe situation (muscle wasting) in cancer and in hip fracture. As another main project the investigation of effects of weight reduction using high level of exercise in combination with low energy intake on physiology and systems biology is ongoing. This study combines the skills from the experts of exercise and nutrition physiology, genetics, systems biology and sports psychology together. These achieved skills and tools from a various types of physiology research are expected to be used in the future to investigate e.g. a concept of personalized exercise in health and disease.

**Arja Häkkinen,** Professor in Clinical Physiotherapy ([https://www.jyu.fi/sport/laitokset/terveys/en/staff/arja-hakkinen](https://www.jyu.fi/sport/laitokset/terveys/en/staff/arja-hakkinen)): Her main research interest has been in understanding the functional and pathophysiological changes associated with musculoskeletal conditions especially in rheumatoid arthritis, osteoarthritis and back and neck disorders. In addition, she has investigated the effectiveness and health utility of various exercise interventions such as strength training aimed at both prevention and treatment. The methods used in rehabilitation need to follow and adapt to the fast development of medicine. Thus, generating the rehabilitation program for these patients has been carried out in multidisciplinary teams together with other specialties of medicine by combining research methods of physiotherapy, medicine, exercise physiology, biomechanics, science of sport coaching and fitness testing, nutrition and psychology ([http://www.ksshp.fi/ffi/Fi/Ammattilaiselle/TULEStutkimus](http://www.ksshp.fi/ffi/Fi/Ammattilaiselle/TULEStutkimus)). It has been very important that the results of the scientific research projects are implemented into serving and improving the clinical practice. Currently the main focus of our team has been on to develop and test novel interventions for lumbar spine fusion patients to maintain or enhance bone and muscle function and thus functioning and quality of life during the rehabilitation process. In addition as the impact of long-term back pain and operative treatment is complex we will also use WHO’s International Classification of Functioning, Disability and Health (ICF) biopsychosocial
model in our Spine Register database to study the predictors of long-term (5-years) outcome and costs of the treatment.

**Dr Timo Jaakkola** ([https://www.jyu.fi/sport/laitokset/liikunta/henkilokunta-staff/jaakkola-timo](https://www.jyu.fi/sport/laitokset/liikunta/henkilokunta-staff/jaakkola-timo)) has a PhD degree in sport pedagogy. He is also adjunct professor (docent) in motor learning (University of Turku). His research interests include learning and teaching of motor skills, participation in physical activity and motivation in sport and exercise settings.

**Heikki Kainulainen** ([https://staff.jyu.fi/Members/hekainul/kainulainen](https://staff.jyu.fi/Members/hekainul/kainulainen)): Experimental research exploits information and techniques from different disciplines in order to explain the causal relations of metabolic diseases (such as obesity, diabetes and cardiovascular disease) and physical activity. One line of the research goes deeper into the molecular regulation of muscle metabolism and growth. In these studies we use experimental models that depict different stages of inherited or acquired aerobic performance and risk factors for metabolic diseases. By analysing the expression of genes globally and individually we have shown the close relationship of aerobic metabolism, i.e. mitochondria – the powerhouses of cells – and especially lipid metabolism to physical performance and metabolic risk factors.

**Professor of Sports & Exercise Medicine, Urho Kujala** ([https://www.jyu.fi/sport/laitokset/terveys/en/staff/kujala-urho](https://www.jyu.fi/sport/laitokset/terveys/en/staff/kujala-urho)) leads different types of investigations related to physical activity, exercise and health. Related to epidemiological research physical activity and health in twins is a long-term research project in collaboration with the University of Helsinki. This longitudinal study has shown that continuous physical activity is associated with reduced future morbidity, as well as a reduced need for hospital care and medication. In particular, they have studied monozygotic twin pairs, who have had discordant physical activity habits for a long period during their adult life. Using this co-twin control design they have shown the beneficial effects of long-term physical activity on body composition, including reduction of ‘high risk’ ectopic fat and improved muscular and adipocyte function, bone quality and multi-dimensional metabolomics measures. Also, they have shown that intrinsic motivation factors are the major determinants of persistent physical activity.


My research interests are in the biological aspects of aging, physical activity and their interaction. Current research focuses on the effects of female hormonal aging on muscle function, muscle and body composition, metabolism, their interaction, and association with disease risks. In addition, I study the role of physical activity/exercise in the regulation of muscle and whole body health during aging as well as the potential interactions with hormonal aging and their molecular markers by using a wide range of the methods of molecular genetics including epigenetics, transcriptomics, proteomics, and microRNA expression studies as well as objective and subjective physical activity measurements, performance measurements, body composition assessments and structured questionnaires to get deeper understanding of the phenomena under investigation. Current studies include human cohorts, mouse models, and cell experiments done in collaboration with international partners or by our own team at University of Jyväskylä. The major aim is to improve understanding of detailed molecular and physiological mechanisms responsible for the maintenance of healthy interaction between muscle and other tissues while age is advancing.

is a senior researcher and adjunct professor of cognitive neuroscience and serves at the division of sport and exercise medicine. Her expertise is centered on the functional imaging of the central nervous system especially as it pertains to neuroplasticity stimulated by physical activity or specific exercises in healthy brain or brain suffering from dysfunction. Her and her collaborators main goal is to understand sensorimotor processes in the brain to the degree that allows significant development of individualized rehabilitation for pain syndromes and motor and cognitive deficits caused by such diseases as cerebrovascular stroke. Her research tools are human electromagnetic brain recordings (MEG, EEG), transcranial stimulation methods (TMS, tDCS) and basic neurophysiological methods.

Selected recent publications from the network:


