Symposium 6

Holistic Approach to Obesity Management: Exploring Exercise, Metabolism, and Muscle Health

Chairpersons

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Dankook University, Korea

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Speakers

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Panel Discussion

Hyo Youl Moon
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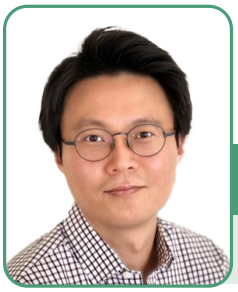

Yuho Kim

University of Massachusetts-Lowell, USA

Education

Period	Affiliation	Position
– **2011-2015**	Syracuse University	Ph.D.
– **2008-2011**	Utah State University	M.S.
– **2005-2007**	Kyung Hee University	M.P.Ed.
– **1998-2005**	Kyung Hee University	B.S.

Affiliations / Experience

Period	Affiliation	Position
– **2017-2020**	National Institutes of Health	Postdoc Fellow
– **2015-2017**	York University	Postdoc Fellow

Committee Memberships

- American Physiological Society
- Frontiers in Physiology
- American Physiological Society
- American College of Sports Medicine
- American Heart Association

Publications

- Y Kim, HA Parry, TB Willingham, G Alspaugh, E Lindberg, CA Combs, JR Knutson, CK Bleck, B Glancy Postnatal development of muscle mitochondria-organelle interactions. *Journal of Physiology.* 602(5):891-912
- Y Kim, P Ajayi, CKE Bleck, B Glancy 3D remodeling of the cellular energy distribution system during postnatal heart development. Philosophical Transactions of The Royal Society B. 337(1864): 20210322
- TB Willingham, Y Kim, E Lindberg, CKE Bleck, B Glancy. The unified myofibrillar matrix for force generation in muscle. *Nature Communications.* 11:3722
- Y Kim, E Lindberg, CKE Bleck, B Glancy. Endothelial cell nanotube insertions into cardiac and skeletal myocytes during coordinated tissue development. *Cardiovascular Research.* 116(2): 260-1
- Y Kim, DS Yang, P Katti, B Glancy. Composition of the muscle mitochondrial reticulum during postnatal development. *Journal of Physiology.* 597(10):2707-2727

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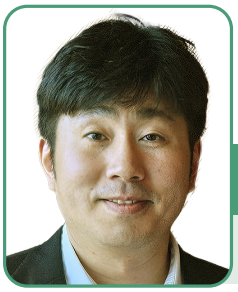
Exercise-Induced Mitochondrial Controls in Skeletal Muscle

Yuho Kim (University of Massachusetts-Lowell, USA)

In skeletal muscle, mitochondria are highly connected through intermitochondrial junctions and crosstalk with other subcellular organelles such as the sarcoplasmic reticulum and lipid droplets. These interactions support muscle energetics, metabolism, and overall cellular homeostasis. Along with their structural role, mitochondrial function is fine-tuned by mechanisms controlling quantity (biogenesis) and quality (dynamics and turnover).

During chronic muscle activity, such as exercise training, mitochondria initially undergo adjustments in quality control mechanisms (mitophagy), followed by an increase in the number of healthy mitochondria (mitochondrial biogenesis). In trained muscles, mitochondrial volume and connectivity also expand, thereby enhancing mitochondrial oxidative capacity.

In contrast, aging leads to the fragmentation and damage of mitochondria in skeletal muscle. Exercise has proven effective in mitigating or even reversing age-related mitochondrial dysfunction. Despite reduced basal aerobic capacity compared to younger muscles, chronic muscle activity not only promotes mitochondrial biogenesis and fusion but also boosts mitochondrial oxidative function in aging muscles. These beneficial effects of exercise on agerelated mitochondrial dysfunction can be further extended to obesity and its combination with aging, where mitochondria have been recognized as a key organelle in the pathogenesis and therapeutic target of sarcopenia and sarcopenic obesity.



Sechang Oh

R Professional University of Rehabilitation, Japan

• Education

Period	Affiliation	Position
– **2011-2014**	Sports Medicine, University of Tsukuba, Ibaraki, Japan	Ph.D.
– **2009-2011**	Health and Sport sciences, University of Tsukuba, Ibaraki, Japan	M.Sc.
– **2005-2007**	Physical Education, Chung-Ang University, Seoul, Korea	M.Sc.
– **1998-2005**	Physical Education, Chung-Ang University, Seoul, Korea	B.Sc.

• Affiliations / Experience

Period	Affiliation	Position
– **2022-Present**	Rehabilitation, R Professional University of Rehabilitation, Ibaraki	Professor
– **2019-2021**	Medical Science, University of Tsukuba, Ibaraki	Assistant Professor
– **2016-2019**	Medical Science, University of Tsukuba, Ibaraki	Research Fellow
– **2016-2019**	Center of Sports Medicine and Health Sciences, Tsukuba University Hospital, Ibaraki	Chief Research / Technical Fellow
– **2014-2016**	The Japan Society for the Promotion of Science, Tokyo	International Research Fellow

• Committee Memberships

- The Japanese Society of Gastroenterology
- The Japan Society of Hepatology
- National Strength and Conditioning Association
- Japan Society of Physical Fitness and Sports Medicine
- Japan Society of Health Promotion

• Publications

- S. Oh*, K. Tanaka, E. Warabi, J. Shoda: Exercise reduces inflammation and oxidative stress in obesity-related liver diseases, "Med Sci Sports Exerc" 45, 2214-2222
- S. Oh*, T. Shida, K. Yamagishi, K. Tanaka, T. Tsujimoto, R. So, J. Shoda: Moderate to vigorous physical activity volume is an important factor for managing non-alcoholic fatty liver disease: A retrospective study, "Hepatology" 61(4), 1205-1215
- S. Oh*, R. So*, T. Shida, T. Matsuo, B. Kim, K. Akiyama, T. Isobe, Y. Okamoto, K. Tanaka, J. Shoda: High-intensity aerobic exercise improves both hepatic fat content and stiffness in obese men with nonalcoholic fatty liver disease, "Sci Rep." 7, 43029
- S. Oh*, T. Tsujimoto, B. Kim, F. Uchida, H. Suzuki, S. Iizumi, T. Isobe, T. Sakae, K. Tanaka, J. Shoda: Weight-Loss-Independent benefits of regular exercise on steatosis and stiffness in Japanese men with NAFLD: A retrospective study, "JHEP Rep", 3(3), 100253
- N. Oshida*, S. Oh*, B. Kim, I. Miura, N. Hasegawa, S. Komine, T. Isobe, J. Shoda: Muscle quality as a potential diagnostic marker of advanced liver fibrosis in patients with non-alcoholic fatty liver disease, "J Obes Metab Syndr". Accepted

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Lifestyle Strategies in the Management of MAFLD: The Role of Muscle Metabolism and Exercise

Sechang Oh (R Professional University of Rehabilitation, Japan)

Metabolic-associated fatty liver disease (MAFLD) is a global health problem characterized by excessive accumulation of liver fat independent of alcohol consumption. Recently, the term MAFLD has replaced non-alcoholic fatty liver disease (NAFLD) to better reflect its association with metabolic conditions such as metabolic syndrome, obesity and diabetes. This change allows for more accurate diagnosis and treatment approaches.

Muscle metabolism is important in the management of MAFLD. Often referred to as the "second liver," muscle shares important metabolic functions with the liver, including energy production, protein synthesis, glycogen storage, and fatty acid oxidation. Regular exercise increases muscle metabolism, improves insulin sensitivity, reduces inflammation, and promotes liver health. Poor muscle quality, as indicated by intramuscular fat accumulation, is a risk factor for advanced liver fibrosis, increasing the risk 7.6-fold. (Oshida and Oh. J Obes Metab Syndr, 2024)

Both aerobic and resistance exercise are beneficial in the management of MAFLD. Aerobic exercise improves cardiovascular health and fatty acid oxidation, which reduces liver fat and fibrosis and improves enzyme levels. Resistance exercise increases muscle strength, mass, and insulin sensitivity and reduces liver fat. A combined exercise program of 150-300 minutes of moderate-intensity or 75-150 minutes of vigorous-intensity aerobic exercise per week, along with resistance training 2-3 times per week, is recommended for patients with MAFLD.

Exercise benefits MAFLD through several mechanisms. It improves insulin receptor signaling, increases glucose uptake, and reduces insulin resistance. Exercise decreases pro-inflammatory cytokines and increases anti-inflammatory markers. It also activates AMP-activated protein kinase, which promotes fatty acid oxidation and reduces liver fat. In addition, exercise boosts antioxidant defenses by increasing nuclear factor erythroid 2-related factor 2 activation, which reduces oxidative stress and inflammation. Myokines from muscle and hepatokines from liver further improve metabolic functions and energy homeostasis.

In conclusion, regular exercise is essential for the management of MAFLD and provides metabolic benefits beyond weight loss. By improving muscle metabolism and reducing liver fat, exercise may slow the progression of MAFLD and improve overall health. Future research should focus on identifying the most effective exercise modalities and intensities to optimize muscle metabolism and develop personalized lifestyle strategies for patients with MAFLD.

Young-Min Park

Incheon National University, Korea

• Education

Period	Affiliation	Position
– **2010-2015**	University of Missouri, USA	Ph.D.
– **2008-2010**	Florida State University	M.Sc.
– **2001-2005**	Sung Kyun Kwan University	B.A.

• Affiliations / Experience

Period	Affiliation	Position
– **2023-Present**	Incheon National University	Associate Professor
– **2019-2023**	Incheon National University	Assistant Professor
– **2019-2019**	University of Colorado Anschutz Medical Campus	Assistant Professor
– **2015-2019**	University of Colorado Anschutz Medical Campus	Post-Doctoral Fellow

• Committee Memberships

- Korean Society of Exercise Physiology
- Korean Society of Sport and Leisure Studies
- Korean Journal of Sport Science
- Korean Society of Physical Education
- The Institutional Review Board (IRB), Incheon National University

• Publications

- Lee H-A, Park Y-M, and Kang N-J. Unilateral hand force control impairments in older women. *EXCLI,* 21:1231-1244
- Kim N-A, Noh G-Y, Hada S, Na K-J, Yoon H-J, Park K-W, Park Y-M, and Jeong S-H. Enhanced protein aggregation suppressor activity of N-acetyl-L-arginine for agitation-induced aggregation with silicone oil and its impact on innate immune responses. *Int J Biol Macromol*, 216:42-51
- Yoon H-J, Kim R-K, Kang N, and Park Y-M. Exercise training with hormone replacement therapy has no synergistic effect on the improvement of lean and fat mass in postmenopausal women: a meta-analysis of randomized controlled trials. *Inter J Human Move Sci*, 15(2):71-85
- Park Y-M, Jankowski CM, Swanson CM, Hildreth KL, Kohrt WM, and Moreau KL. Bone Mineral Density in Different Menopause Stages is Associated with Follicle Stimulating Hormone Levels in Healthy Women. Int. J. Environ. Res. *Public Health* 18(3):1200
- Park Y-M, Jankowski CM, Ozemek C, Hildreth KL, Kohrt WM, and Moreau KL. Appendicular lean mass is lower in late- compared to early- perimenopausal women: potential role of FSH. *J Appl Physiol*, 128(5):1373-1380

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Sarcopenia, Menopause, and Exercise Intervention in Women

Young-Min Park (Incheon National University, Korea)

Age-related declines in skeletal muscle mass (i.e. sarcopenia) contribute to physical disability in older women. Although a menopause-related increase in fat mass is well documented, whether menopause influences muscle mass and bone mineral density (BMD) is unclear. We determined the extent to which skeletal muscle mass and BMD differ across the stages of menopause in women, and whether these differences are associated with estradiol or follicle stimulating hormone (FSH) hormones. This was a cross-sectional study of 144 healthy women (aged 30-70 years), classified as premenopausal (Pre; n=30, 38±6yrs; mean ± SD), early perimenopausal (EPeri; n=31, 50±3yrs), late perimenopausal (LPeri; n=30, 50±4yrs), early postmenopausal (EPost; n=26, 55±3yrs), or late postmenopausal (LPost; n=27, 62±4yrs). Appendicular lean mass (ALM) adjusted by the square of height in meters (ALM index; ALMi) and BMD were assessed using dual-energy x-ray absorptiometry. ALMi was lower in LPeri and LPost compared to EPeri with no significant differences between other groups (Pre, 6.6±0.6; EPeri, 6.8±0.8; LPeri, 6.1±0.8; EPost, 6.5±1.1; and LPost, 6.2±0.9 kg/m2). The prevalence of sarcopenia (ALMi ≤5.67 kg/m2) was 7, 3, 30, 27, and 32% in Pre, EPeri, LPeri, EPost, and LPost, respectively. Compared to EPeri, spine BMD was lower in LPeri, EPost, and LPost and hip BMD was lower in EPost and LPost. Our correlation data showed that ALMi measured across menopause stages was inversely correlated to FSH ($r=-0.28$, $p=0.003$) but not to estradiol ($r=0.088$, $p=0.34$). BMD was inversely associated with FSH (spine: $r = -0.341$; hip: $r = -0.271$, $p < 0.05$) and directly associated with estradiol (spine: $r = 0.274$; hip: $r = 0.256$, $p < 0.05$). The menopause transition appears to be a vulnerable period for the loss of skeletal muscle mass and BMD that may begin during the late perimenopausal transition. Future studies are necessary to investigate the potential harmful effect of FSH on skeletal muscle and BMD.