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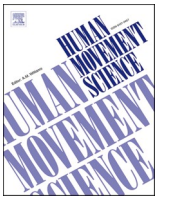

Contributions of Vladimir M. Zatsiorsky to human movement science

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Professor Vladimir M. Zatsiorsky, who turns 90 in December 2022, made substantial contributions to human movement science, specifically, to human biomechanics and motor control.

During the first part of his distinguished career, Vladimir Zatsiorsky fostered the Soviet School of Biomechanics. Many human movement scientists from the Former Soviet Union and other countries (e.g. Bulgaria, Egypt, Germany, Greece, Poland, and Yugoslavia) received training in his well-known Biomechanics laboratory at the Central Institute of Physical Culture in Moscow. Among the best known pioneering studies from that period are those related to the in-vivo determination of inertial properties of human body segments using the gamma-scanning technique, solving the inverse dynamics problem for human walking and running using a three-dimensional full-body model, determining mechanical energy expenditure during human locomotion, topics concerning muscle properties and muscle work, and the application of biomechanical principles to sports (e.g., strength, speed, and power training, optimizing performance in weightlifting, swimming, running, speed skating). Those studies formed the basis of numerous publications and dissertations involving about 50 of Vladimir Zatsiorsky's PhD students. These former students now contribute to the field of Biomechanics and Movement Science in many ways. Some became prominent coaches in Olympic sports that require deep understanding of Biomechanics, such as Klaus Bartonietz (javelin throw), Anatoli Aktov (shooting), Nikolai Kulik (wrestling), Leonid Raitsin (figure skating), and Andrei Vorontsov (swimming). Many other of Vladimir Zatsiorsky's trainees from that period, like the two authors of this editorial, teach and do research in Biomechanics and Movement Science all over the world. During that period Vladimir Zatsiorsky authored or coauthored nine books on various aspects of biomechanics and sports science that were translated into Bulgarian, Chinese, Czech, German, Hungarian, Italian, Japanese, Polish, Portuguese, Romanian, Serbo-Croatian, and Spanish. Vladimir Zatsiorsky, as a member of the Scientific Council on Biomechanics of the USSR Academy of Sciences and the Director of the All-Union Research Institute of Physical Culture in Moscow, significantly influenced the development of biomechanics and sports science research and education in the Former Soviet Union and Eastern Europe. He was awarded the National Gold Medals for the Best Scientific Research in Sports. Because of his contribution to science and practice, Vladimir Zatsiorsky was invited to be a member of the Sub-commission on Biomechanics and Physiology of the International Olympic Committee Medical Commission.

After his emigration to the United States, Vladimir Zatsiorsky started a new line of research in biomechanics and motor control to

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address one of the most difficult yet exciting problems in movement science, the problem of motor redundancy. In his approach to tackling this problem, Vladimir Zatsiorsky chose to focus on the human hand, a part of the body with exceptional complexity and functional versatility. He with his students and colleagues developed and applied a number of experimental and computational approaches to address such issues of the hand function and control as the interaction of digits in simple and multi-digit pressing and prehensile tasks, the role of intrinsic and extrinsic hand muscles in hand action, the control of the magnitude and direction of force produced by several digits, the problem of inverse optimization in movement control, and many others. These studies have resulted in over 150 peer-reviewed publications. During that period, Vladimir Zatsiorsky supervised the dissertation research of over 20 PhD students and published five more books: Science and Practice of Strength Training (Zatsiorsky, Fry, & Kraemer, 2020), Kinematics of Human Motion (Zatsiorsky, 1998), Kinetics of Human Motion (Zatsiorsky, 2002), Biomechanics of Skeletal Muscles (Zatsiorsky & Prilutsky, 2012), and Biomechanics and Motor Control (Latash & Zatsiorsky, 2015). Many of his books are used around the world as textbooks for university undergraduate and graduate courses in biomechanics of human motion.

Over his career, Vladimir Zatsiorsky supervised over 80 doctoral dissertations, published over 400 papers, gave numerous talks at International and National scientific forums and obtained a number of patents. This is truly a prolific and expansive contribution to the fields of Biomechanics, Motor Control and Human Movement Science. For his contributions to fundamental and sports biomechanics, Vladimir Zatsiorsky received the Jim Hay Memorial Award from the American Society of Biomechanics in 2008.

The collection of papers in this special issue, that is authored by former students, postdoctoral fellows and close colleagues of Professor Zatsiorsky, demonstrates the wide range of topics in human movement science typical for the original research of Vladimir Zatsiorsky. Specifically, Madarshahian and Latash investigate the effects of hand dominance and muscle function on finger force-stabilizing synergies in the spaces of motor unit groups of two hand muscles and individual fingers in healthy people (Madarshahian & Latash, 2022). Park and coauthors (Song, Kim, Ambike, & Park, 2022) address the organization of the multi-digit grasp with different mechanical constraints by employing the notion of the referent hand aperture. They demonstrate that grasp control in healthy young subjects involves modulation of the referent aperture and apparent stiffness of digits. Aruin and coauthors (Kaewmanee, Liang, Madrid, & Aruin, 2022) investigate postural responses to expected and unexpected postural perturbations in older and young adults and find that responses of the older adults to unexpected perturbations are weaker and slower, as compared to the young adults. The work of Gorniak and coauthors addresses whether the amount of subcutaneous tissue of the head is large enough to warrant accounting for it to improve the signal to noise ratio when using neuroimaging tools (e.g., electroencephalography, transcranial direct current stimulation, and functional near infrared spectroscopy). Analyzing values of the body mass index (BMI) and the head fat percent in almost 4000 people of ages 19–89 years they report that head fat exceeds 20% of the head mass and can be accurately predicted from BMI. The authors conclude that subcutaneous fat in the head is likely to interfere with neuroimaging methods that measure physiological brain signals through the derma (Gorniak, Meng, & Pollonini, 2022). Oh and Prilutsky demonstrate using hand position matching experiments in 11 participants and the theoretical analysis that non-uniform precision of hand position sense in the horizontal plane (i.e., better precision in the radial than in azimuth direction and closer to the body than farther away) can be explained by posture-dependent geometric transformation from arm joint angles, sensed by arm proprioceptors, to hand position (Oh & Prilutsky, 2022). McNitt-Gray and co-authors investigate how body initial mechanical conditions influence the motor strategies (the redistribution knee and hip joint moments) in standing and running forward somersaulting in skilled athletes. They found that the initial momentum of the body center of mass (CoM) and the initial relative position of the CoM with respect to the ground reaction force vector are critical variables to determine an appropriate motor strategy (Mathiyakom, Wilcox, & McNitt-Gray, 2022). The final article of this issue by Li and Jordan is a review of the carpal tunnel anatomy and mechanics and how they affect hand function and might cause pathological conditions known as the carpal tunnel syndrome (Li & Jordan, 2022).

The contributors to this special issue feel very fortunate that they have had the opportunity to know, work with, and learn from Vladimir Zatsiorsky, one of the great human movement scientists.

Data availability

No data was used for the research described in the article.

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