341. Physiological response during skyrunning in trail runners
H. Tsujikawa¹, S. Nishio², T. Yoshida³, S. Sasaki¹, Y. Iwashara¹, S. Murata¹, J. Nagasawa¹, K. Sugiyama¹ (Faculty of Health Sci. Nurs., Juntendo Univ., Japan, ¹UEC, ²Plana, ³Shizuoka Univ.)

[Aims] Skyrunning (SR) is an extreme sport of mountain running above 2,000 meters, and the number of participants in SR is rapidly increasing in Europe. In Japan, the sport has been growing in popularity since the establishment of the Japan Skyrunning Association (JSA) in 2013. However, the physical loads during SR remain unknown. The purpose of this study was to examine the effects of SR on runners.

[Methods] 7 healthy males and females performed skyrunning (from 1,500 m to 2700 m in altitude) followed by a pre-test (20 m shuttle-run, weight bearing index, vertical jump, muscle hardness and blood, saliva and urine sampling). The data was analyzed as the trained group (TR: n=4, 2 males & 2 females) and the untrained group (n=3, 2 males & 1 female).

[Results] There was no significant difference in mean HR during SR, however %VO₂max indicated a high value in TR (p<0.05). And there were no significant differences in vertical jump, muscle hardness and oxidative stress markers, however WBI was high in TR compared with in the untrained group (p<0.05).

[Conclusion] Compared with the untrained group, TRs performed continuously high intensity exercise with an equal HR level in a hypoxic environment.

Keywords : skyrunning, markers of muscle damage and inflammation, weight bearing index

342. Nitrate ingestion improved hypoxic exercise performance
Masahiro Horiuchi¹, Junko Endo¹, Shohei Dobashi², Yoko Honda³, Masataka Kuchí², Katsuhiko Koyama* (Mt. Fuji Res. Inst., Fujyoshida, Japan, ¹Univ. of Yamanashi, Kofu, Japan)

[Aims] Whether nitrate supplementation improves exercise performance under hypoxia has shown equivocal results. We investigated the impact of nitrate supplementation on exercise performance under hypoxia. [Methods] Nine healthy males performed a 25-minute submaximal (target heart rate ~ 140 bpm) and incremental leg cycling until exhaustion under three conditions: 1) normoxia without any drink, 2) hypoxia (FiO₂ = 13.95 %) with placebo (PL), and 3) with beetroot juice (BR). [Results] The time to exhaustion with BR (513 ± 24 s) was significantly longer than with PL (490 ± 39 s). In addition, peak oxygen uptake showed a higher trend with BR supplementation. [Conclusion] Dietary nitrate supplementation improved hypoxic exercise performance.

Keywords : hypoxia, nitrate, vasodilation

343. Impact of Endurance Exercise in Hypoxia on Muscle Damage, Inflammatory and Performance Responses
Daichi Sumi¹, Chihiro Kojima¹, Kazushige Goto¹ (Ritsumeikan Univ., Shiga, Japan)

[Aims] This study was designed to evaluate muscle damage and inflammatory and performance responses following high-intensity endurance exercise in moderate hypoxia among endurance athletes.

[Methods] Nine trained endurance athletes [maximal oxygen uptake (VO₂max), 62.8 ± 1.6 ml/kg/min] completed two different trials on different days: exercise under moderate hypoxia (H trial, FiO₂ = 14.5%) and normoxia (N trial, FiO₂ = 20.9%). They performed interval exercises (10 × 3 min running at 95% of VO₂max with 60 s of active rest at 60% of VO₂max) followed by 30 min of continuous running at 85% of VO₂max under either hypoxic or normoxic conditions. Venous blood samples were collected before exercise and for 120 min during the post-exercise period. The time to exhaustion at 90% of VO₂max was also determined to evaluate endurance capacity during the post-exercise period. [Results] The H trial induced a significantly greater exercise-induced elevation in the blood lactate concentration than did the N trial (P = 0.02), whereas the elevation in the exercise-induced myoglobin concentration (muscle damage marker) was significantly greater in the N trial than H trial (P = 0.005). The time to exhaustion 2 hours after the training session was shorter in the N trial (613 ± 65 s) than in the H trial (783 ± 107 s, P = 0.02). [Conclusions] In conclusion, among endurance athletes, endurance exercise under moderate hypoxic conditions did not facilitate an exercise-induced muscle damage response or cause a further reduction in the endurance capacity compared with equivalent exercise under normoxic conditions.

Keywords : Hypoxia, Muscle damage, Performance response

344. Influence of different body mass-based exercises on cardiorespiratory and muscular activities
Miki Haramura¹, Yohei Takai¹, Masayoshi Yamamoto¹, Hiroaki Kanelhisa* (National Institute of Fitness and Sports in Kanoya, Kagoshima, Japan)

[Aims] This study aimed to clarify the difference in cardiorespiratory and metabolic responses to body mass-based front lunge and squat exercises with relation to muscular activities. [Methods] Seven healthy adult males performed body mass-based squat and front lunge exercises 200 times. During the exercises, oxygen uptake, heart rate (HR), blood lactate concentration (La), and ground reaction force were measured. Oxygen uptake was expressed as the value relative to body mass (VO₂), and was normalized to maximal VO₂ obtained from an incremental loaded bicycle test (%VO₂max). Electromyograms during the two exercises were recorded from the vastus lateralis (VL), rectus femoris, vastus medialis (VM), biceps femoris, and gluteus maximus (GM). EMG amplitudes during both exercises were normalized to those during maximal voluntary contraction, and expressed as relative value (%EMG MVC). [Results] Time that cardiorespiratory parameters became stable was 4-6 min in both exercises. HR and La did not differ between the two exercises across time. VO₂, %VO₂max, VL %EMGMVC, and VM %EMG-MVC under the stable condition were higher in front lunge exercise than squat exercise. [Conclusion] Cardiorespiratory and muscular activities in body mass-based front lunge exercise are greater than those in body mass-based squat exercise. Exercise-related differences in cardiorespiratory parameters may be due to the difference in muscular activities of VL, VM and GM during the tasks.

Keywords : resistance training, moderate intensity, oxygen uptake
345. Noble mechanisms for anti-atherogenic effect of endurance training
Yuki Shinba1, Hanako Togawa2, Nanami Senoo1, Masahiko Ikeda2, Akihito Morita1, Shinji Miura1 (Grad. Sch. of Integr. Pharm. & Nutri. Sci., Univ. of Shizuoka, 2Tokoha Univ.)

[Aims] Numerous research have confirmed that exercise training reduce the risk of cardiovascular disease (CVD). However, the mechanisms involved in the reduction of CVD risk by training are incompletely understood. Recent epidemiologic study have shown that negative correlation between serum insulin levels and the CVD risk. In mouse, peroxisome proliferator-activated receptor gamma coactivator-1α (PGC-1α) overexpression in skeletal muscle stimulates FNDC5 (secreted as irisin) expression. Therefore, we assume that the PGC-1α overexpression in skeletal muscle prevents atherosclerosis. The aim of this study was to investigate whether PGC-1α overexpression in skeletal muscle suppresses atherosclerosis.

[Methods] We produced apolipoprotein E knockout (ApoE KO) mice. PGC-1α transgenic (ApoE KO/PGC-1α) mice, crossing atherosclerosis-prone ApoE KO mice with muscle-specific PGC-1α transgenic mice. Using this model, we measured plaque area of aortic region and serum lipidoprotein profile. [Results] Plaque area in ApoE KO/PGC-1α mice were reduced 43% as compared with ApoE KO mice. However, there was no significant changes in LDL cholesterol and HDL cholesterol levels in serum. [Conclusions] Our data indicated that overexpression of PGC-1α in skeletal muscle suppresses atherosclerosis in murine models. Endurance exercise training may suppress atherosclerotic disease via muscular PGC-1α dependent way.

Keywords: Atherosclerosis, PGC-1α, ApoE KO mice

346. Acute effect of resistance exercise on cerebral blood flow and arterial stiffness
Nobuhiro Nakamura1, Tsukasa Ikemura2, Isao Muraoka2 (Grad. Sch. of Sport Sci, Univ. Waseda, Saitama, Japan, Faculty of Sport Sciences, Waseda Univ)

[Aims] The purpose of this study was to examine the acute effect of resistance exercise on cerebral blood flow and arterial stiffness. In addition we examined the relationship between cerebral blood flow and arterial stiffness after resistance exercise. [Methods] Eight healthy young adult subjects participated in this study. Each subject took part in three trials: aerobic exercise (AE), high-intensity resistance exercise (HRE), and low-intensity resistance exercise (LRE). In the AE trial, subjects cycled at 60%HRmax on an ergometer. In the HRE and LRE trials, subjects completed 5 exercises at 75%1RM (HRE trial) or 50%1RM (LRE trial). In all of the trials, baseline measurements were obtained after the subjects had rested for 20 min, and the second measurement was obtained immediately after the trials. The third measurement was obtained 10 min after the trials. B-stiffness index and cerebral blood flow were measured at all points. [Results] Cerebral blood flow decreased immediately after and 10 min after the HRE trial. On the other hand, increased after the AE trial and no change was observed after the LRE trial. B-stiffness index increased immediately after and 10 min after the HRE trial, whereas no changes were observed after the AE and LRE trial. B-stiffness index was correlated with cerebral blood flow at rest, immediately after and at 10 min after each trial: r=-0.56, p<0.05, immediately after trial: r=-0.61, p<0.05, at 10 min after trial: r=-0.75, p<0.05).

Keywords: arterial stiffness, cerebral blood flow, high-intensity resistance exercise

347. Does wind-sprinting at warm-up may induce performance enhancement effects?
Kazuki Takizawa1, Taichi Yamaguchi2, Keisuke Shibata3, Nobuyasu Tomabechi1 (Institute of Physical Research, Rakuno Gakuen Univ., Hokkaido Univ.)

[Introduction] In the athletic events, wind-sprinting is usually carried out at warm-up exercise. But there is not clear whether wind-sprinting at warm-up exercise enhances endurance running performance. Therefore, this study investigated effects of warm-up and wind-sprinting combination for endurance running performance enhancement. [Methods] Eight well-trained male university middle or long distance running athletes (age: 19.7 ± 1.0 years, height: 171.1 ± 6.9 cm, weight: 59.4 ± 4.4 kg, VO2max: 71.1 ± 3.5 ml/kg/min) took part in this study. Each subject continued a treadmill run at VO2max until exhaustion (RUN-test) after one of three W-up procedures. The three W-up procedures were 1) 15 minutes running at 70%VO2max (WU), 2) 30 seconds wind-sprinting at 110%VO2max between 30 seconds interval (WS) and 3) 15 minutes running at 70%VO2max plus three 30 seconds wind-sprinting at 110%VO2max between 30 seconds interval (W2). The running performance was evaluated by time to exhaustion (TTE) at RUN-tests. VO2 was continuously measured three minutes before W-up to end of the exercise. [Results and discussion] In the results, there was a significant differences in the TTEs among the WU and W2 (p<0.05, WU: 760.6 ± 266.3 sec., WS: 695.6 ± 254.9 sec., and W2: 665.0 ± 240.9 sec.). VO2 at 5 minutes before RUN-test is lower in WS than other two conditions (p<0.001). And VO2 at 1 minute before RUN-test is lower in WU than other two conditions (p<0.001). These results showed that wind-sprinting may not enhance sub-maximal running performances.

Keywords: warm-up, endurance running, performance

348. Effects of aerobic exercise training on the nocturnal sleep and its blood pressure response
Akira Miura1, Ayano Yorimasa1, Ruiko Saguchi1, Masaki Fujimoto1, Hideaki Kashima1, Masako Yamaoka1, Yoshiyuki Fukuba1 (Prefectural Univ of Hiroshima)

[Aims] We determined effects of aerobic exercise training in early evening on the post-exercise blood pressure (BP), nocturnal sleep, and its BP response. [Methods] Nine healthy young male subjects who did not habitually exercise participated in this study. Each subject performed a 60 min at 50% heart rate reserve cycling, 3 times a week, for 6 weeks in early evening. BP and heart rate (HR) were measured 60 min post-exercise and then each hour from 23:00 to early morning (Holter HR/BP monitoring device). The quantitaive parameters of sleep (total sleep time, sleep efficiency, sleep onset latency, wake time after sleep onset) were determned by the actigraphy accelerometer. [Results] Post-exercise systolic BP was significantly lower than pre-exercise resting value during weeks 1, 3, and 6 of the exercise training period. Compared to pre-training nocturnal measurements, mean BP was significantly lower during weeks 1, 5, and 6 of the exercise training period and during 1 week detraining period. Sleep efficiency was significantly increased during week 5 of exercise training period. And sleep onset latency was significantly reduced during weeks 5 and during 1 week detraining period. [Conclusions] Our results demonstrated that aerobic exercise training (6 weeks, 3 times a week) in early evening has chronically positive effect on quantity of sleep and BP response of nocturnal sleep, even in young normotensive and non-insomniac humans. This study was supported in part by JSPS KAKENHI ([15K01560] to AM)

Keywords: aerobic exercise training, sleep, blood pressure
349. Exercise-induced increase in arterial adropin is related to decrease in arterial stiffness in diabetic rats
Shumphei Fujiyama, Natsuki Hasegawa, Naoki Horii, Koji Sato, Motoyuki Yenitsu (Ritsumeikan Univ., JSRS Research Fellow, Kobe Univ.)
[Aims] This study aimed to clarify whether aerobic training-induced elevation of arterial adropin level is associated with reduction of arterial stiffness and increase in NO production in type 2 diabetic rats. [Methods] Male 20-week-old type 2 diabetic rats (OLETF) were randomly divided into two groups (n=7 each group); sedentary control and aerobic training (treadmill running for 1 hour at 25m/min, 5 day/week for 8 weeks). Age-matched, healthy nondiabetic (LETO) rats (n=7) were used as controls. We evaluated aortic pulse wave velocity (PWV) as an indicator of arterial stiffness. [Results] The results indicated that OLETF-control rats showed significant increase in aortic PWV and decrease in arterial adropin level and eNOS and Akt phosphorylations, with reduction of plasma NOx level, compared to that of LETO rats (p<0.05). However, 8-week aerobic training in OLETF rats significantly decreased aortic PWV and elevated plasma NOx level and eNOS/Akt phosphorylations with increase in arterial adropin levels (p<0.05). In addition, significant correlations were observed between arterial eNOS phosphorylation and arterial adropin level (p<0.05, r<0.596) or aortic PWV (p<0.05, r<0.586). [Conclusions] These results suggest that aerobic training induces the elevation of arterial adropin levels as well as NO production in type 2 diabetic rats. Thus, the increased arterial adropin level may be associated with the beneficial effects of training on arterial stiffness. [Keywords]: Adropin, Aerobic Exercise, Arterial Stiffness

350. The effect of interval training with uphill slope on running economy
Yuriko Higaki, Daichi Sumi, Kazushige Goto (Sport and health science, Ritsumeikan Univ., Shiga, Kusatsu, Japan)
[Aims] The purpose of the present study was to evaluate the effect of 4 weeks of interval training with uphill slope on running economy. [Methods] Twelve male endurance athletes were divided into two groups: the group involving running training with uphill (5%) slope or the group involving the same training on flat level. The training consists of 10 bouts of 3 minutes running (90% of VO2max) with 1 minute active rest between bouts (60%VO2max running). Before and after the training period, maximal oxygen consumption (VO2max), running economy, and maximal power output for lower limbs were evaluated. [Results] There was no significant change in VO2max, VO2, or leg-power and vertical jump height after the training period in either group. [Conclusions] The 4 weeks of interval training did not affect running performance regardless of different gradient. [Keywords]: up-hill, running economy, interval training

351. The effect of exercise and time of day on the diurnal variation of endothelial nitric oxide synthase expression
Mutsuko Hieda, Hisashi Takakura, Hisashi Kato, Tetsuya Iwasa (Doshisha University, Kyoto, Japan)
[Aims] The frequency of myocardial infarction and sudden cardiac death is highest in the morning. Endothelial function could play an important role in explaining elevated cardiovascular risk in the morning. A prior study reported that endothelial function is reduced in the morning compared with other times of day. We hypothesized that endothelial nitric oxide synthase (eNOS) has a diurnal pattern, and that exercise training affects the diurnal variation of eNOS. [Methods] Male Wistar rats were randomly assigned into four groups: a 6T group, exercise training at 6:00; a 20T group, exercise training at 20:00; a 6C control group, time-matched to the 6T group; and a 20C control group, time-matched to the 20T group (each group, n = 8-10). The exercise training groups were forced to run for ~90 min at ~30 m/min, 5 days/week for 9 weeks. [Results] While the expression of eNOS tended to be lower in the morning (C6) than in the afternoon (C20) control groups, exercise training did not induce a difference in levels between the morning (T6) and afternoon (T20) groups. In a comparison of eNOS expression in the exercise training and control groups, T6 tended to show higher levels than C6, but there was no difference between T20 and C20. [Conclusions] These data indicate that variation in eNOS could play an important role in explaining lower morning endothelium-dependent flow-mediated dilatation. The time of measurement must be considered in assessment of arterial function. [Keywords]: endothelial function, exercise training, endothelial nitric oxide synthase

352. Effects of downhill vs level running training at the LT on aerobic capacity
Hisashi Mori, Sumiaki Maeo, Kota Tayashiki, Junichi Toyomura, Hiroaki Kaneshita, Masayoshi Yamamoto (Ritsumeikan Univ., Waseda Univ., NIFS, Miura Dolphins)
[Aims] This study investigated effects of downhill or level running training at the lactate threshold (LT) on aerobic capacity. [Methods] Seventeen young males trained for 5 weeks using a treadmill with -10% slope (downhill group [DG] n = 9) or without slope (level group [LG] n = 8) at LT velocity for 20 min/session, 3 sessions/week. Before and after the training period, the following variables were measured: VO2max, running velocity at LT (vLT), onset of lactate accumulation (vOBLA), and VO2max and VVO2max, and running economy at 70%VO2max (RE) on a level surface. Training velocity, heart rate, and rating of perceived exertion for respiration and leg were measured throughout the training period. [Results] Heart rate during exercise did not differ between the groups (DG: 153.9 ± 9.1 vs. LG: 149.4 ± 9.5 bpm; average of 5 weeks), but the running velocity was significantly (p < 0.01) higher for the DG than LG (DG: 239 ± 18 vs. LG: 200 ± 31 m/min) throughout the training period. After the training, the LG significantly (p < 0.05) improved VO2max (4.9%), vOBLA (6.9%), vVO2max (7.0%), and RE (-4.1%), but none of the variables changed in the DG. [Conclusion] The current results suggest that downhill running training at the LT does not improve aerobic capacity, as level running training does. [Keywords]: Aerobic power, Eccentric exercise, Running Economy
354. **The Effects of Respiratory Muscle Training (soutai kokyu hou) on the Physical and Mental conditions**

Yukio Tanaka1, Sinji Ishihama2, Naotugu Kaneko1, Hideaki Murakami1, Tomoharu Kitada1, Sachio Kawai1, Kazuhiko Sakuma1, Kazunori Koshikawa1, Akira Nakamura1, Hisashi Naito1

(Junetudo Univ., Inzai, Japan)

[Aims] We reported that the control and regulation of muscle vascular tone are maintained well via the central nerve-sympathetic and myogenic coupling in Ki and Budo experts. The purpose of this study is to investigate that the effects of the breathing method on the physical and mental conditions in the elders.

[Method] 1) Subject: The average age was 75.6 years old. 2) The long breathing method: Various breathing exercises (5min).

The slow moving body exercise for relaxation (15min).

1) Tai-ki for exchanging Ki energy with another person (3min).
2) Body reaction time was measured before and the after.
3) The stress level was measured by the Lorish face scale method.
4) Peripheral vasoconstriction and hemoglobin were measured by ASTRIM.

[Result and discussion] Before the breathing method, body reaction time was an average of 421±42 ms (mean±SD) and was 396±37 ms after the breathing method. Body reaction time was reduced clearly (P<.05). It seems that brain net work is active and smooth after the breathing method. Before the average of the value of Face scale was 5.5 and after was 3.0 (P<.05). This result suggests that the breathing method uplifts feeling and makes mental condition bright. The peripheral vessel diameter was contracted in the stress image as compared with the control and after the breathing method, the diameter was extended and in the relaxed image, it was not so changed. These results demonstrate that the breathing method is able to reduce the stress and control the microcirculatory system.

**Keywords:** long breathing exercise, stress, microcirculatory response

355. **Effects of aerobic arm or leg exercise following resistance training on blood flow of the brachial artery and femoral artery**

M Okuyama1, N Kikuchi1, T Okamoto1, R Kobayashi1, K Nakazato1

(Nippon Sport Science Univ)

[Aims] The purpose of this study was to examine the effects of lower-body or upper-body ET following RT on blood flow in the brachial artery (BA) and femoral artery (FA).

[Methods] Seven healthy young men (age: 20.1 ± 1.5 years, height: 170.9 & 4.1 cm, weight: 62.4 & 6.4 kg) were divided into 2 exercise groups. Two exercise groups consisted of aerobic arm exercise following whole-body RT (AT) and aerobic leg exercise following whole-body RT (LT).

Seven subjects crossed over to a different exercise group. All subjects performed whole-body RT (free weight bench press and squat exercises) consisting of 3 sets of 10 exercises at 75% of 1 repetition maximum. Subjects in the exercise groups performed aerobic arm or leg exercise at 65-75% of their maximal heart rate for 30 min immediately after each RT session. Blood flow was measured before and immediately after RT, immediately after ET, and 15 and 30 min after each training session. Pulse wave velocity was measured before and 30 min after ET. [Results] FA blood flow in the LT group was higher at all time points compared with baseline. FA blood flow in the AT group was higher after RT, compared with baseline. BA blood flow in the LT and AT group was higher immediately after RT and immediately after ET compared with baseline.

Additionally, it was significantly increased in the AT group at 15 min after ET. [Conclusions] FA and BA blood flow increased by resistance training sustained by aerobic leg exercise. However, Aerobic arm exercise dose not sustain BA blood flow increased by resistance training.

**Keywords:** Concurrent training, Blood flow, aerobic exercise
357. Effects of failure and non-failure in resistance training with low-load high-repetitions on acute metabolic responses

Kentarō Terada¹, Naoki Kituchi¹, Koichi Nakazato¹ (Nippon Sport Science University)

[Aims] The purpose of this study was to investigate the effects of failure and non-failure in resistance training (RT) with low-load high-repetitions on acute metabolic responses. [Methods] Thirty untrained male volunteers (age: 20 ± 0.8 years, height: 170.1 ± 5.7 cm, weight: 62.9 ± 6.0 kg) were selected to participate in this study. The subjects were randomly assigned to 3 training protocols as follows: low-load (40% 1 repetition maximum [1RM]) training to volitional failure (LVF), low-load training without volitional failure (LNVF), high-load training (HT, 80% 1RM 8 repetitions). Each group performed 3 sets of bench press. We measured work volumes, repetitions, time under load, %change of muscle thickness (MT) of the pectoral major (PM) was measured at before and after of RT. Blood lactate concentration (BLC) was measured at before, after each set, after RT 5 min and 10 min. Power output was measured using a transducer system (GymAware) during the training sessions. We defined the criterion for non-failure as ≈80% of the average of the first 10 repetitions. [Results] No significant differences in total work volumes and total repetitions and BLC were observed in LVF and LNVF. However, time under load was higher in LVF than in LNVF and HT (p<0.01). %change of MT was also higher in LVF than in LNVF and HT (p<0.05). [Conclusions] Our results suggested that LVF has higher time under load and %change of MT than other training protocols.

Keywords: failure, blood lactate, muscle swelling

358. Response of skeletal muscle to acute endurance exercise based on circadian rhythms of clock gene

Hisashi Takakura¹, Daishin Ueno¹, Hisashi Katö¹, Shinashi Masuda², Mutsuko Hieda¹, Tetsuya Izawa¹ (Doshisha University, Kyoto Medical Center)

[Introduction] Clock genes (bmal1 and per2) exhibit circadian rhythm, and the expression pattern of per2 is synchronous with that of pgc-1α in skeletal muscles. Additionally, pgc-1α expression is increased as an acute response to endurance exercise. We found that the timing of exercise training influenced training-induced adaptation; therefore, the timing of exercise may also induce the difference in pgc-1α expression levels after a few hours of acute exercise. [Purpose] This study aimed to determine whether the timing of exercise enhances acute exercise-induced increases in the levels of mitochondrial genes in skeletal muscles. [Method] Male Wistar rats were randomly assigned to the following exercise and control groups. Acute exercise (17 m/min, 60 min) was conducted at two time points: when per2 expression showed the highest and lowest expression (20E and 6E) (each group, n = 6). The gastrocnemius muscle was excised immediately, 3 h, or 6 h later after acute exercise. The mRNA expression levels of mitochondrial genes [Cytochrome c (cyto c) and citrate synthase (cs)] and pgc-1α in the deep portion of the gastrocnemius muscle were measured by real-time PCR. [Result] Pgc-1α expression was significantly increased immediately after acute exercise only at 6E. Cs was also increased at the same time point, whereas cyto c was increased by acute exercise, irrespective of the timing of exercise. [Conclusion] The differential adaptation in skeletal muscle might be caused by the differential PGC-1α expression after acute exercise.

Keywords: clock gene, skeletal muscle, mitochondrial biogenesis

359. Irisin response to different muscle contraction during running exercise in humans

Yoshifumi Tsuchiya¹ ², Sahiro Mizuno³, Ikuhiro Morii², Kazushige Goto¹ (Nagasaki University, JSPS Research Fellow, Ritsumeikan University)

Irisin leads to increasing in energy expenditure. However, information about influence of exercise-induced muscle damage on irisin response has not been reported. Therefore, we hypothesized that down-hill running (with larger muscle damage) would elicit exercise-induced irisin response compared with level-running (with smaller muscle damage) under same exercise duration and VO2 during the exercise. The purpose of present study was to compare exercise-induced irisin response between level-running (LR) and down-hill running (DHR). Fifteen healthy males were randomly assigned to the LR group (n = 8) or DHR group (n = 7). Subjects in the LR group conducted 30 min of treadmill running exercise with 0 % slope, whereas the subjects in the DHR group performed the same treadmill running exercise with -10 % slope. Exercise intensity set as 70 % of V̇O2 during the exercise. The purpose of present study was to compare: low-load high-repetitions on acute metabolic responses.

Keywords: failure, blood lactate, muscle swelling

360. Characteristics of upper-body pull exercise power in Japanese female wrestlers

Tatsuki Naka¹, Masaaki Kanno¹, Shota Shidochi¹, Kazuhito Sakae¹, Nonhiro Shima³ (Shigakkan University, Aichi Gakuen University, Tokai Gakuen University)

[Aims] This study aimed to compare the pull power, power endurance, and number of repetitions of female wrestlers with those of track-and-field sprinters to elucidate the physical strength characteristics required by female wrestlers. [Methods] Twenty female wrestlers (8 Olympic- and/or world-class and 12 national-class) and 14 female sprinters (including 3 championship students) performed upper-body pull. Subjects lie in a prone position on a bench and pull a barbell. Their power was measured by every-10 kg increased weight. To measure power endurance, the power to reach number of maximum repetitions were measured using the load at their maximum power. All measurements were obtained using a power meter (GymAware). [Results] Subjects in the wrestler group demonstrated more power at 30, 40, and 50 kg than subjects in the sprinter group. Although both groups showed a significant reduction in power endurance after at least 30% of the number of maximum repetitions, the wrestler group showed a significantly higher number of maximum repetitions. The world-class wrestlers had abilities that exceeded those of the national-class wrestlers. [Conclusions] Female wrestlers were characterized by their ability to exert high upper-body pull power under heavy loads, and their ability to maintain a high level of power and to repeat motions. These abilities are related to their competitive performance. This study suggests that higher pull power endurance in the upper-body exercise play a role in improving their competitive performance level.

Keywords: load-power relationship, world-class athletes, female wrestling
361. **Comparison of quadriceps muscle size and VO_{2max} in middle-aged and older recreational cyclists with young adults**

Hayao Ozaki¹, Tomoharu Kitada¹, Toshiharu Natsume¹, Shuichi Machida¹, Hisashi Naito¹, Shizuo Katamoto¹

([Aims] We compared lower limb muscle size, muscle strength, and VO_{2max} between untrained young adults (UYs) and middle-aged and older recreational cyclists (MOCs) and investigated the relationship between training frequency and muscle size, muscle strength, and VO_{2max} among MOCs. [Methods] Nine UYs (age, 25–30 years) and 8 MOCs (age, 48–62 years) voluntarily participated in this study. They underwent muscle thickness (MT) evaluation, a maximal exercise test on an ergometer to determine the VO_{2max}, and maximal strength tests. Additionally, we determined the mean training distance and frequency of training per week in the last year by using a questionnaire. [Results] There were no significant differences in the VO_{2max} and the muscle thickness (MT) of the anterior aspect of the thigh (AT) or the posterior aspect of the lower leg between UYs and MOCs. Nevertheless, the maximal isometric and isokinetic strengths of knee extensors and flexors were significantly higher at all angle velocities in UYs than in MOCs. In MOCs, VO_{2max} and the MT of the AT significantly correlated with self-reported training frequency per week. The MT of the AT tended to correlate with VO_{2max}, but not with isometric knee extension strength. [Conclusions] MOCs and UYs have comparable quadriceps muscle size and VO_{2max}, but lower maximal strength of the knee extensors and flexors. Furthermore, cyclists with higher (compared with lower) training frequency had a significant difference in the RPE and V̇AS. [Conclusions] In conclusion, the different recovery modalities of icing were equally effective on muscle fatigue during the recovery period.

**Keywords**: cycling, muscle adaptation, aerobic capacity

362. **Effects of exercise and nutritional supplementation in community-dwelling frail elderly women**

Hunkyung Kim¹, Miji Kim¹, Yuko Yoshida¹, Takao Suzuki²

([Aims] Frailty has been associated with physical disability and mortality, as well as a cause of long-term care in the elderly. Therefore, it is important to establish preventive measures and interventions. Purpose: The purpose of this study was to investigate the effects of a three month exercise and nutritional intervention on community-dwelling frail elderly women. Methods: Among 1,835 community-dwelling elderly women who participated a comprehensive geriatric survey, 331 were defined as frail and 131 were included in the trial. Participants were randomized into one of the nutritional supplementation groups were provided with MFGM or placebo to be taken daily for three months. Body composition, physical function, and blood component data were collected. Results: Pre- and post-intervention comparisons showed that there were significant differences in usual walking speed (F=6.904, P<0.001), TUG (F=6.124, P=0.001), BDNF (F=2.837, P=0.041), and IGF1/IGFBP3 (F=3.831, P=0.012) between the groups. The frailty reversal rate was 57.6% in the exercise+MFGM group, 51.5% in the exercise+placebo, 28.1% in the MFGM, and 30.3% in the exercise+placebo group (β=8.828, P=0.032). Compared with the placebo, the exercise+MFGM group was over three times as likely to reverse frailty (OR=3.12, 95%CI=1.13-8.60). Conclusion: The results suggest that exercise in combination with nutritional supplementation can improve frailty status.

**Keywords**: Frail, Exercise, Nutrition

363. **Comparison of the various recovery modalities on muscle fatigue in between exercise**

Yui Kataoka¹, Hiroshi Suito², Keisuke Teramoto²

([Aims] In some athletic events, the competitive matches are performed several times a day, and players are required to have rapid recovery in a brief amount of rest time. In general, one of the recovery modalities for muscle fatigue is the use icing and massage, however, the effect of these methods on muscle fatigue is unclear. The aims of the present study were to investigate the comparative effect of icing, icing + passive recovery (massage) and icing + active recovery (light exercise) on muscle fatigue. [Methods] Six male and 8 female students volunteered for this study. All participants performed two times maximal repetitive elbow flexion-extension exercise at 50 % maximum voluntary load and randomly assigned to topical icing either icing + massage or icing + light exercise in seated position (rest) after the exercise. Measurements were taken before and after the elbow flexion exercises: muscle strength and endurance of elbow flexion and RPE, VAS. [Results] There were no significant differences in the rate of recoveries of muscle strength and endurance compared with the rest. Moreover, there was no significant difference in the RPE and VAS. [Conclusions] In conclusion, the different recovery modalities of icing were equally effective on muscle fatigue during the recovery period.

**Keywords**: Muscle fatigue, Icing, Passive and active recoveries

364. **Effect of combined training in a hypoxia on strength and intermittent performance**

Zhong Huang¹, Kazumichi Kurobe², Masato Nishiwaki³, Takuma Arimitsu³

([Aims] High-intensity training in a hypoxia reportedly has a positive effect on sprint performance. This study aimed to examine the effect of combined training with resistance and sprint exercise in a hypoxia on muscle strength and intermittent exercise performance. [Methods] Eight healthy adult male subjects were tasked with performing resistance exercises and sprints in a hypoxia (H; FiO_{2} = 12.7%) or normal-oxygen (N; FiO_{2} = 20.9%) three times a week for 8 weeks. They participated both H and N group at an interval of at least 8 weeks. One-repetition maximum (RM), 10RM, muscle cross-sectional area (CSA), intermittent exercise performance (IEP), and isokinetic knee hip-joint flexion and extension torque were measured before and after training. [Results] After training 1RM, 10RM, CSA, peak power during IEP, and isokinetic knee extension torque significantly increased in both groups. Though no significant differences were observed in H and N group. On the other hand, the hip-joint flexion and extension torque significantly increased only in the H group, while the rate of increase in the H group also tended to be higher than in the N group. [Conclusions] These results suggest that combined training is effective in increasing muscle strength and CSA and in improving power performance. Moreover, hypoxic stimulation may facilitate the increase of isokinetic joint strength.

**Keywords**: combined training, hypoxia, power
365. The relationship between upper limb SSC ability and shot put performance
Kazufumi Terada1,2, Takanari Yoshimoto1, Tatsuki Nakagawa2, Yousuke Kobayashi2, Hisashi Yoshida3, Daisuke Yamamoto2,5, Toshiaki Nakatani2,5 (Tei University/Tei University Grad School)

[Introduction] The relationship between athletes’ ability to perform the stretch-shortening cycle (SSC) movements with their upper limbs (ULs) and shot put performance (SP) has not been studied in detail. The purpose of this study was to examine the relationship between an index to evaluate the ability using the SSC movement in the ULs and SP records in male collegiate track and field athletes.

[Methods] Fifteen healthy men aged 19.9 ± 0.9 years without disease or impairment affecting the musculoskeletal system were enrolled in this study; ten of the subjects specialized in throwing, and 5 specialized in the decathlon. The measures used were the rebound jump index (RJI) and vertical jump test (VJ) for the upper and lower limbs, torque of the isometric knee extension (KE), height, body weight, and weight of the upper half of the body (WU). We also investigated all-time personal SP, long jump, standing long jump, standing quintuple jump (SQJ), back throw with 12 pounds shot (BT), and one-repetition maximum on bench press and full squat, standing quintuple jump (SQJ), back throw with 12 pounds shot put (SP), and one-repetition maximum on bench press and full squat.

[Results] Correlation analysis with Spearman’s rank method revealed that SP was related to the RJI for the ULs, VJ for the ULs, right side of the KE, BT performance, height, weight, and WU (r = 0.56–0.70). Partial correlation coefficient analysis, in which height and body weight were used as the control variables, revealed that SP was related to the RJI for the ULs (r = 0.73) and SQJ (r = 0.67). [Conclusion] These results suggest that SP is strongly related to the RJI for the ULs.

Keywords: extremities, shoulder, elbow

366. Effects of static, dynamic, and combined stretching on flexibility and isometric muscle force
Shingo Matsuo1,2, Shigeyuki Suzuki3, Masahiro Iwata1,2, Wakako Tsuchida3, Taizan Fukaya4, Eiji Yamanaka6, Yuji Asai1 (Fac. Hlth. Sci., Nihon Fukushi Univ.; Handa, Japan; Dept. Phys. Ther., Grad. Sch. Med., Nagoya Univ., Nagoya, Japan)

[Aims] The aim of this study was to investigate the effects of static, dynamic, and static plus dynamic stretching on range of motion (ROM), passive torque (PT) at pain onset, passive stiffness, and isometric muscle force. [Methods] A randomized crossover trial was conducted. Seven healthy young men undertook 300-s static, dynamic, and combined stretching (150-s static stretching followed by 150-s dynamic stretching, and 150-s dynamic stretching followed by 150-s static stretching) of right knee flexors actively on four separate days in random order. ROM and passive stiffness during knee extension, PT at pain onset, and isometric knee-flexion force were measured using an isokinetic dynamometer immediately before and after stretching. [Results] All stretching methods significantly increased ROM and PT at pain onset, and significantly decreased passive stiffness and isometric knee-flexion force immediately after stretching. The magnitude of change in all measurements between stretching methods was not different. [Conclusions] These results suggest that 300-s of stretching increases flexibility and decreases isometric muscle force, with the effects of stretching similar between the stretching methods.

Keywords: static stretching, dynamic stretching, warm-up

367. Relationship between core stability and different types of athletic performance
Takahumi Kubo1, Mitsuru Higuchi2 (Grad Sch of Sport Sci, Waseda Univ.; Faculty of Sport Sci, Waseda Univ.)

[Aims] Core exercise for sport and health has become very popular in Japan. For this reason, there are many books and articles about core exercise. However, these books are lack of evidences and whether core exercise is good for athletic performance or not differ from articles. So, the aim of this study was to investigate effect of core stability on different types of athletic performance and to prove clearly which core stability or muscle strength is more effective for athletic performance. [Methods] Sixteen male athletes (age = 20.9 ± 1.5 years, height = 175.5 ± 4.8, weight = 72.8 ± 8.0) were evaluated with McGill’s endurance test, back squat 1RM, bench press 1RM, vertical jump, broad jump, hexagonal jump test, 20-m sprint, 40-m sprint. [Results] There were correlations between core stability and broad jump (r = 0.673, p<0.01), hexagonal jump test (r = 0.648, p<0.05). There were also correlations between muscle strength and vertical jump(r = 0.645, p<0.05). However, there were not correlations on 20-m, 40-m sprint neither core stability nor muscle strength. [Conclusions] Both core stability and muscle strength were correlate with different types of athletic performance. Following this result, we should train both core stability and whole body muscle strength.

Keywords: core exercise, athletic performance, muscle strength

368. Effect of chemical stimulation of cold receptors with menthol on walking performance in older adults
T Tokunaga1,2, C Tanado2, H Sugawara2, S Kiji1, Y Watanabe1, T Saitou1, M Tomonura1, M Sudou1, Y Hashimoto1, M Muro1 (Kao Corp., Toho Univ.)

[Background] Physical stimulation of cold receptors of the skin has a positive effect on performance in low load training in older adults, but it is not clear whether chemical stimulation of cold receptors with a chemical substance (CCS) has the same effect. [Aims] We examined the effect of CCS, over the quadriceps muscle, on walking performance in older adults. [Methods] Healthy older women (60-69yrs, N=42) were divided into 3 groups (Group A: CCS + walking, Group B: Walking, Group C: Non-exercise). Groups A and B participated in free walking for 30 minutes a day, twice a week, for 6 weeks, and menthol gel was applied to subjects in Group A to chemically stimulate cold receptors in the front of the thigh just before each training session. Body composition, thigh girth (TG), maximum knee extension strength (MVC), rate of force development (RFD), free walking speed, and the Short-Form 36-Item Health Survey version 2 (SF-36v2), were measured before and after the training protocol and the changes were examined. [Results] Walking speeds significantly increased in Groups A and B, but there was no difference between the two groups. MVC, RFD and SF-36v2 significantly increased in Group A but no changes were observed in Groups B and C. Muscle mass and TG did not change in all of the groups. [Conclusions] These results suggest that CCS over the quadriceps muscle using menthol gel is effective for improving walking performance in older adults through the facilitation of muscle activity and, therefore, also has the potential to improve quality of life (QOL).

Keywords: menthol, walking performance, older adults
369. **Thrust-back: A new strategy for increased concentric velocity and muscle activation during power training**

Akihiro Sakamoto¹, Hisashi Naito¹ (Juntendo University)

[Aims] In power training, not only heavy resistance but also light resistance is chosen to develop speed-oriented power ability. No matter what resistance is assigned, power training should be conducted at maximum effort (or velocity). Under light loadings, projectile movements using Smith machine are recommended to minimize decelerations near the end of the concentric phase. Exercise type is, however, limited since Smith machine can be used mainly for vertical pushing exercises. This study evaluated our new training strategy, Thrust-Back, where a spotter pushes back the bar or the limbs of a lifting performer, instead of the lifter having to decelerate the concentric movement himself or herself. [Methods] Twenty-one resistance trained men performed fast bench press (BP), seated-row (ROW) and knee extension (KE) at 50, 40, 30% 1RM (5 reps each) with and without thrust-back (TB vs. CON). A wireless goniometer quantified the peak joint angular velocities about the elbow (BP and ROW) and the knee (KE). EMG was recorded from the pectoralis major and triceps lateral head (BP), posterior deltoid and latissimus dorsi (ROW), and vastus lateralis and medialis (KE) to examine muscle activations. [Results] The peak concentric angular velocities were 1.06-1.16 times greater for TB than CON (P<0.05). TB also resulted in greater EMG amplitudes than CON for all exercises across wide concentric ranges (P<0.05). [Conclusions] Thrust-back successfully increased concentric velocity and muscle activation during training compared to normal fast lifting, helping to overcome the issue of equipment constraints associated with Smith machine.

**Keywords:** joint angular velocity, EMG, resistance training

370. **Endurance training causes distinct changes in mitochondrial morphology in different skeletal muscle types**

Daiki Nakano¹, Kana Takagi¹, Shuichi Machida¹ (Juntendo University)

In response to both endogenous and exogenous stimuli, mammalian mitochondria undergo dynamic structural remodeling via fusion and fission events that support biogenesis, maintain functional integrity, and assist in the removal of dysfunctional organelles. Due to the contractile properties of the skeletal muscle, the mechanisms mediating mitochondrial shape changes in different skeletal muscle types may be complex and diverse. We tested this hypothesis in a rodent model of endurance exercise training. Six female Sprague Dawley rats (4 weeks old) were assigned to either endurance training (80% $\overline{V_O}_2$ max, 120 min/day, 5 days/week) or to a sedentary control environment for 8 weeks. Upon completion of each intervention, the soleus and vastus lateralis (VL) muscles were dissected, and approximately 600 intermyofibrillar mitochondria were analyzed with transmission electron microscopy. We estimated the shapes and sizes of sampled mitochondria using ImageJ software based on measurements of surface area, perimeter, aspect ratio (AR), form factor (FF), circularity, and roundness. In the soleus muscle, endurance training affected mitochondrial morphology, i.e., decreased AR and FF and increased circularity compared with the sedentary soleus samples. In contrast, we observed no morphological changes in VL mitochondria. In conclusion, endurance training caused skeletal muscle-specific mitochondrial adaptations. Differences in fiber composition between muscle types are likely to account, at least in part, for the observed effects.

**Keywords:** mitochondrial morphology, endurance training, skeletal muscle specificity

371. **Effects of low-intensity leg press exercise with restricted leg muscle blood flow on muscle activation**

Koji Kurita¹ (Physical Conditioning Production)

AIM To compare the EMG activity of blood flow restricted(limb) and non-restricted(buttock) muscles during leg press exercise with and without restricted leg muscle blood flow. METHODS A cross-over intervention study. Seven healthy adults performed 3 sets (30,15, and 15reps) of leg press exercise (30%1RM) during two different conditions, restricted leg muscle blood flow(R) and non-restricted (NR). A specially designed elastic cuff belt in the condition of R was placed at the most proximal position of the thigh. Surface EMG was recorded from the rectus femoris(RF), vastus lateralis(VL), medial hamstrings(MH), and glutaeus maximus (GM) muscles, and root mean square value of EMG, RMS, normalized as the relative exercise intensity(%). RESULTS During 3sets of exercise, gradual increases in RMS were observed in VL and GM in condition of R (p<0.05). A significantly change was not shown in MH and RF(p=0.05). CONCLUSION Increases in activation of the non-restricted trunk muscle during leg press exercise with restricted leg muscle blood flow might be an important factor for blood flow restricted training induced trunk muscle hypertrophy. The difference was shown in the muscular activity of each muscle of the leg (RF, MH and VL). The cause might be a physical oppression of the belt.

**Keywords:** blood flow restriction, oppression, muscular activity


374. A study of the mutual relationship of multiple types of physical fitness and athletic ability

Kazumichi Kurobe1 (Hannan Univ., Matsubara, Japan)

[Aims] There are many methods to measure physical fitness and athletic ability in humans, but the mutual relationship of physical fitness is not completely clear, specifically with regards to their interdependence. This study aimed to examine the correlations among various physical fitness test data. [Methods] Sixteen healthy male adults participated in this study. All of the subjects performed 9 kinds of physical fitness tests as follows: 1) grip strength, 2) back strength, 3) number of sit-ups, 4) number of side-to-side jumps, 5) standing jump, 6) vertical jump, 7) maximum anaerobic power measured by cycle ergometer, 8) long-seat body anteflexion, and 9) reaction time with visual stimulus. A correlation analysis was applied to determine the relationship between the data for all of the tests. [Results] Back strength was found to have a significant correlation with the standing jump, maximum anaerobic power (p<0.01), grip strength, sit-ups, and the vertical jump (p<0.05). Back strength was widely related to physical fitness, not only in the upper body, but also in the lower body. Furthermore, vertical jump performance was significantly correlated with the number of sit-ups (p<0.05), but there was no significant correlation between the standing jump and sit-ups. Long-seat body anteflexion and reaction time did not have significant correlations with any other tests. [Conclusions] Back strength was strongly correlated with muscle strength and overall power ability in the whole body. Although not observed in the standing jump, the results of the vertical jump were closely related to sit-ups, in spite of similar jump performance.

Keywords: physical fitness, athletic ability, correlation

375. Influence of glycemic index ingested before exercise in muscular endurance capacity

Tomakki Okamura1, Yoshio Suzuki2 (Faculty of Health Sci. Kyoto Kyoji Univ. Urayasu, Japan, 2Faculty of Health & Sports Sci. Juntendo Univ. Inzai, Japan)

[Aims] This study aimed to assess the effect of GI differences of the carbohydrates ingested before high intensity exercise on the power output and endurance capacity as well as blood glucose levels. [Methods] Eight healthy male college students participated in the study. The subjects underwent three experiments in a cross-over manner with testing days separated by at least 7-d. They took either glucose, fructose or erythritol (1g/kg BW) an hour prior the exercise. The exercise comprised of 16 sets of knee extension flexion with different rest periods and repetitions. [Results] After resistance training, MT increased significantly at post, 2min and 5min in 12S-20R group, whereas a significant increase was observed only at post in 3S-20R and 12S-180R groups. However, there were no significant differences in change rate at post between groups. [Conclusions] These findings suggest that muscle swelling was observed for a longer period by increasing repetition frequency or shortening rest intervals, although there were no significant differences between protocols in magnitude of muscle swelling immediately after training.

Keywords: glycemic index, muscular endurance capacity, blood glucose

376. Effect of long sprint running on jumping performance

Syunosuke Ando1, Kazuhiro Yamazaki1, Tosho Yanagiya1 (Juntendo University)

[Aims] Vertical stiffness (Kvert), defined as the ratio of height change to ground reaction force during contact phase, has been used as the index of stretch shortening exercise (SSC). Hobara et al. estimated changes in Kvert during 400m sprint running, and reported it to peak in the phase between 50-100 m, it decreased after that. This phenomenon leads us to the hypotheses that decreased running speed in the latter part of long sprint event had related to the decrease in the ability of vertical jumping. Therefore the purpose of this study was to investigate the cause of decline in that latter part of long sprint running from a viewpoint of vertical stiffness. [Methods] Seventeen sprinters were divided into two groups, elites and controls, according to their personal best 400m time (49.23±1.84sec, 46.36sec to 55.31sec). They run 300m using non-motorized treadmill (Curve, Woodway) in all their effort. Before and immediately after the sprint running, they had hopping jump for 15 times on the force platforms. Kvert and jump height (JH) during hopping was estimated by ground reaction data. [Results] As a results, 300m time were for 45.6±2.33sec and 49.8±3.56sec, in Elites and controls, respectively. After 300m sprint, JH decreased for 32% and 43% in elites and controls, respectively. Moreover, Kvert and jump height (JH) during hopping was estimated by ground reaction data. [Conclusions] After sprinting and hopping, there was no significant correlation between the standing jump and sit-ups. Long-seat body anteflexion and reaction time did not have significant correlations with any other tests. [Conclusions] Back strength was strongly correlated with muscle strength and overall power ability in the whole body. Although not observed in the standing jump, the results of the vertical jump were closely related to sit-ups, in spite of similar jump performance.

Keywords: long sprint running, vertical stiffness, vertical jump height
377. **Effects of Press tack needle stimulation on continuous isokinetic exercise**

Yasuhisa Kaneko1,2, Eiji Furuya2, Naoya Tsunoda3, Ayumi Sakamoto4, Takafumi Hamaoka1 (1 Tokyo Medical Univ., 2 Kuretake College, 3 Kokushikan Univ.)

**[Purpose]** The aim of this study was to examine the effects of press tack needle stimulation on continuous isokinetic exercise of knee extensors. **[Methods]** Subjects were 12 triathletes (age: 22±3 yrs, height: 173.4±5.5, weight: 64.5±3.3). They performed repetitive isokinetic knee extension exercise (5 sets of 30 repetition, angular velocity: 60 deg/s) after 1) press tack needle stimulation (Seirin Pyonex, needle length: 0.6mm) on quadriceps (SP10, ST34) (acuQ), and 2) press tack needle stimulation on lumbar region (BL23, BL24, BL25, BL26 and BL32) (acuL), and 3) Placebo needle on lumbar region (P). Peak torque, total work and average power were observed. Rate of changes of those indexes from the first set were evaluated. **[Results]** There were no significant differences on Peak torque, total work and average power among groups at the first set of exercise. Peak torque of P group significantly decreased to 12.9±3.8%, 13.6±3.9% (4th set), 5th set, respectively, p<0.05) while no significant changes were observed in acuQ and acuL. There was a significant decrease in total work of P group (10.9±2.4%, 12.5±3.2%, 13.9±3.7% (3rd, 4th, 5th set, respectively, p<0.01), and also of acuQ group(5.0±1.2% at 3rd set, p<0.05). For average power, a significant difference was observed at 5th set between P group and acuL group(5.0±1.2% at 3rd set, p<0.05). For average power, a significant difference was observed at 5th set between P group and acuL group(5.0±1.2% at 3rd set, p<0.05). For average power, a significant difference was observed at 5th set between P group and acuL group(5.0±1.2% at 3rd set, p<0.05). For average power, a significant difference was observed at 5th set between P group and acuL group(5.0±1.2% at 3rd set, p<0.05). For average power, a significant difference was observed at 5th set between P group and acuL group(5.0±1.2% at 3rd set, p<0.05). For average power, a significant difference was observed at 5th set between P group and acuL group(5.0±1.2% at 3rd set, p<0.05). For average power, a significant difference was observed at 5th set between P group and acuL group(5.0±1.2% at 3rd set, p<0.05). For average power, a significant difference was observed at 5th set between P group and acuL group(5.0±1.2% at 3rd set, p<0.05). For average power, a significant difference was observed at 5th set between P group and acuL group(5.0±1.2% at 3rd set, p<0.05). For average power, a significant difference was observed at 5th set between P group and acuL group(5.0±1.2% at 3rd set, p<0.05). For average power, a significant difference was observed at 5th set between P group and acuL group(5.0±1.2% at 3rd set, p<0.05).

**Conclusions** These results suggested press tack needle stimulation on the muscle, or on the same innervation area prior to the isokinetic exercise suppress the decrease of muscular output caused by fatigue. **Keywords**: Acupuncture, Press tack needle, isokinetic exercise

378. **Comparison of Factors Related to Jump Performance in Volleyball Players and Swimmers**

Mami Yoshimura1, Yoshihisa Unemura1 (1 Grad. Sch. Health and Sport. Sci., Chukyo Univ., Aichi, Japan)

[Aims] The study was investigated to compare the length and thickness of Achilles tendon (AT), the stiffness of ankle joint, and the leg extension strength of swimmers with that of volleyball players. Furthermore, factors decided to jump performance between the two groups were compared. **[Methods]** The participants were 17 male swimmers (age, 20 ± 1 yrs; sport history, 15 ± 1 yrs; height, 174.6 ± 6.2 cm; body mass, 70.0 ± 6.9 kg) and 16 male volleyball players (age, 20 ± 1 yrs; sport history, 10 ± 2 yrs; height, 180.9 ± 4.0 cm; body mass, 76.3 ± 9.1 kg). **[Results]** As a result, the volleyball players had a significantly greater AT length ratio and AT thickness than the swimmers. There were no significant differences between the swimmers and volleyball players in leg extension strength or stiffness of the ankle joint. However, the swimmers had significantly greater range of motion than the volleyball players. The length of the AT and leg extension strength were significantly correlated to jump performance in the swimmers. While there were no significant correlations in the volleyball players. **[Conclusions]** This study suggests that the morphology of the AT and the factors decided to jump performance may alter after the long exercise training period. **Keywords**: jump performance, achilles tendon stiffness, different playing characteristics

379. **The effect of muscle function on the cooling before exercise**

Keisaku Kimura1, Yasuharu Watanabe2, Yukihiro Yoshida3, Kenji Katayama1 (1 MUIIM, Kyoto, Japan, 2 MUIIM, Kyoto, Japan)

Cooling is performed as first aid for the injury and the conditioning after exercise. It is reported that cooling effects reduce of muscle tension and pain relief, inhibition of metabolic products as a physiological function. However, the effect of cooling before exercise is poorly understood. In this study, we clarify the effect of cooling before exercise. In addition, we refer to the effect of the different ice bag sizes (small and middle, large). Ten male volunteers participated in this study. Biceps brachii muscle of subjects were assigned to the cooling group and non-cooling (normal) group. Muscle stiffness and electromyogram were measured during a maximum voluntary contraction of 20% and 40%, 60%. In cooling group, Biceps brachii muscle was taken cooling for ten minutes at the beginning, and then, %MVC was performed. The effect of different ice bag sizes is researched under the same condition (during a maximum voluntary contraction of 20% and 40%, 60%). Muscle stiffness and electromyogram decreased significantly during a maximum voluntary contraction of 60% by the cooling of ten minutes. Electromyogram during a maximum voluntary contraction of 60% decreased significantly in all of ice bag sizes. We suggest that cooling may effect the reduction of muscle activity, through the inhibition of alpha motor unit from reduction of the motor unit activity and the action potential of muscle fiber. In addition, even cooling area is patial, it may be induced the reduction of muscle activity for the target muscle. In conclusion, cooling before exercise may prompt the efficient muscle contraction. **Keywords**: cooling, Before exercise, ice bag

380. **Effects of concentric and eccentric training on the stiffness and blood circulation of tendon in vivo**

Keitaro Kubo1, Hideaki Yata2 (1 Dept. Life Sciences, Univ. Tokyo, 2 Univ. Wako, Tokyo)

Introduction The aim of the present study was to investigate the effects of concentric (CON) and eccentric (ECC) training on the stiffness and blood circulation of tendon, and determine whether relative changes in tendon stiffness are related to those in tendon blood circulation. Methods Nine subjects completed 12 weeks (3 days/week) of a unilateral training program for knee extensors. They performed five sets of CON or ECC knee extension exercises at 80% of 1RM with 10 repetitions per set. In each subject, the right and left legs were randomly allocated to each of the two training protocols. Before and after training, muscle strength and thickness, cross-sectional area, stiffness, blood volume, and oxygen saturation of the patellar tendon were measured. Results No significant differences in the relative increase in muscle strength, thickness, or oxygen saturation of tendon were found between CON and ECC. Blood volume and cross-sectional area of the tendon did not change for both protocols. Tendon stiffness increased significantly by 55.8 % for CON (p=0.014), but not for ECC (p=0.246). Furthermore, the relative change in tendon stiffness did not correlate with that in blood volume (r=0.139, p=0.582) or oxygen saturation (r=-0.154, p=0.542) of the tendon. Conclusion These results suggest that tendon stiffness increased after concentric training, but not after eccentric training, although no significant differences in the changes in the size and blood circulation of tendon were found between the two protocols. Furthermore, changes in tendon stiffness were not related to those in tendon blood circulation. **Keywords**: patellar tendon, knee extension, stiffness
381. Transcriptome response to high-intensity intermittent training in human skeletal muscle
Eri Miyamoto-Mikami1,2, Katsunori Tsuji3, Natsuki Hasegawa3, Shumpei Fuji13, Takafumi Hamaoka4, Hiroaki Kanehisa5, Izumi Tabata2, Motoyuki Iemitsu1 (USPS Research Fellow, Natl. Inst. of Fitness & Sports in Kanoya, Kagoshima, Japan, Ritsumeikan Univ., Shiga, Japan, Tokyo Medical Univ., Tokyo, Japan)

[Aims] High-intensity intermittent training (HIIT) is one of the cost effective trainings, because this training induces increases in both the anaerobic and aerobic capacities in spite of only a total of ~4 min for one session. However, the molecular adaptations of human skeletal muscle to this training remain unclear. The aim of this study was to identify changes in gene expression in skeletal muscle induced by the HIIT. [Methods] Eleven healthy young men underwent a 6-week HIIT program (6 to 7 sets of 20-s cycling at an intensity of about 170% VO2max with a 10-s rest between each set, 4 sessions/week). Before and after the intervention, we evaluated VO2max, maximal accumulated oxygen deficit (MAOD), and global gene expression in the vastus lateralis muscle by microarray analysis. [Results] The HIIT significantly increased VO2max and MAOD. Of the 24838 genes analyzed in the microarray analyses, the expressions of 79 genes were significantly increased after the HIIT. Gene ontology (GO) analysis showed that these genes were significantly enriched for the GO categories of glucose metabolism, mitochondrial membrane, extracellular matrix organization, and angiogenesis. [Conclusions] This study identified 79 genes as potential candidate genes associated with the increases of anaerobic and aerobic capacities.

Keywords: transcriptome, high-intensity interval training, anaerobic capacity

382. Neuromuscular activity of the hip and knee extensors during cycling with high intensity interval exercise and constant load exercise
Shouhei Kondo1, Ryoosuke Ando1, Keisho Katayama1, Koji Ishida1, Hiroshi Akima1 (Nagoya Univ, Nagoya, Japan)

[Aim] It is well known that high intensity interval exercise (HIE) improves endurance performance more than constant load exercise (CE). In terms of neuromuscular activity during cycling, much attention have been paid to knee extensors muscle, which makes the greatest contribution to cycling exercise. However, it was suggested that hip extensors greatly contribute to cycling exercise. The purpose of this study was to compare the neuromuscular activity of the knee extensor (vastus lateralis: VL) and hip extensor (biceps femoris: BF, gluteus maximus: GM) between during HIE and CE. [Method] Twelve male distance runners (age: 21±1 yr) performed HIE, consist of 4 sets of 4-min exercise at 80-85% VO2peak with 3-min of active resting period at 30% VO2peak, and CE, consists of 28-min constant load exercise at about 60% VO2peak. Total works (I) and times (28-min) were identical between HIE and CE. The surface electromyographic signal was recorded from VL, BF and GM. RMS was calculated during the last 10 cranks every minute. RMS at each time was normalized by the value of the RMS at 100% VO2peak. Normalized RMS was averaged during 28-min, and average normalized RMS for each muscle was compared in HIE and CE. [Results] The averaged normalized VL and BF RMS did not differ between HIE and CE (VL: 61±15% vs. 58±22%, BF: 42±14% vs. 42±14%), whilst that of GM was significantly greater during HIE than CE (44±4% vs. 25±7%, P < 0.05). [Conclusions] These results suggest that greater neuromuscular activity of GM in HIE may contribute to higher training effect of HIE.

Keywords: neuromuscular activity, EMG, high intensity interval exercise

383. The effects of short-duration, high-intensity static stretching on flexibility
Taizan Fukaya1, Shigeyuki Suzuki1, Eiji Yamanaka1, Masahiro Iwata1, Shingo Matsuo1,2, Wakako Tsuchida1,2, Yuji Asai1 (Grad. Sch. Med., Nagoya Univ, Nagoya, Japan, Fac. Hlth. Sci., Nihon Fukushi Univ, Handa, Japan)

[Aims] Static stretching (SST) increases range of motion (ROM) and passive torque (PT), and decreases passive stiffness (PS), resulting in improved flexibility. Recently, we reported that the effects of 5 minutes of high-intensity SST on flexibility were greater if the stretches were painful than if they were non-painful. However, whether high-intensity SST would have similar flexibility benefits if performed for a shorter duration has not been determined. Therefore, the aim of this study was to investigate the acute effects of short-duration, high-intensity SST on flexibility. [Methods] Fourteen healthy men volunteered to participate in this study. All participants performed 1 minute of SST at 100% intensity and 1 minute of SST at 120% intensity, in random order. During 100% intensity SST the stretch position was held at the maximal ROM achievable without pain. SST outcomes were assessed based on ROM, PT at onset of pain, and PS before and after stretching. [Results] ROM and PT at onset of pain increased significantly after SST at both intensities, but the increase was significantly greater at 120% than 100%. PS significantly decreased after SST at both intensities; this decrease was significantly greater at 120% than 100%. [Conclusions] Our results indicate that high-intensity SST more effectively enhances flexibility than non-painful SST, even when the SST duration is short.

Keywords: static stretching, stretching intensity, flexibility

384. The effects of eccentric contractions induced by electrical stimulation on quadriceps femoris muscle
Minoru Tanaka1, Noriaki Maeshige1, Hiroyo Konno2, Akihiko Ishihara1, Hidemi Fujino1 (Kobe Univ, Nagoya Women’s Univ, Kyoto Univ)

[Aims] The purpose of the present study was to investigate whether eccentric contraction training induced by electrical stimulation for quadriceps femoris muscle enhances knee extension torque and muscle thickness compared with electrical stimulation training alone. [Methods] Twenty-two health males (age: 23±3 years) in the acute response trial and seven males in the long period (6 weeks) training trial were studied. We evaluated muscle thickness and torque evoked electrical stimulation (NMES) or eccentric contraction induced by NMES (NMES+ECC) in the quadriceps femoris muscle of healthy males. The current intensity was set 30%MVC force. Pain and discomfort level were measured using a numeric rating scale (NRS) and heart rate variability (HRV) of low frequency (LF) / high frequency (HF) ratio. [Results] The torque of quadriceps muscle in NMES+ECC was higher than the NMES alone. Additionally, there were no significant differences in pain and discomfort between NMES and NMES+ECC. In the long trial, although the NMES did not promote the quadriceps muscle torque and muscle thickness, those in the NMES+ECC were higher than in the NMES. [Conclusions] These results suggest that this eccentric contraction induced by NMES treatment may be effective as a training strategy.

Keywords: Electrical stimulation, eccentric contraction, muscle thickness
385. Acute effects of static stretching combined with jogging on strength and flexibility


[Aims] The aims of this study were to investigate the combined effects of static stretching and jogging on strength and flexibility. [Methods] Ten young men completed two exercise sessions in random order. The sessions consisted of either 5 min of treadmill jogging followed by 5 min of static stretching (jog + SST) or 5 min of static stretching of the right hamstrings followed by 5 min of treadmill jogging (SST + jog). Isometric knee flexion strength was measured before and after each session. Knee range of motion (ROM), passive stiffness during knee extension, and passive torque at maximal ROM (PT) were measured before, between, and after each session. [Results] In SST + jog sessions, jogging did not significantly influence any outcomes. However, after static stretching the ROM and PT increased while passive stiffness and isometric strength decreased. In SST + jog sessions, static stretching significantly increased ROM and PT; these increases persisted after jogging. However, passive stiffness and isometric strength did not change during the SST + jog sessions. [Conclusions] These results suggest that stretch-induced strength loss can be reversed by jogging after static stretching. The increase in ROM induced by static stretching was sustained after jogging; this was likely due to increased stretch tolerance.

Keywords: static stretching, warm-up, jogging

386. Relationship between recovery time and ribosome biogenesis in resistance training

Takayuki Kato, Hiroyuki Asai, Yuji Asai, Taizan Fukaya, Hisashi Naito (Univ. Sapporo Med., Hokkaido, Japan)

[Introduction] The muscle stiffness, which associated with the decreased stiffness of antagonist muscles, was not known whether the decrease in the stiffness of antagonist muscles after static stretching involve in the torque of agonist muscles. [Aims] The aim of this study was to investigate the effect of decrease in the stiffness of hamstrings muscle due to static stretching on isokinetic knee extension torque. [Methods] Nine healthy men (age, 21.3 ± 0.8 years) volunteered for this study. The muscle stiffness of biceps femoris (BF) inferred from the shear elastic modulus and isokinetic knee extension torque were measured before and immediately after 5 min of static stretching. The shear elastic modulus was measured using ultrasound shear wave elastography. Isokinetic knee extension torque at 120 degree × 5 count-1 was measured using BIODEX, and mean torques were calculated. [Results] The shear elastic modulus of the BF muscle was decreased after static stretching (-24%, p<0.01). Mean torque during isokinetic knee extension was increased after static stretching (7.8%, p<0.05). [Conclusion] These results suggest that increased isokinetic knee extension torque after static stretching of the hamstrings may be related to the decreased stiffness of antagonist muscles.

Keywords: stiffness, static stretching, antagonist muscle

387. Effect of reduced muscle stiffness of hamstring by static stretching on knee extension torque

Ryotaro Yamada, Takuya Kato, Keigo Taniguchi, Masaki Katayose (Univ. Sapporo Med., Hokkaido, Japan)

[Introduction] The muscle stiffness, which associated with the decreased stiffness of antagonist muscles, was not known whether the decrease in the stiffness of antagonist muscles after static stretching involve in the torque of agonist muscles. [Aims] The aim of this study was to investigate the effect of decrease in the stiffness of hamstrings muscle due to static stretching on isokinetic knee extension torque. [Methods] Nine healthy men (age, 21.3 ± 0.8 years) volunteered for this study. The muscle stiffness of biceps femoris (BF) inferred from the shear elastic modulus and isokinetic knee extension torque were measured before and immediately after 5 min of static stretching. The shear elastic modulus was measured using ultrasound shear wave elastography. Isokinetic knee extension torque at 120 degree × 5 count-1 was measured using BIODEX, and mean torques were calculated. [Results] The shear elastic modulus of the BF muscle was decreased after static stretching (-24%, p<0.01). Mean torque during isokinetic knee extension was increased after static stretching (7.8%, p<0.05). [Conclusion] These results suggest that increased isokinetic knee extension torque after static stretching of the hamstrings may be related to the decreased stiffness of antagonist muscles.

Keywords: stiffness, static stretching, antagonist muscle

388. The effects of training intensity of neuromuscular electrical stimulation on muscle hypertrophy and strength gain

Takayuki Kato, Hiroyuki Asai, Yuji Asai, Taizan Fukaya, Hisashi Naito (Univ. Sapporo Med., Hokkaido, Japan)

[Aims] Generally, high-intensity neuromuscular electrical stimulation (NMES) more than 70% of maximal voluntary contraction (MVC) needs to induce muscle hypertrophy and strength gain. However, the effects of low-intensity electrical stimulation on muscle hypertrophy and strength gain remains unclear. Therefore, the aim of present was to examine the effects of training intensity of NMES on muscle hypertrophy and strength gain. [Methods] Eight untrained males volunteered to participate in this study. One leg underwent NMES at maximal tolerable intensity for knee extensors (HIGH) and the other leg underwent NMES at one half of HIGH (LOW). They were applied one NMES session per day, for 3 days per week, for 8 weeks. Muscle thickness and isometric muscle strength of knee extensors were measured before and after the training periods. [Results] Muscle strength evoked by NMES at the last training session reached 70.4% and 35.1% of MVC in HIGH and LOW, respectively. Muscle thickness and isometric muscle strength of knee extensor significantly increased in both condition, however the magnitude of exercise induced muscle hypertrophy and strength gain in LOW is relatively low compared to HIGH. [Conclusions] Eight weeks of low-intensity NMES training can induce muscle hypertrophy and strength gain in untrained young male participants, although the magnitude is relatively lower compared to high-intensity NMES.

Keywords: muscle thickness, quadriceps, isometric strength
389. Relationships between body mass and muscle volume in lower limb muscles
Toshihiro Ikebukuro¹, Hideaki Yata², Tomonobu Ishigaki³, Masahiro Kouno⁴, Keitaro Kubo¹ (¹ Univ. Meiji, Tokyo, Japan, ²Univ. Wako, Tokyo, Japan, ³Univ. Tokyo, Tokyo, Japan)  

[Aims] It is known that the muscle size (thickness, cross-sectional area, volume) was significantly correlated to the body mass. If a muscle contributes greatly as an anti-gravity muscle, the size of that muscle (e.g., muscle volume) may be highly correlated to body mass. In the present study, we examined the relationships between the muscle volume and body mass for lower limb muscles, i.e., knee extensors, knee flexors, adductors, plantar flexors, and dorsiflexors.  

[Methods] Twenty-four healthy males volunteered for this investigation. From the magnetic resonance images, the volumes of knee extensors, knee flexors, adductors, plantar flexors, and dorsiflexors and each synergist muscle were determined. [Results] For all muscle groups, the muscle volume values were highly correlated to the body mass. For knee extenders, the correlation coefficient between them for rectus femoris was significantly lower than that for vastus intermedius. For knee flexors, the muscle volumes of biceps femoris long head and semimembranosus were significantly correlated to the body mass, whereas these relations for biceps femoris short head and semitendinosus were not significant. [Conclusions] These results suggested that there was no difference in the degree of contribution for an anti-gravity muscle among all lower limb muscles. Furthermore, the degree of contribution for an anti-gravity muscle was relatively lower for rectus femoris, biceps femoris short head, and semitendinosus.  

Keywords: muscle volume, body mass, lower limb

390. The effects of ankle joint angle and contraction level on the fascicle length of triceps surae
H Tanaka¹, T Ikezoe², M Nakamura³, T Hirono², N Ichihashi⁴ (¹ Kyoto Univ. Hosp., Kyoto, Japan, ²Kyoto Univ., Kyoto, Japan, ³NUHW, Nigata, Japan)  

[Aims] We recently reported that improvement of muscle strength was observed only at 0 degree and 10 degree plantarflexion after isometric resistance training at 20 degree plantarflexion with 30%MVC (Maximum voluntary contraction), which suggests that the improvement of muscle strength was depended on the fascicle length of medial gastrocnemius (MG) during training (JSCR, 2016). The purpose of the present study was to investigate the effects of the ankle joint angle and contraction level on the fascicle length of triceps surae muscles including lateral gastrocnemius (LG) and soleus (SOL).  

[Methods] The subjects comprised 10 healthy young men. The fascicle length of triceps surae (MG, LG, SOL) was measured every 10 degree through the range of ankle joint position from 20 degree dorsiflexion to 30 degree plantarflexion under four conditions of contraction level [rest, 30%MVC, 60%MVC, and MVC] using B-mode ultrasound. [Results] In all muscles, the fascicle length was shortened by increasing of plantarflexion angle and contraction level. The fascicle length at 20 degree plantarflexion with 30%MVC was almost the same as those at 0 degree and 10 degree plantarflexion with MVC in MG and SOL, and at 0 degree, 10 degree and 20 degree dorsiflexion with MVC in LG, respectively. [Conclusions] The results of present study showed that the fascicle length of not only MG but also LG and SOL are affected by the ankle joint angle and contraction level.

Keywords: Fascicle length, Triceps surae, Ultrasound imaging

391. Effects of menstrual cycle on body weight and intracellular and extracellular fluid
Mikako Sunaga¹, Kayoko Kamemoto², Mizuki Yamada¹ (¹ Nippon Sport Sci Univ, Tokyo, Japan, ²Teikyo Univ, Tokyo, Japan.)  

The ovarian hormones have fluid retention action. Therefore, it has been suggested the body weight and the body composition are changes in the phase of menstrual cycle. [Aims] The purposes of this study was to compare changes in body weight and intracellular and extracellular fluid phase of the menstrual cycle. [Methods] The subjects were eight women (age, 21.6±1.1years) with regular menstrual cycle. Subjects performed 30min of cycling at an intensity of 60% VO₂peak at three points during menstrual cycle (follicular phase, FP; ovulation; OV, luteal phase; LP). For each data collection, blood samples were collected and measured body weight and composition was performed at rest (0min), immediately (30min) after the exercise (60min), 60min after the exercise (90min). The duration each menstrual cycle phase was estimated by assessing ovarian hormone levels. Blood analyses for ovarian hormones (estradiol and progesterone), renin activity and aldosterone were conducted. [Results] Blood estradiol and progesterone levels were significantly higher in the LP than in the FP (p<0.05). The body weight tended to increase in the LP in compared with the OV. The extracellular fluid of trunk was significantly higher in the LP than in the FP and OV (p<0.05). Renin activity between the progesterone significantly and positively correlated (r=0.632, p<0.05). [Conclusion] The body weight gain of the luteal phase was induced by the increase of the body fluid volume.  

Keywords: ovarian hormone, water retention, renin activity

392. Effects of resistance training during 8 weeks bed rest on intramuscular fat, subcutaneous fat and skeletal muscle tissue muscle of the thigh
Madoka Ogawa¹², Akito Yoshiko³, Hiroshi Akima¹ (¹ Nagoya University, JSPS)  

[Aim] The purpose of this study was to quantify the effects of exercise during 8 weeks bed rest on intramuscular fat, subcutaneous fat and skeletal muscle tissue muscle of the thigh. [Methods] Twenty-one men participated in 8 weeks bed rest. They were randomly assigned resistance training group (TR group, n=13) or control group (CTR group, n=8). During the bed rest, they were controlled the nutrition. TR group performed training for 3 days a week. Training was consisted bilateral leg press, single/double leg heel raise and back and foot raise. Axial images of the mid-thigh were taken before and after the bed rest. Intramuscular fat cross-sectional area (CSA), subcutaneous fat CSA and skeletal muscle tissue CSA were measured from these images. [Results] After the bed rest, intramuscular fat CSA was significantly decreased in TR group (before: 25.8 ± 10.5 cm² vs. after: 15.1 ± 6.2 cm², p = 0.010) and unchanged in CTR group. Subcutaneous fat CSA after the bed rest was not changed and both groups. Skeletal muscle tissue CSA after the bed rest was significantly decreased in CTR group (before: 138.8 ± 13.4 cm² vs. after: 117.7 ± 11.3 cm², p = 0.000), but unchanged in TR group. [Conclusion] Resistance training during 8 weeks bed rest suppresses muscle atrophy and reduces the intramuscular fat.  

Keywords: bed rest, resistance training, intramuscular fat
Skeletal muscle adaptation under HIF activation

Aki Nunomiya1, Junchul Shin2, Yasuo Kitajima3, Takashi Dan1, Toshio Miyata4, Ryoichi Nagatomi1,2 (Grad School of Med., Tohoku Univ., Graduate School of Biomed. Eng., Tohoku Univ., 3Nagasaki Univ.)

[Background and aims] Activation of hypoxia-inducible factor (HIF), which is known as a master regulator of the hypoxic response, is regulated by prolyl hydroxylase domain 2 (PHD2). Phd2 deficient mice shows high hematocrit as part of hypoxic response. Moreover, we revealed that activation of HIF pathway induced by Phd2 deficiency enhances the effect of a 4-week endurance training. However, the adaptation in skeletal muscle under Phd2 deficiency remains unexplained. Thus we examined the alteration in skeletal muscle of trained Phd2-deficient mice and the relationship with endurance capacity. [Methods] We divided Phd2+/+Rosa26/Cre mice (control mice) and Phd2−/−Rosa26/Cre-ER(T2) mice (Phd2-deficient mice) into untrained and trained groups. The trained group was subjected to 4-week treadmill training. [Results] We observed muscle fiber-type conversion toward slow type fiber in gastrocnemius muscle of Phd2-deficient mice. Additionally, trained Phd2-deficient mice exhibited a wide distribution of SDH-positive fiber. On the other hand, the phenomenon was not found in untrained-mice. These data suggest that there is possibility the fiber-type conversion induced by Phd2 deficiency requires training to obtain the function as slow type fiber. [Conclusion] Phd2 deficiency induces muscle fiber transition toward slow type fiber, and endurance training may complement the function as slow type fiber.

Keywords: Phd2, hypoxic response, skeletal muscle

Effect of change in eccentric and concentric phase ratio in squat exercise on hormonal responses

K. Shibata1, K. Nosaka2, K. Takizawa3, Y. Kuroda4, M. Mizuno1 (Hokkaido Univ., ECU (AUS), 1Inst. Physical Development Research, 1Hokkaido Univ.)

[Aim] This study compared two squat exercise protocols in which the ratio of the eccentric (ECC) and concentric (CON) contraction phase was different to test the hypothesis that longer CON would have greater hormonal responses. [Methods] Seven physically active male students (20.9 ± 1.2 y, 173.1 ± 4.1 cm, 65.0 ± 3.6 kg, squat 1RM: 105.7 ± 12.1 kg) participated in this study. After a familiarization session, parallel back squat at 75%1RM in which 2 s for CON and 4 s for ECC (C2E4), and 4 s for CON and 2 s for ECC (C4E2) were performed until volitional failure in each set for 3 sets with a 3 min rest between sets in a counter-balanced order separated by at least 3 days. For each protocol, the number of successful repetitions in each set was recorded. Venous blood samples were obtained before (PRE) and 15 min after (15-min) each exercise, and growth hormone (GH), IGF-1, testosterone, and cortisol were measured. [Results] The number of total repetitions was greater (p<0.05) for C4E2 (26.7 ± 5.8) than C2E4 (22.9 ± 5.0). GH increased (p<0.01) similarly in C2E4 (PRE: 0.6 ± 0.5 ng/mL, 15-min: 9.9 ± 6.9 ng/mL) and C4E2 (0.3 ± 0.4 ng/mL, 10.9 ± 6.4 ng/mL). No significant changes in IGF-1, testosterone and cortisol were observed after C2E4 and C4E2. [Conclusion] These results did not support the hypothesis. It is concluded that the modulation of the ECC and CON phase ratio in squat has little effect on hormonal responses, when the total muscle contraction time is the same.

Keywords: squat, repetition duration, growth hormone

Effects of three types of warm-ups on flexibility and strength in ankle joint

Kosuke Takeuchi1,2, Masatoshi Nakamura3, Fumiko Tsukuda1, Masahiro Takemura1 (Bivako Seikai Sport College, Tsukuba Univ., 3Nagata Univ. of Health & Welfare)

Aims Athletes commonly perform warm-up routines before competition to improve flexibility and performance. A warm-up comprises aerobic exercise, anaerobic exercise, and passive warm-up using external heat modalities. The purpose of the study was to compare the influence of three different warm-ups on flexibility and isometric strength in the ankle joint. Methods Fourteen men randomly performed three different warm-ups conditions for 10 min: Bike (cycling ergometer, 60 W, 60 bpm), MVC (repeated maximum voluntary contraction of the ankle plantar flexion, 10 reps, 5 sets) and Hot (immersion of their lower limb in water bath, 40 degrees C). To assess flexibility, range of motion (ROM) of ankle dorsiflexion, passive torque at terminal ROM, muscle tendon unit (MTU) stiffness, and muscle tendon junction (MTJ) displacement were examined before and after the warm-ups. For isometric strength assessment, peak torque during MVC was measured after flexibility assessment. Results ROM and passive torque at the terminal ROM were increased in all warm-up conditions. However, MTU stiffness and MTJ displacement were not changed. Peak torque during MVC was increased in the Bike group. Conclusions The passive property of the ankle plantarflexor muscles was not changed after active or passive warm-ups. ROM was increased through increases in tolerance for stretching. An aerobic warm-up is effective for athletes because it enhances isometric strength.

Keywords: warm-up, flexibility, isometric strength

Effect of the menstrual cycle phase on comfortable self-paced running

Kanako Ohno1, Shuichi Machida1, Hisashi Naito1 (Juntendo Univ.)

[Aims] During the menstrual cycle, mental and physical conditions change. It has been suggested that comfortable self-paced running (CSPR) during the luteal phase (LP) improves the mood state. Several authors have reported that the rate of perceived exertion (RPE) values change with the change in menstrual cycle phase. The purpose of this study is to clarify whether running speed in CSPR is affected and mood before and after CSPR is changed by the menstrual cycle phase. [Methods] Five young women with regular menstrual cycles voluntarily participated in this study. The study consisted of CSPR for 15 min and completion of the Profile of Mood State (POMS) and a modified Moos Menstrual Distress Questionnaire (MDQ) before and after CSPR. These activities were weekly performed for 4 weeks. The weeks provided in the follicular phase (FP) and LP were analyzed. [Results] No significant difference was observed either between FP and LP in terms of running speed in CSPR (113 ± 14 m/min vs 113 ± 7 m/min) or in POMS scores prior to CSPR. Interestingly, the vigor score on POMS increased, whereas the fatigue score decreased after CSPR in LP but not in FP. There was no significant difference in the score of MDQ between FP and LP before and after CSPR. [Conclusions] The data demonstrated that running speed was not affected by the menstrual cycle phase. It also suggests that CSPR was effective in improving the mood state in LP, but the mood was not changed before and after CSPR in FP.

Keywords: menstrual cycle, comfortable self-paced running, mood
397. Effect of upper limb and lower limb heating on badminton-specific performance

Koichiro Tanahashi1, Yukina Oku1, Keisei Kosaki1, Kou-saku Yamamoto1, Seiji Maeda1 (Univ. Tsukuba)

[Aims] Warm up is considered to be essential for optimum athletic performance. Active warm up is a widely accepted as a practice before every athletic event. Several studies have reported that not only active warm-up but also passive warm-up improve physical performance (i.e., flexibility and agility performance). However, the effect of passive warm-up on badminton-specific performance remains unclear.

[Methods] Nine athletes from university badminton teams participated in a randomized crossover study comparing the effect of upper and lower limb heating (temperature approx. 42 °C for 20 min) and control condition on badminton-specific performance. After each heat trial, we measured tympanum temperature as body temperature and wall volley test (WVT) and badminton-specific agility test as badminton-specific performance test.

[Results] No significant difference in WVT score was observed between trials. In addition, no significant difference in agility time was observed between trials. However, agility time that adjusted for tympanum temperature after the heat trial was significantly faster (p < 0.05) in the lower limb heating condition compared with the control condition and, tended to faster (p = 0.07) in the upper limb heating condition, and tended to faster (p = 0.07) in the lower limb heating condition compared with the control condition.

[Conclusions] The present study suggests that lower limb heating may have a beneficial effect for badminton-specific agility performance.

Keywords: Warm up, Heating, Badminton

398. The Effect of blocked vision on the reproducibility of ballet leg positions in elite synchronized swimmers

Yusaka Komori1, Mizuki Kamiyoshi2, Haruna Onishi2, Yukie Shimura1 (Osaka International University, Japan, 'Doshisha University, Japan)

Introduction Synchronized swimming competition includes a figure session and a routine session. All specified 200 figures are constituted from movements of the leg, such as hip extension flexion movements. In particular, the ballet leg positions (from a back layout position to raise a leg and to keep the hip flexion angle at 90 degree) account for 40% of the figures. Therefore, precise control of hip flexion angle is important for synchronized swimmers.

The purpose of this study was to examine the effect of blocking a swimmer’s vision on the reproducibility of ballet leg positions among elite junior and senior synchronized swimmers.

Methods A total of 24 elite female synchronized swimmers participated in this study. The participants were divided into the following 2 groups: junior group and senior group. The participants performed the ballet leg positions under normal visual conditions and also with vision blocked, in water and on dry land. The repositioning error (RE) of the hip flexion angle was evaluated using an image analyzing system with high speed video cameras.

Results and discussion In water and on land, there were no differences in the RE for achieving the ballet leg position under blocked or normal visual conditions in either age group. These findings showed that the precise reproducibility of ballet leg position was not correlated with vision either in water or on dry land. Elite synchronized swimmers are able to achieve high reproducibility of ballet leg positions without reliance on visual cues.

Keywords: Synchronized swimming, Bllet leg position, reproducibility

399. Predicting 4km individual pursuit performance of cyclist from critical power

Mutsumi Kamba1, Akihoro Sakamoto1, Hisashi Naito1, Shizu Katamoto1 (Hantendo Univ.)

[Aims] Critical power (CP) is the maximum work rate able to be sustained without a performance decrement for a prolonged time period. Time-to-exhaustion (x-axis) and pedaling power (y-axis) usually exhibit a reciprocal function, with the asymptote parallel to the x-axis indicating CP. CP has been found a good predictor of aerobic endurance performance (17 and 40km race time), despite minimal equipment requirements to measure (cycle ergometer only), compared to other typical techniques (VO2max, anaerobic or lactate threshold, or OBLA test). Endurance cyclists often participate in 4km individual pursuit race (middle distance race), where the anaerobic energy supply is importantly involved (about 30%). It is, however, not clear whether CP remains valid when predicting race performance of middle-range events. This study, therefore, identified the relationship between critical power and 4km individual pursuit performance of competitive cyclists.

[Methods] Six male cyclists performed a 4km time trial (TT) on a race track, and constant power pedaling test (90 rpm) at four loads (kp = 6, 7, 8 or 8.5% body mass per test) on a cycle ergometer. CP was calculated from the time vs. power relationship obtained from the ergometry test. Power output during the 4km TT (race power, RP) was also identified using power tap. [Results] CP was strongly related to the 4km race time (r=-0.91, p<0.05). RP was greater than CP by 53±38W. The RP-CP difference, however, was not correlated with 4km race time. [Conclusion] Critical power may be a good predictor of 4km individual pursuit performance.

Keywords: Power output, middle-range events, cycle ergometer

400. Impact of Inserted Rest Period During Repeated Sprint Exercise on Performance Adaptations

Akiho Ikutomo1, Nobukazu Kasai1, Kazushige Goto1 (Ritsumeikan Univ.)

[Aims] The purpose of the present study was to compare the influence of inserted rest period during repeated sprint training on performance adaptations. [Method] Twenty-one, well-trained athletes (age:20.1±1.1year, height: 172.6±7.5cm, body weight: 61.9±7.4kg) were divided into either a continuous training group (CON, n=10) or separated training group (SEP, n=11). The training protocol in both groups consisted of 2 sets of 12×6s maximal sprint with 24s rest between sprints. However, in the SEP group, 7min of active rest period was inserted every 4 sprints in order to attenuate metabolite accumulation. The training was lasted 3days/wk for 3 weeks. Before and after the training period, repeated sprint ability [12×6s maximal sprint with 24s rest] and VO2max were evaluated. [Results] Both groups showed significant increases in mean power output during latter half of the repeated sprint test (p<0.05). However, a significant increase in maximal power output during was observed only in the SEP group (p<0.05). VO2max was significantly increased only in the SEP group (p<0.05) [Conclusions] The 3 weeks of repeated sprint training significantly improved repeated sprint ability in trained sprinters. A significant increase in maximal power output during early part of 12 sprints was observed, when 7 min of active rest period was inserted every 4 sprints. These findings suggest that rest periods during repeated sprint training play an important role in adaptation of maximal power output.

Keywords: Repeated sprint, Maximal power, Rest period
401. The effect of carbohydrate drink intake before acute tennis training on cognitive function and serve accuracy
Yuta Kuroda1,2, Toru Ishihara2, Masao Mizuno2 (1Department of Sport Education, Hokkusho Univ., 2Hokkaido Univ.)

[Aims] This study was aimed at examining the effects of carbohydrate drink intake before acute tennis training on cognitive function and serve accuracy. [Methods] Twelve men participated, including seven from the All Japan Student Tennis Championship. They performed 30 min tennis training. The water intake (water conditions) or carbohydrate intake (glucose conditions) was carried out before acute tennis training and it carried out at randomized double blind trial. This study focused on inhibitory control. Inhibitory control in this study was assessed using the Stroop Color-Word Test (SCWT; Stroop, 1935). In this study, Inhibitory control was evaluated using mean RT, mean number of error, mean reaction time interference (incongruent trial - control trial) and mean number of error interference (incongruent trial - control trial). Serve accuracy was determined as the number of successful serves out of 20. The service test was performed at the PRE and POST time points, and the success of each serve was judged by two referees who were tournament-level tennis players. [Results] Reaction times and number of error were not observed significant differences between two conditions in PRE and POST. Interference of reaction times and number of error were not observed significant differences between two conditions in PRE and POST. Serve accuracy did not differ significantly between two conditions in PRE and POST. [Conclusions] In this study, the carbohydrate containing drink intake did not affect the cognitive function and serve accuracy.

Keywords: serve performance, central nervous system, sports nutrition

402. A Study of Physiological Responses and Accelerations at the Joint on Nordic Walking in the Different Styles
Yutaka Iwaihara1, H. Tsujikawa2, S. Yatsu2, T. Saitou2, H. Tomita2, K. Sugiyama1 (1Shizuoka Univ., 2Juntendo Univ., 3SIST)

With its walking style to make more use of muscles throughout the body, Nordic Walking (NW) is used in physical therapy and training. It has high general versatility, but NW offers different results in the physiological responses depending on its walking style although the study has not fully executed. We aim to clarify its characteristics by comparing the effects due to the different styles with an indicator of the physical workloads which is calculated by adding accelerations at the joint on the cardiorespiratory responses. We have measured VO2, HR, RPE and accelerations for 8 healthy adults while they took 4 different styles of walking (WA: normal walking, SU: support level, HE: health level, FI: fitness level). For the loading rate, the speeds equivalent with 4.5, 6.5 and 8.5m/s from WA were calculated for each subject. VO2 under SU indicated higher than that of WA, but there was no significant difference and it was in the same level with HE. On the other hand, it was 16% lower than FI (p<0.01). In terms of SU, we can assume that it is suitable for older people or one who does not usually exercise as it does not stimulate too much of the cardiorespiratory responses. FI can be considered as a style which is close to a training based on the fact that VO2 under FI was about 13% higher than HE (p<0.05) as well as the results for the acceleration values. The characteristics of each NW style have been clarified. It has indicated that selecting the style properly based on the physical strength or purpose will lead to having a good effect more safely.

Keywords: Nordic Walking, Styles of Walking, Cardiorespiratory Response

403. Study of eating habits by Sports: study on junior athletes
Mika Kawai1 (Ryukoku Univ.)

[Aims] Nutritional support is just as necessary as sports-science in improving competitiveness, but junior athletes often have little understanding in this matter. This research aims to obtain a basis for the nutritional support optimized for training progress and environment of each sport with different nutritional requirement. [Methods] This research was conducted on 171 athletes of field hockey, canoe, water polo, boat and wrestling includes fundamental items, training progress, eating habits and daily life. Training, eating habits and daily life of each sport were compared in a chi-squared test (p<0.05). Then, relations among eating habits, training and daily life were examined. (1) the eating habits score (total 18 points) was obtained by 18 questionnaires, (2) the score was classified into 3 categories and (3) relationships with training and daily life were examined with chi-squared test. [Result] For boys, the height was higher in boat (173.3±5.0cm) and shorter in wrestling (168.1±4.8cm). BMI was higher in wrestling (22.9±3.2) and lower in water polo (20.9±0.8). Number of days spared for training was smaller in wrestling (4.8±1.9days/wk). Number of days spared for training was smaller in wrestling (4.8±1.9days/wk). For girls, significant difference was seen in training progress. There were no male water polo attentive of fat, iron and instant food intake and mealtime. However, they have breakfast and three meals everyday suitably. Through the relationship between training and daily life concerning eating habits for all athletes, were difference. [Conclusions] Better nutritional support would be possible by understanding training as well as environment, together with characteristics of each sport, it has been suggested that looking into environmental factors other.

Keywords: junior, eating habits, training

404. Efficacy of Interval Nordic Walking in Sedentary Middle-Aged Women
Yasuo Kimura1, Mamoru Hisatomi1, Kazuko Ohki2, Naoki Nakagawa2, Shoichi Yamazaki2 (1Inst. Fitness & Health Sci., 2Sugiyama Jogakuen Univ., 3Sanno Univ., 4Ishinomaki-Senshu Univ.)

Aims: To investigate the efficacy of a nordic walking (NW)- and a walking (W)-interval training program on physical health status and exercise capacity in middle-aged women. Methods: 18 volunteers (age:62.2±6.1 yrs.) were recruited and randomized to either NW (n=10) or W (n=8). Stature, body mass (BM), BMI, % body fat (BF), heart rate (HR), heart rate reserve (HRR), blood pressure (BP), VO2peak, grip and leg strength and bone mass were measured. A questionnaire survey examined geriatrics of depression scale (GDS) and Quality of Life. HR and RPE were recorded. Interval training consisted of 6 x 5 min with 4 min at preferred walking speed + 1 min. maximal walking speed, and trained three days per week for 12-week. Results: BM (NW:54.4±4.6 - 53.3±4.2 kg, W:54.0±5.2 - 52.8±5.4 kg), BMI (NW:24.8±2.2 - 24.5±1.9 kg/m², W:24.4±1.8 - 23.9±2.0 kg/m²), BF (NW:26.6±4.4 - 24.5±3.3 %, W:25.6±3.4 - 23.6±2.5 %) and diastolic BP (NW:86±9 ~ 79±8 mmHg, W:85±5 ~ 73±7 mmHg) were changed significantly in both groups. VO2peak increased only in NW group (23.7±2.6 ~ 27.6±5.0 ml/kg/min). Mean HR and % of time at high intensity (~60% of HRR) were not influenced by the modality of exercise. GDS score tended to improve in both groups. A significant improvement in NW group was seen in regard to subjective health, everyday feeling, human relation and life satisfaction. Conclusions: NW could be a useful tool to improve physical health status and exercise capacity in previously sedentary middle-aged women.

Keywords: interval nordic walking, fitness, middle-aged and older women
Whole blood assay of oxidative stress by i-STRap method and d-ROMs test

F Ito¹, T Ito², T Shinya³, K Sato¹, T Mitsui¹, F Tajima⁴

[Aims] Erythrocytes are vulnerable to oxidative stress during intense exercise because of their continuous exposure to high oxygen fluxes. However, the majority of the human studies have measured the oxidative status of plasma or serum. The present study aimed to develop a new method for the assessment of oxidative stress in whole blood. [Methods] 1) Antioxidant potential in plasma was determined by BAP test. The radical scavenging capacity of whole blood was quantified by i-STRap method (Dojin Glocal). 2) Hydroperoxide contents in blood were measured by a newly developed test based on reactive oxygen metabolites test. [Results] 1) Wheelchair half marathon race showed different effects on the antioxidant potentials of whole blood and plasma. 2) d-ROMs test has been used for the measurement of hydroperoxides in plasma. However, when used for the measurement of hydroperoxides in whole blood, this test ruptured erythrocytes and released their contents into reaction mixture. We then added glucose to a reaction mixture to adjust osmolality and changed pH in the reaction mixture from 4.8 to 5.8 in the presence of Fe²⁺. By using this modified method, we could determine lipid peroxidation in whole blood and erythrocytes. [Conclusions] 1) Exercise leads to differences in oxidative stress status between plasma and blood. 2) A reliable and sensitive test for the assessment of oxidative stress of whole blood was developed.

Keywords: oxidative stress, d-ROMs test, erythrocytes

Studies on sports vision of junior high school table tennis players

Hiromi Murakami¹, Tuyoshi Hamano¹, Toshio Moritani², Takeshi Yamamoto³, Hiroshi Masuda⁴, Tokio Tasaka⁵
(Kyotosangyo, Univ, ‘Kyotokacyo, Univ, ‘Kyotosaga, arts, Univ, ‘Doshisha, Univ)

[Aims] The aim of this study was to examine sports vision of junior high school table tennis players by gender. In addition, to examine the differences in factors (i.e., static visual activity: SVA, kinetic visual activity: KVA, dynamic visual activity: DVA, contrast sensitivity: ocular motor skill: OC, depth perception: DP, visual reaction time: VRT, and eye-hand coordination: E/H) that constitutes sports vision by gender. [Methods] 16 junior high school table tennis male players (JTM group) and 19 junior high school table tennis female players (JTF group) were recruited for this study. 11 male university students (NM group) and 10 female university students (NF group) were also recruited as control groups. Visual activity of subjects were >1.0. Multiple linear regression analysis (stepwise method) was performed to examine the degree of contribution to the sports vision among factors (SVA, KVA, DVA, OC, DP, VRT, and E/H). [Results] Mean value of VRT in JTF group were statistically higher than that of in JTM group. Not statistically, mean value of KVA, DVA and OMS in JTF group were higher than those of in JTM group. Degree of contribution to the sports vision differ by gender. In JTM group, OMS, SVA, VRT, CS and DP were highly contribution to the sports vision. SVA, KVA, DVA and VRT were highly contribution to the sports vision in JTF group. [Conclusions] Our results indicate the differences in VRT by gender and degree of contribution to the sports vision also differ by gender.

Keywords: Junior high school table tennis player, sports vision, gender difference degree of contribution

Relationships among coordination motor abilities, social cognitive abilities, and language abilities

Akito Mochizuki¹, Michiko Sudo², Kenji Ito³, Eiji Kirino³
(Asso. of Coaching Value., ‘Juntendo Univ., ‘Tokyo Medical Ctr. ‘Juntendo Univ.)

[Aims] The purpose of this study was to investigate the interrelations among coordination motor abilities, social cognitive abilities, and second language abilities. [Methods] Twenty-six healthy college students (13 males and 13 females) served as subjects. They performed both one-person and two-person coordination exercises for 40 seconds each. We analyzed the scores for these exercises and the results of social and language abilities. We examined social abilities in terms of memory span and empathizing. Empathizing was measured by self-reports on the Systemizing, Empathy, and Autism Spectrum Quotients (SQ, EQ, and AQ). For the measurement of language abilities, we used the TOEIC listening/reading section scores and the total score, together with reading rate and vocabulary size. [Results] One-person cross touch scores and working memory showed a positive correlation, while in two-person exercises the cross touch scores negatively correlated with working memory. The gender-segregated analysis showed that some motor abilities strongly correlated with language and social abilities. [Conclusions] The persons with high coordination abilities were shown to have a high ability of working memory, and the females with high coordination abilities were shown to have a high second language ability. The males with high abilities of SQ and EQ showed a high ability of analyzing movements of others and moving accordingly.

Keywords: coordination, social cognition, second language

The factors associated with the increment in joint range of motion after dynamic stretching

Takamasa Mizuno¹ (Nagoya Univ., Aichi, Japan)

[Aims] It was demonstrated that dynamic stretching (DS) improves muscle strength, muscle power and joint range of motion (ROM). It was suggested that these effects of DS would associated with potential abilities on muscle strength and/or properties of joint flexibility. The purpose of the present study was to clarify the relationships between potential abilities of participants and the rate of increase in ankle ROM after DS. [Methods] Fifteen participants volunteered for this study. The ROM of the ankle was measured before and after DS. In addition, passive torque and displacement of the muscle-tendon junction were measured before DS. The DS consisted of seven sets of 15 repetitions of ankle dorsiflexion and plantarflexion. Isometric maximal voluntary contractions of ankle dorsiflexion and plantarflexion were also measured. [Results] Passive ROM was significantly increased after DS. Positive correlation was observed between the rate of increase in passive ROM after DS and active ROM during DS. Additionally, negative correlation was observed between the rate of increase in passive ROM after DS and ratio of passive ROM before DS to active ROM during DS. However, there is no significant correlation between the rate of increase in passive ROM after DS and the indicators of muscle strength. [Conclusions] We demonstrated that there are significant correlation between the rate of increase in passive ROM after DS and 1) active ROM during DS, 2) ratio of passive ROM before DS to active ROM during DS. This results suggest that the increase in active ROM during DS is important to improve the rate of increase in joint ROM after DS.

Keywords: dynamic stretching, flexibility, muscle strength
411.  
Acute effects of a high-speed dynamic warm-up of the upper body performed in the sitting position on chest pass distance in female basketball players  

Kazuma Senzaki¹, Akira Iwata¹, Yuta Otuki¹ (Osaka Pref Univ, Osaka, Japan)  

Aims: Dynamic warm-ups are considered to increase performance in basketball games. However, the rules of the International Basketball Federation state that bench members should perform warm-ups in the sitting position during the game. The purpose of this study is to examine the effects of a high-speed dynamic warm-up of the upper body performed in the sitting position on chest pass distance.

Methods: Twenty-eight female high school basketball players participated in this study. All of the subjects were subjected to three different protocols: (1) a high-speed warm-up in the standing position, (2) a high-speed warm-up in the sitting position, and (3) sitting alone (Control). The warm-up protocols consisted of 8 minutes and 6 movements (elbow flexion and extension, wrist flexion and extension, forearm pronation and supination, scapular adduction and abduction, elevation and depression, and upward and downward rotation).

Results: There was no difference between the pre- and post-warm-up mean chest pass distances in the control conditions (pre: 7.93±0.52m, post: 7.85±0.47m). On the other hand, both high-speed warm-up protocols resulted in the post-warm-up mean chest pass distance being significantly greater than the pre-warm-up mean chest pass distance (standing: pre: 7.80±0.63m, post: 7.85±0.48m; sitting: pre: 7.85±0.48m, post: 8.21±0.51m). The effects of the two warm-up protocols did not differ significantly. Conclusions: High-speed upper body warm-ups are very effective at increasing the chest pass distance, even if the warm-up is performed in the sitting position.

Keywords: basketball, high-speed dynamic warm-up, sitting position

412.  
Exercise intensity in university rugby players  

Tomo Onishi¹, Norio Saga¹, Eisuke Hiruma¹, Kei Kato¹, Aiko Sekiguchi¹, Toshikatsu Fukuda¹, Atsuro Okano¹, Manabu Okı², Kenji Kokatsu¹, Masayuki Iwade³ (Teikyo University, Tokyo, Japan, TRY WORKS Co.)  

[Aims] Although several former studies reported the running distance (RD) and the running speed (RS) during rugby matches, the relationship RD and RS between during the matches and the practice is not clear. The purpose of this study was to compare RD and RS during rugby matches with during practice by using Global Positioning System (GPS). [Methods] Twenty male players (Foreword: FW n=11,Backs: BK n=9) participated. GPS data were obtained during the Japanese University Championship finals and 13 practice sessions (6 physical practice and 7 skill practice sessions). The data were the total running distance (TRD) and the distance and the repetitions of the high-intensity running (HIR). The speed of HIR was faster than 5m/sec. [Results] The values of HIR during the 2nd in BK were significantly higher than the 1st (p<0.05). The running distance of HIR during the 2nd in FW tended to increase during the 1st (HIR-1st 117.1±77.3m, HIR-2nd 206.9±129.1m, p<0.06). The values of HIR during physical practice sessions were higher as compared with during the match. [Conclusions] TRD and HIR in FW and BK tend to increase during the 2nd of the match. It is suggested that the exercise intensity during the physical practice session need to be higher than during the match. The training effect of HIR from practice may be used the increased RD and RS during the 2nd of the match.

Keywords: rugby match, rugby practice, GPS
413. Changes in grip strength and jump performance with menstrual cycle phases in collegiate female athletes
Shiori Chiba¹, Kanako Ohno¹, Daiki Nakano¹, Hayao Ozaki³, Hisashi Naito³, Shuichi Machida³ (Nihon University)

[Aims] Muscular strength has been reported to be highest in the ovulation phase compared to other menstrual cycle phases. However, the effect of menstrual cycle phase on more dynamic performance involving power, such as jump height, remains to be seen. This study investigated the change in muscular performance including both static (grip strength) and dynamic power tasks (squat jump and counter-movement jump) across the menstrual cycle. [Methods] Thirty collegiate female athletes participated in this study. Based on the basal body temperature (3 months) and the level of luteinizing hormone (LH) in the urine (2 months), the timing of (1) menstrual, (2) follicular, (3) ovulation and (4) luteal phases were determined per individual. The subjects were then categorized into two groups: presence (ovulation group) or absence of ovulation (non-ovulation group). Grip strength and jump performance were measured once in each of the four phases. To evaluate jump performance, squat jump (SJ) and counter-movement jump (CMJ) were undertaken. [Results] CMJ height significantly improved in the ovulation phase exclusively for the ovulation group (p<0.05). Grip strength and SJ height were stable across the four phases for both ovulation and non-ovulation groups. [Conclusion] Dynamic power performance involving stretch-shortening cycle may be influenced by the menstrual cycle phase, with an improvement occurring in the ovulation phase. The change in performance, however, may be limited to individuals with ovulation.

Keywords : ovulation phases, squat jump, counter-movement jump

414. Effects of ReCoF or DeCoF treatment combined with exercise on anti-oxidative stress
Daisuke Shindo¹, Naoko Onuma¹, Eriko Matsuo², Shigeru Matsubara¹, Masato Suzuki¹ (Nihon Univ., Chiba, Nihon Univ., Tokyo, The Jikei Univ., Tokyo)

Aims In this study we used an animal model of obesity-induced diabetes, Otsuka Long-Evans Tokushima Fatty (OLETF) rats, and a normal control, Long-Evans Tokushima Otsuka (LETO) rats, to examine the effects of long-term (5-week duration) intake of 2.5% regular commercial coffee (ReCoF) and decaffeinated coffee (De-CoF) contained in powdered rat chow, and combination of voluntary exercise with ReCoF or DeCoF intake on body weight (BW), blood pressure (BP), indices of oxidative stress and anti-oxidative stress. [Methods] At 24 weeks of age, the OLETF rats were housed individually and randomly divided into the following groups: a sedentary control group (OLETF-Sed), ReCoF intake group (OLETF-ReCoF), DeCoF intake group (OLETF-DeCoF) an exercise treatment group (OLETF-Ex), ReCoF intake combined with exercise group (OLETF-ReCoF&Ex), and DeCoF intake combined with exercise group (OLETF-DeCoF&Ex). Pre- and post-treatment indices of oxidative stress (d-ROMs) and anti-oxidative stress. Results and Conclusions OLETF-Sed group showed an increase in BW, BP and d-ROMs, and a decrease in BP in AGE with age. OLETF-Ex inhibited BW gain, increased d-ROMs and BP. ReCoF and/or DeCoF treatment inhibited BW gain, and decreased BP. Combination treatment with resulted in a remarkable improvement in BW and BP. ReCoF and/or DeCoF treatment and combination treatment showed a tendency to lower oxidative stress and increase anti-oxidative stress.

Keywords : chlorogenic acid, oxidant stress, antioxidant effect

415. Effect of aquatic training for walking ability using lower leg water-resistance equipment in elderly
Yoshihiro Katsura¹, Shin-ya Ueda², Shigeo Fujimoto³ (Kogakuin University, Morinomiya University of Medical Sciences, Sounai University)

[Aims] To prevent falls in Japan, both gait and resistance training of the lower extremities are recommended. Recently, aquatic exercise using water buoyancy and resistance have commonly been performed by the elderly. We have now produced water-resistance equipment that can wear on the lower leg. The purpose of the present study was to evaluate the efficacy of aquatic exercise training using the new equipment for the elderly. [Methods] Subjects were divided into two groups a resistance group of twelve subjects (using water-resistance equipment) and a non-resistance group of eight subjects (without the equipment). The aquatic exercise training was 90 min, three times per week for 8 weeks, and mostly consisted of walking. All subjects underwent anthropometric measurements, physical performance testing and profile of mood states (POMS). [Results] Significant improvements were observed in muscle strength in plantar flexion (p<0.05) and the timed up & go test (TUG) (p<0.001) in both groups. Additionally, 5-m maximum walking speed (p<0.01) and POMS (tension and anxiety) scores (p<0.05, r=-0.621) in the resistance group. As it became easier to maintain posture, stand, and move, tension and anxiety in everyday life were alleviated with improvement of strength of the lower extremities and balance function. [Conclusions] The present aquatic exercise training using water-resistance equipment may be used by the elderly to improve balance and walking ability, which are associated with the prevention of falls and care.

Keywords : elderly, aquatic training, walking ability

416. The influence of sleep quality on muscle loss accompanying weight reduction in obese men
Toru Yoshikawa¹, Misu Tachihara¹, Hiroshi Kagamai¹, Kanae Myoenzono¹, Takehiko Tsujiimoto¹, Kiyoo Tanaka¹, Seiji Maeda¹ (Univ. Tsukuba, Ibaraki, Japan)

[Aims] Weight loss induced by energy intake restriction alone leads to a decrease in muscle mass. Recent studies suggested that sleep quality plays a fundamental role in the regulation of muscle mass. We aimed to determine the influence of sleep quality on a change in muscle mass after a diet-induced weight loss. [Methods] Sev- enteen obese (Japanese criteria: BMI >= 25 kg/m²) men, age, 54 ± 9 years; BMI, 29 ± 2 kg/m²; expressed as mean ± SD) completed a 12-week dietary modification program for weight reduction (1680 kcal/day, well-balanced nutrient). Before and after the diet program, body mass, whole body muscle mass (DEXA), and sleep quality (Pittsburgh Sleep Quality Index: PSQI) were measured. Based on the median value of the mean PSQI score of before and after the diet program, subjects were divided for analysis into two groups: lower sleep quality (LSQ; n = 8; mean PSQI score range, 4.5-7.0) or higher sleep quality (HSQ; n = 9; mean PSQI score range, 1.5-4.0) groups. [Results] There were no significant differences in baseline characteristics between LSQ and HSQ groups. Changes in body mass after the diet program were -9 ± 3 kg in LSQ group, and -10 ± 4 kg in HSQ group (NS). The proportions of weight loss as muscle were 52 ± 11% in LSQ group, and 35 ± 11% in HSQ group (p < 0.05). [Conclusions] These results suggest that high sleep quality suppresses the reduction in muscle mass during diet-induced weight loss in obese men.

Keywords : Sleep quality, Weight loss, Muscle mass