193. Mild hyperbaric oxygen increases microcirculation in nailfold and parasympathetic nerve activity

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Aims: Hyperbaric Oxygen has the effects of increasing oxygenation in the blood by dissolving oxygen into the blood plasma. This research investigated the effects of mild hyperbaric oxygen (mHBO) exposure on microcirculation in nailfold and parasympathetic nerve activity in healthy subjects. Methods: Fifteen healthy individuals (24.6 ± 4.9 years old) were exposed to normobaric (1.0 ATA, 20.9% oxygen) and mHBO (1.4 ATA, 30.8% - 39.5% oxygen) conditions in a mild hyperbaric oxygen chamber for 70 minutes in the supine position. Peripheral capillary oxygen saturation, skin temperature, skin moisture, blood flow in capillaries of the nailfold, blood flow in skin and skin rate were measured during both conditions. Results: Peripheral oxygen saturation, skin temperature and moisture were increased after exposure to mHBO although that was unchanged after exposure to the normobaric condition. Mean blood velocity in capillaries of the nailfold was increased from 92μm/s to 126μm/s after exposure to mHBO however it was not changed under normobaric condition. The blood flow in the skin was increased from 52ml/min to 69ml/min after exposure to mHBO. Furthermore, the heart rate was decreased and parasympathetic nerve activity was increased after exposure to mHBO. Conclusion: These results show that exposure to mHBO condition is effective for healthy people in the microcirculation of peripheral tissues.

Keywords: mild hyperbaric oxygen, microcirculation, parasympathetic nerve

194. Effect of repeated sprint exercise with post-exercise blood flow restriction on muscle oxygenation

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[Aims] Blood flow restriction (BFR) during high intensity exercise is difficult due to increased blood flow in working muscles. The purpose of the present study was to determine the effect of repeated sprint exercise with post-exercise blood BFR (BFR during rest periods between sprints) on muscle oxygenation in working muscles.

[Methods] Eleven health males performed two different trials on different days: either repeated sprint exercise with BFR during rest periods between sets (BFR trial) or without BFR (CON trial). A repeated sprint exercise consisted of three sets of 3×6-s maximal sprints (pedaling) with 2×4 min rest periods between sprints and 5 min rest periods between sets. In BFR trial, two min of BFR (100-120mmHg) for both legs was conducted between sets. During the exercise, power output, arterial oxygen saturation (SpO2) were evaluated. Muscle oxygenation for the vastus lateralis muscle, exercise induced change on muscle blood flow and muscle oxygen consumption (using near-infrared spectroscopy) were measured. [Results] During BFR between sets, BFR trial presented significantly higher deoxygenated hemoglobin (P < 0.01) and lower tissue saturation index in working muscles (P < 0.01) than those in CON trial. Moreover, power output each sprint throughout nine sprints did not differ significantly between the two trials. [Conclusions] Repeated sprint exercise with post-exercise BFR augmented muscle deoxygenation and local hypoxia during sets, without interfering power output.

Keywords: Repeated Sprint Exercise, Blood flow restriction, Muscle oxygenation

195. Effects of 4 weeks of habitual eccentric exercise on myocardial perfusion index

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[Aims] Eccentric exercise (ECC) is an excellent exercise mode, because it improves muscle strength, energy expenditure, and insulin resistance compared with concentric exercise (CON). However, it is unclear whether ECC has a benefit on vital organ from the point of view of circulation physiology. The purpose of the present study was to investigate whether there are distinct mode-of-action-dependent effects on myocardial perfusion index. [Methods] Seventeen young men were randomly assigned to CON (n = 9) and ECC groups (n = 8). Both groups performed exercise programme, which consisted of resistance exercise (bilateral bicep curl) 3 days per week for 4-week (5 sets of 10 repetitions at 75% of 1-repetition maximum). One repetition of each group was 3 sec ECC and 1 sec CON in ECC group and 3 sec CON and 1 sec ECC in CON group. Before and after intervention, subendocardial viability ratio (SEVR), myocardial perfusion index, was evaluated from estimated central blood flow, exercise ventilation (using near-infrared spectroscopy) were measured. [Results] Before intervention, SEVR was not significantly different between CON in ECC group and 3 sec CON and 1 sec ECC in CON group. After intervention, SEVR in ECC group significantly increased after intervention (P < 0.05), while CON group was not. [Conclusion] The present findings suggest that a habitual ECC improves myocardial perfusion.

Keywords: eccentric exercise, myocardial perfusion, young men

196. Effect of hyperventilation on reaction time and jump height performed upon a starting signal

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[Aims] Hyperventilation lowers body CO2 levels and in turn delays ventilatory responses to metabolic CO2 accumulation. Swimmers often hyperventilate voluntarily before the dive-start to reduce the number of inhalations between strokes and thus the water resistance. Other physiological responses to hyperventilation include increased neuromuscular excitability and decreased O2 diffusion and perfusion. The former effect may result in improved jump distance during the dive-start, whereas the latter effect, when occurring at the cerebral level, may result in increased reaction time via the deterioration of cognitive functions. Hence, this study investigated the effects of prior hyperventilation on jump height and whole body reaction time performed in response to a sound stimulus. [Methods] Ten university swimmers (21.3±1.3 years, 168.0±10.3 cm, 64.8±11.5 kg) anticipated a sound stimulus after the command “take off” and then jumped vertically from squating position on a force-plate in response to the sound. Prior to each jump, subjects breathed normally (CON) or hyperventilated for 60-s (HV) using a counterbalanced cross-over method (V̇E: 9.9±4.4 or 80.1±18.1 L/min, RR: 17.2±7.6 or 40.1±0.2 breaths/min, TV̇E: 596.3±169.9 or 1998.3±449.3 mL, P,CO2: 35.6±4.3 or 15.2±1.2 mmHg, respectively). [Results] Both jump height (33.3±7.5 vs. 33.0±7.4 cm) and whole body reaction time (0.546±0.045 vs. 0.545±0.054 s) were not significantly different between the two conditions (CON vs. HV, respectively). [Conclusion] Hyperventilation prior to a swimming race does not affect the dive-start performance.

Keywords: cerebral blood flow, excitability, ventilation
197. Effect of increasing maximal oxygen debt by sprint training on energy supply dynamics immediately after the start of supermaximal exercises

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[Aims] Increased maximal oxygen uptake, the ability to provide aerobic energy, has been shown to accelerate the oxygen kinetics after the onset of exercise. On the other hand, it is not clear whether an improved maximal accumulated oxygen deficit (MAOD), which is the anaerobic energy supply capacity, increases the supply of oxygen deficit after the onset of exercise. This study aimed to examine the effect of sprint training (ST), with the aim of improving MAOD, on energy supply dynamics immediately after the onset of exercise.

[Methods] Nine males (age 23±2 years) performed ST which had five 10-s bouts with a 5-s rest between each bout. The training was conducted twice a day, four days a week for four weeks. The exercise was performed at intensities equivalent to 100%, 125%, and 150% of the maximum oxygen uptake at the pre-training, and oxygen uptake and oxygen deficit were measured every 15 s for 1 minute after the onset of the exercise.

[Results] After training, maximal oxygen uptake did not change and MAOD increased significantly. At all exercise intensities, oxygen uptake and oxygen deficit per 15 s for 1 minute after the onset of the exercise did not change in any interval. [Conclusions] These results indicate that even if only the anaerobic energy supply capacity was improved by ST, it did not affect the energy supply dynamics immediately after the onset of high-intensity exercise.

**Keywords:** sprint training, oxygen uptake, oxygen deficit

198. Effect of combined anaerobic and strength training on central blood pressure

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[Aims] Regular anaerobic exercise decreases central blood pressure (BP), whereas strength training increases it. However, it is not known how the central BP adapts to a combination of anaerobic and strength training. Kendo is ideal for investigating this question since its training encompasses anaerobic and resistance training components. [Methods] We used a cross-sectional study design to determine central BP of 36 young university kendo athletes (kendo athlete group) and 29 young sedentary individuals (control group). Central hemodynamics were estimated from carotid arterial waveforms via general transfer function. Stroke volume was computed from brachial arterial waveforms using the Modelflow method. The stroke volume index was calculated as the stroke volume/body surface area. [Results] Central systolic BP and central pulse pressure were higher in the kendo athlete group than in the control group (both, \(P < 0.01\)). Central diastolic BP did not differ between the two groups. Stroke volume index was significantly higher in the kendo athlete group than in the control group (\(P < 0.05\)). Furthermore, there was a significant positive correlation between central pulse pressure and stroke volume index (\(r = 0.34, P < 0.01\)). [Conclusions] A combination of anaerobic and strength training may increase central pulse pressure through the increases in left ventricular systolic function.

**Keywords:** central blood pressure, anaerobic training, resistance training

199. Study of Interval-Training Intensity-Dependent Adaptation Process in Respiratory, Circulatory, and Metabolic System

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[Aims] The purpose of this study was to investigate the effects of differences in training intensity on the development of short- and long-term exercise adaptation in the respiratory and circulatory metabolic system by HIT. We measured and evaluated the respiratory and metabolic dynamics during maximal exercise before and after HIT.

[Methods] The subjects were 16 college student athletes who were divided into a 95% intensity training group (95%TG) and 80% intensity training group (80%TG). HIT performed a step exercise at each step exercise to exhaustion training group (95%TG) and 80% intensity training group (80%TG). HIT performed a step exercise at each step exercise to exhaustion training group (95%TG) and 80% intensity training group (80%TG). HIT performed a step exercise at each step exercise to exhaustion training group (95%TG) and 80% intensity training group (80%TG). HIT performed a step exercise at each step exercise to exhaustion training group (95%TG) and 80% intensity training group (80%TG).

[Results] Central systolic BP and central pulse pressure were higher in the kendo athlete group than in the control group (\(P < 0.01\)). Central diastolic BP did not differ between the two groups. Stroke volume index was significantly higher in the kendo athlete group than in the control group (\(P < 0.05\)). Furthermore, there was a significant positive correlation between central pulse pressure and stroke volume index (\(r = 0.34, P < 0.01\)). [Conclusions] A combination of anaerobic and strength training may increase central pulse pressure through the increases in left ventricular systolic function.

**Keywords:** central blood pressure, anaerobic training, resistance training

200. The effect of isometric training on sleep during training and detraining

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[Aims] This study aimed to evaluate whether isometric training could improve sleep perturbation.

[Methods] Eighteen normotensive young women were randomly assigned to either the control (n=9) or the training (n=9) group. The training group performed unilateral isometric handgrip sessions three times per week for 8 weeks. The training protocol consisted of four 2-min sets of isometric handgrip exercise at 25% of maximal voluntary contraction, separated by 3-min rest periods. The Pittsburg Sleep Quality Index (PSQI), the Epworth Sleepiness Scale (ESS), and the resting blood pressure (BP) were measured at baseline (Pre), following training intervention or control period (Post), and after 6 weeks of detraining period (Follow-up).

[Results] The systolic BP indicated significant interaction, and the training group noted a hypotensive effect at Post. However, the BP regressed to the Pre level at Follow-up. The PSQI global score was significantly reduced only in the training group at Post, and was retained at Follow-up. ESS scores indicated trends in interaction. Isometric handgrip training appeared to improve daytime sleepiness and this improved score was retained at Follow-up.

[Conclusions] These results suggest that isometric handgrip training may improve sleep quality and reduce daytime sleepiness, and may mediate hypotensive effects. Future studies are needed to reveal the underlying mechanism of the hypotensive effect due to sleep changes following isometric handgrip training.

**Keywords:** isometric training, young women, sleep and sleepiness
201. Effects of exercise and nap on the following nocturnal sleep, its haemodynamic response, mood, and appetite in the next morning

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\textbf{[Aims]} We determined effects of exercise and nap in evening on the following nocturnal sleep, its haemodynamic response, mood, appetite, and task processing capacity in the next morning. \textbf{[Methods]} Ten healthy young female subjects (21-22 yr) participated in this study. This experiment consisted of control session without exercise (control), exercise session included 60 min on cycle ergometer exercise at an intensity 50% heart rate reserve (E condition) in the evening or taking a 20min nap after lunch (N condition) or combined E condition and N condition (EN condition). In four conditions, E, N, EN, and control blood pressure (BP) and heart rate were measured nocturnal sleep, each hour from 23:00 to early morning. The quantitative parameters of sleep were determined by the actigraphy accelerometer. The subjective sleep feelings were estimated in the morning by completing a questionnaire on sleep (OSA_MA). And the subject was asked the feeling of mood, appetite, and hunger in EN condition significantly higher than that of control. The subjective wake up feeling of sleepiness right after waking up in E conditions was significantly lower than control. The response time of task processing in EN condition was significantly shorter than control. JSPS KAKENHI (19K11445) to AM) 

\textbf{Keywords :} exercise, sleep, blood pressure

202. Effects of repeated bout effect on vascular stiffness

Takanobu Okamoto\textsuperscript{1}, Yuto Hashimoto\textsuperscript{1}, Hideaki Kashima\textsuperscript{1}, Masako Yamakoa\textsuperscript{1}, Yoshiyuki Fukuba\textsuperscript{1}

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\textbf{[Aims]} Repeating eccentric exercise for several weeks after the initial bout provides a protective effect against muscle damage, which is called the repeated bout effect. This study investigated the effect of repeated bouts of eccentric resistance exercise (EC) on arterial stiffness. \textbf{[Methods]} Four untrained healthy young men (22.8 ± 0.5 years) performed two bouts of EC (EC1, EC2) separated by 2 wks. Subjects performed EC while lowering a dumbbell (80% one-repetition maximum) over the course of 3 s, and then returned the dumbbell to the starting position over the course of 3 s, with the investigator holding the weight. The exercise consisted of 6 sets of 10 contractions, performed alternately on the left and right sides with 2 mins between sets. Carotid-femoral pulse wave velocity (cPWV), maximal isometric torque (MVC) and muscle soreness were measured before and 1, 24, 48, 72 h after exercise. \textbf{[Results]} There was a tendency for EC2 to suppress increases in cPWV compared with EC1 at 48 (EC1: 47.8 ± 26.2 cm/s vs. EC2: 43.0 ± 24.6, P = 0.90) and 72 (EC1: 67.3 ± 22.2 cm/s vs. EC2: 52.5 ± 16.7, P = 0.70) h. EC2 suppressed increases in MVC compared with EC1 at 1 to 72 h (P = 0.018, 0.008, 0.001 and 0.003, respectively). There was a trend for muscle soreness to be lower after EC2 compared with EC1 at 48 h (P = 0.088). Conclusion: These results suggest that repeated bouts of EC reduce muscle damage and suppress increases in arterial stiffness.

\textbf{Keywords :} Eccentric exercise, Repeated bout effect, Pulse wave velocity

203. Effect of repeated bout effect of eccentric resistance exercise on arterial stiffness

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\textsuperscript{1}Nippon Sport Sci. Univ.

\textbf{Purpose:} Repeating eccentric exercise for several weeks after the initial bout provides a protective effect against muscle damage, which is called the repeated bout effect. This study investigated the effect of repeated bouts of eccentric resistance exercise (EC) on arterial stiffness. \textbf{[Methods]} Four untrained healthy young men (22.8 ± 0.5 years) performed two bouts of EC (EC1, EC2) separated by 2 wks. Subjects performed EC while lowering a dumbbell (80% one-repetition maximum) over the course of 3 s, and then returned the dumbbell to the starting position over the course of 3 s, with the investigator holding the weight. The exercise consisted of 6 sets of 10 contractions, performed alternately on the left and right sides with 2 mins between sets. Carotid-femoral pulse wave velocity (cPWV), maximal isometric torque (MVC) and muscle soreness were measured before and 1, 24, 48, 72 h after exercise. \textbf{[Results]} There was a tendency for EC2 to suppress increases in cPWV compared with EC1 at 48 (EC1: 47.8 ± 26.2 cm/s vs. EC2: 43.0 ± 24.6, P = 0.90) and 72 (EC1: 67.3 ± 22.2 cm/s vs. EC2: 52.5 ± 16.7, P = 0.70) h. EC2 suppressed increases in MVC compared with EC1 at 1 to 72 h (P = 0.018, 0.008, 0.001 and 0.003, respectively). There was a trend for muscle soreness to be lower after EC2 compared with EC1 at 48 h (P = 0.088). Conclusion: These results suggest that repeated bouts of EC reduce muscle damage and suppress increases in arterial stiffness.

\textbf{Keywords :} Eccentric exercise, Repeated bout effect, Pulse wave velocity

204. Effects of electrical stimulation-induced resistance exercise training on white and brown adipose tissues and plasma meteorin-like concentration in rats

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\textbf{[Aims]} Resistance exercise training (RT) may induced morphological and metabolic adaptations such as minimalize of adipocytes size, or increasing of PGC-1a protein in adipose tissue with increasing myokine named meteorin-like (Metrnl), however, it has been unclear. The purpose of this study was to clarify whether RT induced morphological and metabolic adaptations in white adipose tissue (WAT) and brown adipose tissue (BAT) in rats. \textbf{[Methods]} Male Wistar rats were divided into control and RT groups (n = 8 each). RT group received isometric contraction by electric stimulation (Voltage: ~22 V, Stimulation frequency: 100 Hz. 3-s stimulation × 10 contractions with a 7-s interval between contractions and 3-min rest between sets) to their both gastrocnemius muscles for 3 times a week for 4 weeks. \textbf{[Results]} Four weeks of RT significantly decreased weight of subcutaneous WAT with being smaller size of the adipocytes (p < 0.05 vs. Control), increased mitochondrial enzymes (p = 0.051) and PGC-1a protein contents (p < 0.05) in BAT. Furthermore, plasma Metrnl concentration was significantly higher in RT group compare to Control (p < 0.05), and there is positive correlation between Metrnl concentration and BAT PGC-1a proteins. \textbf{[Conclusions]} RT stimulation increases PGC-1a protein expression in BAT with Metrnl elevation.

\textbf{Keywords :} brown adipose tissue, mitochondria, meteorin-like
205.  
**Effect of hypoxia exposure after endurance training on muscle oxidative metabolism**

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**Aims** To comprehensively improve oxidative metabolism in skeletal muscle, both oxygen delivery and oxygen utilization capacity need to be increased. The purpose of this study was to examine whether short-term hypoxia exposure after endurance training (HAT) enhances oxygen delivery and oxygen utilization capacity. **[Method]** Male Wistar rats were assigned randomly to endurance training under hypoxia (TUH), HAT, endurance training under normoxia (TUN), and control groups. The rats in the training groups underwent treadmill running at ~30 m/min for ~90 min, 5 days per week for 9 weeks. Rats in the HAT group were exposed to 12% O2 for 3 h after endurance training. Rats in the TUH group underwent treadmill running at 90% of the normal protocol speeds under 15.4% O2. After finishing the training period, blood components (red blood cells (RBCs) and hemoglobin concentration (Hb)) and the level of mitochondrial protein (COXIV) were measured. **[Results]** The COXIV level was significantly higher in the HAT group than in the TUN group. The number of RBCs and Hb did not show significant differences among the groups. **[Conclusion]** Stimulation with either hypoxia or training alone enhanced different factors involved in aerobic metabolic capacity. Meanwhile, it is suggested that the combination of hypoxia and training offsets their individual effects, such as increased blood components and the mitochondrial protein level.

**Keywords**: Hypoxia, Mitochondria, Endurance training

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206.  
**Impact of carbohydrate-electrolyte dissolved in alkaline electrolyzed water on physiological responses during exercise under heat stress**

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**Aims** We investigated whether carbohydrate-electrolyte (CE) beverage dissolved in alkaline electrolyzed water (A-CE) on physiological responses during exercise under heat stress. **[Methods]** Ten males completed two exercise trials in heated environment (35 °C of room temperature, 50 % of relative humidity) under two conditions: CE-dissolved in purified water (P-CE) and A-CE. The exercise test consisted of 30-min treadmill running (at an intensity corresponding to their 65 % of heart rate reserve adjusted in heated condition) and repeated sprint cycling (10 × 7-s maximal sprints) with 35-min rest interval between the two exercises, in double-blind, crossover design. Before and after the running, and after the cycling, participants drank the P-CE (0 ppm in hydrogen concentrations, pH 3.8) or A-CE (0.3 ppm, pH 4.1). Before, during (rest interval between the running and the cycling), and post exercise test, blood samples were obtained. **[Results]** Repeated sprint performances, oxidative stress responses, and hydration status did not differ between P-CE and A-CE trials. Drinking the A-CE significantly attenuated the blood lactate accumulation during treadmill running exercise, but not during repeated sprint cycling in the heated condition. **[Conclusions]** Our present findings suggest that A-CE does not change the repeated sprint performance, whereas it might improve exercise efficiency during, at least in part, endurance exercise under heat stress.

**Keywords**: Hydrogen-rich water, Endurance exercise, Repeated sprint exercise

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207.  
**Upper body resistance training increases lipid metabolism during subsequent lower limb aerobic training**

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**Aims**: Lower limb aerobic training (LLAT) after resistance training (RT) resulted in greater energy expenditure and lipid metabolism than LLAT alone. However, previous studies have suggested that lower extremity-training impacted the results. Therefore, we conducted upper body RT to determine the effects of RT on energy metabolism during subsequent LLAT. **[Methods]** Nine male university throwers were included in the study. After 30 min of seated rest (C condition) or upper body RT (R condition) before LLAT, the subjects performed 60 min of bicycle ergometer exercise at approximately 50% VO₂ max intensity. We calculated each participant's energy expenditure, carbohydrate oxidation, and lipid oxidation. We also assessed autonomic activity by analyzing heart rate variability before LLAT. **[Results]** There was no difference in energy consumption between the two conditions. Carbohydrate oxidation was lower and lipid oxidation was higher in the R condition than in the C condition. Over time, differences were observed for both carbohydrate and lipid oxidation conditions up until 30 min after LLAT. Furthermore, the sympathetic activity of the R condition was higher than that of the C condition before AT. Discussion: RT promoted sympathetic nervous activity. Therefore, carbohydrate oxidation decreased and lipid oxidation increased during LLAT. **[Conclusion]** Upper body RT increases the subsequent lipid metabolism during LLAT.

**Keywords**: resistance training, lower limb aerobic training, lipid metabolism

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208.  
**Change in muscle hardness in the proximal, middle and distal part of human rectus femoris after maximal knee extension exercise**

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**[Aim]** To determine the change in muscle hardness in the proximal, middle, and distal part of human rectus femoris after maximal knee extension exercise. **[Methods]** Six healthy males (21.8±1.5 years) performed maximal isometric contraction (IM), concentric contraction (CC), and eccentric contraction (EC) of knee extensors. Muscle hardness in the proximal, middle, and distal part of rectus femoris was measured by strain elastography before and after exercise, and the rate of changes between the values was calculated as the value before the exercise 100%. **[Results]** A significant main effect in part was found in IM and EC exercise (p<0.05). Muscle hardness in the proximal part (97.3±20.3%) was significantly higher than that in the middle part (99.2±27.1%) and the distal part (82.8±20.7%) in IM exercise, and muscle hardness in the proximal part (83.9±22.3%) was significantly higher than that in the middle part (93.4±21.0%) in EC exercise. **[Conclusions]** These results indicated that the magnitude of change in muscle hardness after maximal knee extension exercise was different among the proximal, middle, and distal part of human rectus femoris. It was shown that the change in the distal part was higher after the IM exercise whereas the proximal part was higher after the EC exercise.

**Keywords**: elastography, quadriceps femoris, bi-articular muscle
209. Analysis of knee joint kinematics during drop jump: mechanisms of jump height alteration with varying platform heights with regard to SSC utilization
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[Aims] Drop jump (DJ) height increases with platform height due to increased utilization of the stretch-shortening cycle (SSC) effects; however up to a certain level. The platform height that exhibits greatest DJ height is described as the optimum platform height. Beyond this, the DJ height begins to fall. The mechanism of this phenomenon is still under debate. Thus, this study evaluated the utilization of SSC effects with varying platform heights by examining knee joint kinematics. [Methods] Nine male track sprinters (19.7±1.1 years, 178.3±6.1cm, 69.1±4.6kg) performed DJ from the optimum (calculated by interpolation) and ±70% optimum platform heights (3 conditions). DJ heights, joint angular velocities and maximum flexion angles of the knee during landing (eccentric phase), and the time spent in transition from eccentric to concentric (stretch to shortening) phases were measured using a jump mat and electrogoniometers. [Results] DJ height was greatest and the time spent in phase transition shortest for the optimum platform height (p<0.05). The velocity (peak and mean) and the angle of the knee flexion during landing were greater for higher platforms (p<0.05). [Discussion] The SSC utilization is augmented with faster and longer stretching of the muscle, and with swift SSC phase transition. Beyond the optimum platform height, the speed and length of muscle stretching were increased further, however the SSC phase transition became slow due to increased eccentric momentum. This may explain the reduction of DJ height.

Keywords: plyometrics, eccentric momentum, stretch-shortening cycle

210. The effect of glycation state on strength training effect in young male
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[Aims] In this study, we aimed to clarify the effect of glycation state on the strength-enhancing effect of strength training. [Methods] The subjects were 20 healthy male university students, and after measuring the subcutaneous glycation state with an AGEs sensor, they were classified into two groups, a low value group (L) and a high value group (H). Both groups were subjected to three sets of leg extension exercises (10 times/set) three times a week for 12 weeks at a load of 80% of the maximum lift. The glycation state and the maximum lift weight were measured before and after the training. [Results] The maximum lift weight before training was significantly higher in the L group than in the H group (L group: 64.9 kg, H group: 50.8 kg, p = 0.02). There was no significant difference between the two groups in the maximum lifting weight after the exercise (L group: 99.5 kg, H group: 103.8 kg, p = 0.14). The glycation state was significantly decreased by training in both groups (L group: 0.44→0.36 a.u., p<0.001; H group: 0.53→0.40 a.u., p<0.001). [Conclusions] Strength training improves body glycation status in young men. On the other hand, although a negative relationship was found between the glycation state of the body and muscle strength when muscle training was not performed, it was revealed that the glycation state of the body does not affect the muscle strengthening effect of strength training.

Keywords: glycation, training

211. Bone mineral density measured by dual-Energy X-ray absorptiometry in collegiate canoe sprint athletes
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[Aims] The aim of this study was to investigate the status bone mineral density (BMD) in collegiate canoe sprinters. [Methods] Subjects were 61 collegiate canoe (n=30) and kayak (n=21) sprinters from a top university team. Total-body BMD was measured (each year for 4 years) in the supine position at the end of strength training before the race period using total-body dual-Energy X-ray absorptiometry (DXA). Systemic scan data were divided into four regions: the head, the upper extremities, the lower extremities, and Trunk. [Results] While total-body BMD in collegiate canoe sprinters was within normal ranges, it was extremely low. In site-specific BMD, the upper limbs and lumbar spine BMD were greater than that in general collegiate students reported previously. On the other hand, BMD of the lower extremities were less than that in general collegiate students, but similar to that of swimmers. There was a significantly correlation between age and total-body BMD (r=0.361, p<0.01). [Conclusions] Our results show that total-body BMD in collegiate canoe sprinters is low compared to normal ranges. However, upper body BMD is greater and lower extremities is lower in these subjects compared to general collegiate students. In our subjects, the deficit in BMD of the lower extremities was the reason total-body BMD tended to be low. Total-body BMD tended to increase over the three years of observation, but remained at a lower value than the reference mean.

Keywords: Sprint canoe and kayak, Site-specific analysis, Lower extremity BMD

212. Sex differences of lifting velocity and blood lactate concentration during resistance exercise
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[Aims] Recent studies has been reported that increased blood lactate and changes in velocity resistance exercise are associated with chronic training responses, such as strength gain and muscle hypertrophy. However, there is a few studies have examined gender differences. The purpose of present study was to consider sex differences of lifting velocity and blood lactate concentration during resistance exercise. [Methods] Fourteen well-trained subjects (9 men, age: 21.1±0.7years, weight: 72.5±8.1kg, height: 171.8±5.9cm, squat 1RM:137.8±31.0kg: 6 women, age: 20.2±1.1years, weight: 56.7±5.2kg, height: 158.2±5.2cm, squat 1RM: 68.3±15.1kg) were participated in present study. They performed parallel squats exercise for muscle hypertrophy (10 repetitions at 70% of 1RM, rest 2 min). We measured blood lactate concentration before, during, and after the resistance exercise. We also measured lifting velocity during resistance exercise using a transducer (GymAware). [Results] The average velocity in the 1 set and 4 sets were 0.54m/s and 0.48m/s for men and 0.46m/s and 0.47m/s for women, respectively. Furthermore, changes in lifting velocity from first repetition to last were 27% for men and 10% for women. Women tended to maintain lifting velocity compared with men (p=0.076).Higher blood lactate after resistance exercise was observed in men (8.7mmol/L) compared with women (4.0mmol/L, p=0.0027). [Conclusions] Our results suggested that women has a lower changes in lifting velocity and lower blood lactate concentration during exercise for muscle hypertrophy than men.

Keywords: hypertrophy, velocity, sex difference
The effect of decrease in cooling rate of post-exercise icing on the occurrence of DOMS during the training process and changes in muscle cross sectional area induced by the resistance training

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[Aims] This study examined the effects of decrease in cooling rate of regular post-exercise icing on the occurrence of delayed onset muscle soreness (DOMS) during the training process and muscle hypertrophy induced by the resistance training. [Methods] Ten male and twelve female subjects participated in resistance training: 5 sets of 8 arm curl exercises with the nondominant arm (experimental arm) at workload of 8 RM, 3 times a week for 8 weeks. Subjects' dominant arms served as controls (control arm). Subjects were randomly divided into 10°C or 20°C cooling treatment groups or the control group (C10, C20, and NC, respectively). In the cooling treatment groups, a cold pack, maintained at a constant temperature of 10°C for C10 and 20°C for C20, was applied over the front of the experimental upper arm for 20 minutes after exercise. Muscle cross sectional area (CSA) was measured by MRI before and after the training period. Muscle soreness was evaluated using a visual analog scale before every training session. [Results] Experimental arm/control arm ratios of muscle CSA increased significantly after training in NC and C20 but did not increase in C10. DOMS during training process in C20 and C10 were lower than that in NC. [Conclusion] These results suggest that decrease in cooling rate of post-exercise icing may attenuate its deleterious effects on muscle adaptations to resistance training observed in icing at higher cooling late.

Keywords: cryotherapy, strength training, muscle hypertrophy

Correlation between physical characteristics and composition of gut microbiota in elite marathon runners

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Backgrounds: Completely functional intestine and colon ensure an adequate supply of nutrients. Recent research suggests that gut microbiota support the intestinal function. Endurance runners routinely perform long-term endurance training. Aim: This study aims to investigate the correlation between microbiota composition and physical characteristics in high physical activity marathon runners.

Methods: We enrolled 13 female marathon runners. Each athlete was asked to take their stool sample for gut microbiota analysis. We classified gut microbiota by Techno Suruga Laboratory Co., Ltd. These samples were analysed 16S rDNA by next-generation sequence analysis. Results: The microbiota of six athletes revealed the presence of Prevotella spp. This study suggests that the obesity-associated intestinal microbiota in female elite-marathon runners is characterised by a higher Bacteroidoides/Firmicutes ratio. Conclusions: We hypothesise that this is a form of physiological adaptation to allow a longer period of glycogen consumption of skeletal muscle in long-distance training. These results suggest that marathon runners need to maintain intestinal bacteria that create an energy-efficient body for long hours of running.

Keywords: gut microbiota, marathon runner, body mass index

Validity of Bioelectrical impedance analysis & skinfold thickness method for body composition assessment in Rugby player

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[Aims] The purpose of this study was to investigate the validation of body composition assessment method using Bioelectrical impedance analysis (BIA) and skinfold thickness method (ST) compared with dual energy X-ray absorptiometry (DEXA) method as gold standard method in Rugby player. [Methods] This study used BIA (In Body 770, In Body Co. Ltd., Japan), ST (Sum2, Sum3, Sum6) (Slim Guide Skinfold Caliper, Creative Health Co. Ltd.) and DEXA (DXA CS-7 Version1.33, Konica Minolta Co. Ltd., Japan). The subjects were 40 athletes (Age 19.9±1.1 year, Height 176.8±5.6cm, Body mass 94.1±14.6kg) belonging to the university Rugby football club. [Results] The result was as follows. The %FAT in whole body by ST method (Sum2, Sum3, Sum6) method and BIA method were high correlated with the values measured by DXA (p<0.05). In %FAT there is no systematic error by examination of the validity by the Bland-Altman method, and there are all data in 95% limits of agreement. Therefore it was suggested that ST method (Sum2, Sum3, Sum6) and BIA method were effective for an evaluation of the whole and segmental body composition in Rugby football player.

Keywords: dual-energy X-ray absorptiometry, bioelectrical impedance analysis, skinfold thickness method

Effects of exercise training combined with fermented soybean beverage intake on cognitive and exercise capacity in the elderly

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[Aim] Aging promotes muscular atrophy and is also associated with decreased physical functions. The combined of exercise and nutritional intake has been used for protein synthesis in the muscle, and its effectiveness has been reported especially for amino acid intake. We investigated the effects of combined intake of fermented beverages and exercise training. [Methods] 21 elderly subjects participated. Each subject consumed 250 ml/day of beverage 5 days a week, and underwent a home exercise program. The cognitive function was evaluated by Stroop test using a personal computer, and the exercise capacity was evaluated for grip and leg muscle strength, aerobic capacity and flexibility. [Results] Skeletal muscle mass was significantly increased after the duration of beverage intake and the combination of beverage intake and exercise compared to before the intervention. The accuracy rate and reaction time of the Stroop test, leg muscle strength and obstacle walking speed were significantly improved by the combined use of beverage intake and exercise compared with those before intervention. [Conclusion] This study revealed that the intake of beverages (diet) containing amino acids is effective for maintaining the body composition of the elderly, and that the combined use of exercise programs that can be carried out at home improves cognitive function and exercise capacity.

Keywords: Training and nutrition, Amino acid, elderly
217. Effect of pedal force effectiveness on gross efficiency during endurance cycling among male cyclists

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[Aims] Gross efficiency (GE), the ratio of work to energy expended, is important in endurance cycling. In endurance cycling, it is unclear why GE decreases over time. We hypothesized that the index of pedal force effectiveness (IFE), the ratio of tangential force to resultant force acting on each crank, may cause the decrease in GE. This study aimed to investigate the change in IFE over time and its relationship with GE. [Methods] Seven male cyclists performed 100-minute endurance cycling using a road racing bicycle on triple rollers and a constant friction loading apparatus. Subjects used gear ratio corresponding to their 60% maximal oxygen uptake, at 90 revolutions per minute. Oxygen uptake, respiratory exchange ratio, pedal force at every 30° of the crank angle, heart rate, blood lactate, and ratings of perceived exertion (RPE) were measured every 20 minutes. [Results] Over time, GE and IFE significantly decreased (p<0.05), and oxygen uptake, heart rate and RPE significantly increased (p<0.05). There were no changes in respiratory exchange ratio and blood lactate. Compared to 20 minutes of exercise, radial forces generated during the downstroke phase at crank angles of 150° and 180° significantly increased at 100 minutes (p<0.05). There was a significant positive correlation between IFE and GE (r=0.07, p<0.05). [Conclusions] The decrease in GE over time may be related to the decrease in IFE due to the increase in the radial force near the bottom dead center during the downstroke phase.

Keywords: cycling, efficiency, pedal force

218. Changes in performance immediately after low-load resistance exercise that to failure or not

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[Aims] It is important to perform to failure for muscle hypertrophy, and even low-load resistance training to failure have been shown muscle hypertrophy. Recently, We have reported that low-load resistance exercise to non-failure has similar responses compared with to failure. Therefore, the purpose of present study was to examine the effects of low-load resistance exercise to failure or not on acute changes in strength and vertical jump. [Methods] Twelve subjects (6 men and 6 women) with training experience performed 3 protocol of squat exercises. Three protocol of exercise were performed using a crossover design: 40% 1RM to failure, 40% 1RM to non-failure, and 75% 1RM to failure. All exercises were performed in three sets with three minutes of rest intervals. Lifting velocity was measured during the exercise using a transducer. The vertical jump and leg extension strength were measured before and immediately after the exercise. In addition, RPE was measured after the exercise. [Results] Changes in vertical jump and leg extension strength were not reduced in the immediate post measurements of low-load, non-failure and high-load, to failure exercise. Also, there was a significant decrease in low-load, to failure exercise (p<0.05). The RPE was lowest in the low-load, non-failure exercise among the three protocols. [Conclusions] Our results were suggested that low-load resistance exercise to non-failure may help to maintain strength and vertical jump performance after exercise.

Keywords: Low-load, non-failure, Lifting velocity

219. Relationship between exertion power and load and rest time during 10 seconds of sprint interval exercise

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[Sprint interval training (SIT) has been reported similar improvement of maximal oxygen uptake (VO\(_{\text{max}}\)), with long slow distance training even if short duration and low volume. In sprint interval training, peak power during session may affect chronic training response. The purpose of present study was to investigate the relationship between power output and, load and rest intervals during 10s sprint interval exercise (SIE). [Methods] Six male subjects was participated in present study. They performed 4 types of SIE (load: 7.5% or 10%, Rest intervals: 1 min or 4 min) using cross over design. In addition, 1RM of squat and VO\(_{\text{max}}\) were measured as characteristics of physical fitness. [Results] The load of 10% showed higher power compared with that of 7.5%. Changes in power output during session was smaller in 4 min of rest intervals compared with those of 1 min. [Conclusions] Our results suggested that SIE with 10% load and 4 min rest maintained power output. Furthermore, subjects with higher muscle strength had higher power output on 10% load, and subjects with higher endurance had small changes in power output after both rest intervals. In the future, it will be necessary to consider the optimal 10s SIT for each individual through long-term intervention studies.

Keywords: SIT, Power, VO\(_{\text{max}}\)

220. The validity of the five-point pass as a simplified assessment instrument of soccer pass skill

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[Aims] The aim of the present study was to investigate the validity of the five-point pass as a simplified assessment instrument of soccer pass skill. [Methods] Study 1 was designed to examine the effects of the width of the area on the number of passing errors (PE), heart rate (HR), and movement distances (MD) during the five-point pass task. Twenty college soccer players participated in study 1. All subjects took part in the basic and applied tasks of the five-point pass on three different areas measuring 10x10, 20x20, and 30x30 m. Study 2 was designed to examine the effects of competitive levels on PE, HR, and MD during the five-point pass task on the 10x10 m area. Forty (elite, n = 20; non-elite, n = 20) college soccer players participated in study 2. [Results] Mean HR and MD values were significantly lower during the applied task of the five-point pass on the 10x10 m area than during the basic task, but not on the 20x20 m or 30x30 m area. [Results (Study 2)] Mean PE values during the basic and applied tasks of the five-point pass were significantly higher in non-elite than in elite subjects. Mean HR and MD values during the basic and applied tasks of the five-point pass were significantly lower in non-elite than in elite subjects. [Conclusions] The present results suggest that the five-point pass task on the 10x10 m area is a better tool as a simplified assessment instrument of soccer pass skill.

Keywords: soccer, pass skill, heart rate
222. Characteristics of Jumping Ability in Male Volleyball Players An attempt to analyze jumping abilities of different types

Seiji Aruga

[Aims] The purposes of this study were firstly to identify the factors relevant to the characteristics of jumping abilities of male volleyball players, and secondly to categorize the subjects into four types by jumping abilities to reveal their respective characteristics. [Methods] We measured various jumping abilities, forms, as well as muscle strength and power on 24 university male volleyball players, with following findings. [Results] 1) There was a significant positive correlation between the measurements of counter movement jumps and approach jumps. Meanwhile, no significant correlation was found between the rebound jump (RJ) index and the measurements of approach jumps and counter movement jumps. 2) The players were categorized into the groups with different jumping abilities based on the average values of counter movement jump measurements and RJ-index, resulting in the categorization of four out of seven wing spikers into RJ-superior group while no middle blocker out of five into this group. The group superior in both traits included only setter and libero players. They had significantly lower heights than those of the players in the group inferior in both traits, showing significantly higher squat and power clean 1RM/body weight ratios. [Conclusions] These results suggested that the categorization based on the average values of counter movement jump measurements and RJ-index used in this study is effective for conducting efficient individualized training aimed at improving jumping ability.

Keywords: Volleyball, Jump, Rebound jump index

224. Effect of blood flow restriction on aerobic exercise-induced cognitive function and serum brain-derived neurotrophic factor level in Japanese older adults

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[Background] Aerobic exercise (AE) is well known to provide benefits to cognition and mood via increasing brain-derived neurotrophic factor (BDNF) concentrations. Although Blood flow restriction (BFR) exercise is recognized as a beneficial strategy for increasing skeletal muscle mass and strength, effects of BFR on AE-induced changes in cognition and serum BDNF level in humans remain to be elucidated. [Aims] To investigate the acute effects of BFR on AE-induced changes in cognition and serum BDNF level in Japanese older adults. [Methods] Nine participants (66.3±7.9 yrs) performed 30-min cycling with BFR or non-BFR (NBFR) in crossover design. The AE intensity was set at 30% of heart rate reserve. The BFR condition was achieved using 60 mmHg pressure cuffs placed around the proximal region of the thighs. Cognitive function was assessed using the color-word Stroop task before and after each condition. [Results] There were no significant effects of BFR on any cognitive parameters; however, the reverse-Stroop interference score increased after BFR compared to that before exercise. Furthermore, serum BDNF level was significantly decreased after NBFR cycling. [Conclusions] These finding suggested that, with a mild intensity exercise and light pressure cuffs, single BFR cycling could not augment cognitive function and serum BDNF concentration in Japanese older adults.

Keywords: blood flow restriction, cognition, BDNF
225. Evaluation of physical fitness in wheelchair badminton athletes - Time analytics from international para-badminton WH1 singles games -
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[Background] A detailed performance analytics of para-badminton athletes has not been revealed. Especially in wheelchair class, due to the characteristics of the competition, it is necessary to use the upper limbs to drive the wheelchair, hit the shuttle and brake the wheelchair in order to hit a single stroke, and this process must be continued continuously and intermittently. As a result, the risk of injury to the upper limbs including the shoulder joint is high, but the international required physical fitness level is not yet clarified.

[Purpose] The purpose of this study was to clarify the physical fitness standard required of para-badminton WH1 athletes through time analytics from international para-badminton WH1 singles games at the upper levels.

[Methods] We selected matches between the top 10 ranked players in the WH1 class in the world (898 innings in all) and recorded WP (working period | rally time in seconds) and RP (resting period | rest time in seconds) and stroke numbers in each inning. [Results] The average WP per inning was 8.9 seconds (0.9-62.3 seconds), the average RP was 12.7 seconds (1.0-57.7 seconds), and the average number of strokes per inning was 7.0 (1-48); the WP/RP was 0.7 and the stroke tempo was 1.3 strokes per second.

[Conclusions] As an international benchmark of physical fitness in the WH1 singles event of Para-badminton, the players are required to compete with each other at a rate of one hit per second for the entire match, with a W/R ratio of 1:1.4 intermittent exercise, and to continue to do so for about 7 hits.

Keywords: Time analytics, W:R ratio, number of strokes

226. The effect of sprint drills on sprint performance in junior soccer player
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Aims This study aims to clarify the effects of a 22-weeks sprint drills on the temporal-spatial and kinetics variables of a 50-m sprint in junior soccer players. Methods A total of 24 junior soccer players aged from 10 to 14 years were involved in sprint drills 3 times a week for a period of 22 weeks. The drills were consisted of four drills focused on quick leg movement and maximal velocity. Before and after the intervention, sprint velocity, step frequency, step length and impulse of horizontal and propulsive direction during a 50-m sprinting were determined with a 50 force plates system.

Body height, body mass and sitting height were also measured. Results There were significant main effects for sprint velocity, step frequency index, step length index, vertical impulse. No significant difference in step frequency, step length and aerial time was found for the intervention period. The impulse of propulsive and foot contact time increased during the initial acceleration phase. Conclusions This current findings demonstrated that for junior soccer players, a 22-weeks sprint drills may enhance sprint velocity, step frequency index during the middle acceleration phase and maximal speed phases and increase the impulse of vertical during all phase. On the other hand, this sprint drills decrease step length index during the initial acceleration phase and middle acceleration phase.

Keywords: sprint training, biomechanics, children

227. Effect of different styles in 20 meters shuttle run test on number of arrivals and subjective fatigue
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[Background] The 20m shuttle run test (20mSRT) is a method of estimating overall endurance using a graded exercise in which subjects run a set distance at increasingly faster speeds. However, it is essential to consider the impact that locomotor muscle fatigue due to the quick turn performed after each 20m sprint has on the number of successful shuttles. [Aims] This study compared the number of successful shuttles and subjective fatigue for the conventional 20mSRT (Standard SRT) and a 20mSRT that does not require quick turns (Round SRT). [Methods] Participants were 17 male college students. For the circular SRT, participants circled around a 20m square track. Measurement for each condition was performed in random order with an interval of one week between conditions. [Results] The number of successful shuttles for the Round SRT was found to be significantly higher than the Normal SRT. Subjective fatigue did not increase after either type of SRT compared to before in either condition. [Conclusion] Round SRT, which does not require a quick turn, has been shown to be a method that does not overburden participants and can easily and accurately measure endurance.

Keywords: Endurance, Turn back, performance

228. Relationship between shooting ability and chest pass long throw ability of Mini Basketball Players
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[Aim] College basketball players with high shooting accuracy are reported to have a high ability for long-distance throwing in chest pass or shooting. However, the relationship in mini basketball players is still unclear. The purpose of this study was to clarify the relationship between shooting accuracy and chest pass distance in mini basketball players. [Methods] Twenty-seven mini basketball players (age: 11.6 ± 0.6 years) participated in this study. To measure shooting accuracy, each player performed 20 jump shots from the free-throw line, and the number of successful shootings was counted. The long-distance throwing ability was determined by the maximum value of in five throws of chest pass. [Results] The mean number of successful shootings was 12.6 ± 2.5, and the mean distance of the chest pass was 8.6 ± 1.5 m. No significant correlations was found between shooting accuracy and the distance of the chest pass in the mini basketball players (r = 0.349, p = 0.719). [Discussion] The main result of this study is that shooting ability is not related to the ability of long-distance throwing. This result shows that adults and elementary school basketball players have different shooting ability determinants. Therefore, mini basketball players should perform a specialized practice to improve shooting accuracy.

Keywords: mini basketball, shooting accuracy, chest pass distance