Effects of carbohydrate with leucine-enriched essential amino acids on muscle protein synthesis

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[Aims] Leucine-enriched essential amino acids (LEAAs) and insulin have been reported to enhance muscle protein synthesis (MPS) after exercise. However, it is unclear the effect of co-ingestion carbohydrate, which induces insulin release, with LEAAs on MPS. In this study, we evaluated the co-ingestion effect of carbohydrate with LEAAs on MPS after exercise in rats. [Methods] 8 weeks male SD rats were made to perform strenuous jump exercise (200 jumps), after which they ingested distilled water and 1 g/kg LEAAs with or without 1 g/kg of glucose. Thirty minutes after the oral administration, rats were injected with L-[ring-13C5]-phenylalanine as tracer. Twenty minutes after the tracer injection, blood sample and the gastrocnemius muscle were collected under anesthesia. The fractional synthesis rate was determined by measuring the incorporation of tracer into skeletal muscle protein. [Results] Immediately after the exercise, plasma insulin concentration was significantly lower than that at the basal level. Co-ingestion of glucose with LEAAs alleviated the reduction in plasma insulin concentration, while LEAAs ingestion alone did not. LEAAs administration with or without glucose led to a higher MPS compared with water administration (P<0.05). However, the co-ingestion of glucose with LEAAs did not induce further increases in MPS compared with LEAAs ingestion alone. [Conclusion] Co-ingestion of glucose with LEAAs does not additionally increase MPS. **Keywords**: muscle protein synthesis, leucine, carbohydrate

Effects of whey peptide intake after resistance exercise on mTOR signaling in skeletal muscle in male and female

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[Aims] Protein intake after resistance exercise (RE) activates mammalian target of rapamycin (mTOR) signaling in skeletal muscle, which stimulates muscle protein synthesis. However, the effects of sex on mTOR signaling after protein intake and RE in human skeletal muscle remains unclear. The purpose of this study was to determine the effects of whey peptides intake after RE on mTOR signaling in skeletal muscle in male and female. [Methods] Male (n=7, 66.9 ± 7.6 kg) and female (n=6, 56.8 ± 9.3 kg) subjects performed 6 reps. × 4 sets). Immediately after exercise, the subjects took whey peptide drinks (0.19 g/kg). At resting and 1h post-exercise, muscle protein synthesis (MPS) was measured. [Results] MPS increased compared with those of rest, but there were no differences between male and female. The phosphorylation of Akt, mTOR, S6K1 and S6 after RE and protein intake significantly in-differences between male and female. The phosphorylation of Akt, mTOR, S6K1 and S6 after RE and protein intake significantly increased compared with those of rest, but there were no differences between male and female. [Conclusions] Whey peptides intake after RE activates muscle mTOR signaling in female as well as male. **Keywords**: Intracellular signaling, muscle protein synthesis, protein intake

Pre-exercise casein hydrolysate ingestion enhances mitochondrial enzyme activity compared with the intact casein ingestion in slow twitch muscle of high-fat diet-fed mice

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[Aims] We have previously shown that pre-exercise casein hydrolysate supplementation enhances mitochondrial enzyme activity in slow twitch muscle of high-fat diet-fed mice. However, it is unclear whether these effects are due to the ingestion of casein hydrolysate or intact casein. Thus, the aim of this study was to compare the effects of casein hydrolysate and intact casein on mitochondrial adaptation. [Methods] Mice were randomly divided into four treatment groups: the control group (Con), the endurance training group (Tr), the endurance training with intact casein group (Cas+Tr), and the endurance training with casein hydrolysate group (CH+Tr). Mice were ingested any water, intact casein, or casein hydrolysate (1.0 mg/g BW) and subjected to endurance training (15-25 m/min, 60 min, 5 times/week, for 4 weeks) 30 min after the ingestion. Muscular mitochondrial enzyme activity, citrate synthase (CS) activity was measured. [Results] In plantaris muscle, CS activities in Tr, Cas+Tr, and CH+Tr groups were significantly higher than that in Con group. On the other hand, CS activity in CH+Tr group was significantly higher than those in Con and Cas+Tr groups in soleus muscle. [Conclusions] Pre-exercise casein hydrolysate supplementation enhances mitochondrial enzyme activity compared with intact casein in slow twitch muscle of high-fat diet-fed mice. **Keywords**: Casein hydrolysate, mitochondrial enzyme activity, endurance training

Effects of L-citrulline intake on running performance

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[Aims] About the mechanism that the L-citrulline supplementation (Cit-suppl.) reduces the fatigue by the high-intensity exercise, it is thought that we examine it from a point of view called NO-producing increase or the NH3 detoxification increase. The aim of this study was to examine it from the viewpoint of latter. [Methods] Ten-week-old male F344 rats were randomly assigned to Cit group and Con group. The rats were run on the treadmill with the speed of 40m/min until exhaustion. Before and after the exercise, we mea-sured the ammonia detoxification of skeletal muscles and the liver by amino acid analysis. [Results] Cit-suppl. significantly extended the time to exhaustion in high-intensity exercise. As for the skeletal muscles, Glu and Gln conc. related to the ammonia detoxification were significantly higher in the soleus and plantaris and Gln conc. in the soleus tended to be higher after the exercise than those in Con group, but the Glu conc. in plasma were not significantly increased by Cit-suppl. As for the liver, the conc. of Cit and ornithine which construct of the urea cycle were significantly increased after the exercise, and the conc. of urea which is the last metabolism product of the urea cycle was significantly higher plasma level after the exercise in Cit group. [Conclusion] Cit-suppl. increased high-intensity exercise time to exhaustion and the phenomenon is explained by the ammonium detoxification acceleration in the liver urea cycle in Cit-suppl. **Keywords**: L-citrulline, High intensity exercise, Ammonium detoxification
Effect of conjugated linoleic acid intake on endurance performance in student athletes

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[Aims] Conjugated linoleic acids (CLA) was reported to enhance endurance in mice by promoting the β-oxidation of lipid metabolism and decreasing the amount of lactic acid in the blood after exercise. However, the effect of CLA on endurance performance in human has not reported. Therefore, the purpose of this study was to examine the effect of CLA intake on endurance performance and anti-fatigue in student athletes. [Methods] A double-blind, crossover study was conducted with 10 male student athletes. Each subject was administered with either CLA (net 0.9 g/day) or a placebo for 14 days and then with a load of 70%peak VO2 for 40 min and then with a load of 70%peak VO2 until exhaustion on the cycle ergometer. [Results] Upon CLA intake, amount of body weight variation and of exercise time variation significantly increased (p<0.05). In addition, variation in value of serum lactate dehydrogenase LD-1 after exercise significantly decreased (p<0.05). Amount of variation of flicker value marginally increased (p<0.1), and that of rating of perceived exertion during exercise marginally decreased (p=0.1). [Conclusions] These results suggested that CLA intake for 2 weeks may have an effect on endurance performance and anti-fatigue in student athletes.

Keywords: conjugated linoleic acid, endurance performance, anti-fatigue

Energy intake and consumption based on competition level - A study in University Students-

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[Aim] To compare nutrient intake and lifestyle activities in student athletes based on competition level. [Methods] University male students, who were swimming club members, were divided into an upper-level group (University C, First Rank Kanto League) and a lower-level group (University K, Fourth Rank Kanto League). For the dietary survey, subjects recorded their diet for three consecutive days (two weekdays and one holiday), and the results were analyzed using Excel Eiyo-kun ver. 7.0 (Kenpakusha). The survey on students’ lifestyle activity status was performed on the same days as the dietary survey. The total daily energy consumption was calculated based on the intensity of physical activity and time using the following equation: METs × body weight (kg) × time (h) × 1.05. [Results] In the upper-level group (n=20), the body mass index (BMI) was 23.0 ± 1.0 and body fat percentage was 12.4 ± 2.0%. In the lower-level group (n=12), BMI was 21.4 ± 1.0 and the body fat percentage was 15.4 ± 4.0% (p<0.05 between the groups for BMI and body fat percentage, respectively). The energy intake was 3463 ± 924 kcal/day in the upper-level group and 2637 ± 702 kcal/day in the lower-level group (p<0.05). The total energy consumption was 4359 ± 748 kcal/day in the upper-level group and 3694 ± 884 kcal/day in the lower-level group (p<0.05). [Conclusions] The total energy consumption exhibited by the upper-level group was higher than that exhibited by the lower-level group. Moreover, energy intake also increased in accordance with this trend, indicating that good performance in exercise was maintained.

Keywords: energy intake and consumption, student athletes, competition level

The relationship between physical activity level and energy balance in older people-Fukuoka island study-

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[Aims] Aging is associated with decreased physical activity, which may in turn lead to lower energy expenditure (EE). Previous studies also suggest that appetite may be dysregulated in older individuals. Epidemiologic studies have shown that the relationship between energy intake (EI) and EE is U-shaped in young and middle-aged adults. However, the relationship between physical activity level (PAL) and energy balance (EB) is unclear in older people. We aimed to assess the effects of different levels of physical activity on dietary EI and EB. We hypothesized that those with high PAL would adjust their EI to maintain EB, while those with low PAL would have positive EB (i.e., EI > EE). [Methods] The study participants were 56 older people (age: 72 ± 7 years). EI was assessed via dietary records for 3 days and EE and PAL were calculated using a tri-axial accelerometer. Participants were divided into three groups in accordance with their PAL, and we analyzed the relationship between PAL and EB. [Results] The mean step count for all participants was 6199 ± 2722 (men: 6535 ± 2903, women: 6053 ± 2626). PAL was negatively correlated with EB (r = -0.402, p = 0.001). EB in the lowest PAL group (PAL: 1.34 ± 0.05) was -176 ± 261 kcal/day, and in the highest PAL group (PAL: 1.61 ± 0.07) was -95 ± 261 kcal/day. [Conclusions] These findings suggest that sedentary lifestyles may not correspond with EB and, thus, lead to accumulated energy surplus and to weight gain.

Keywords: Energy balance, Physical activity level, Older people

Dietary patterns and visceral obesity in middle-aged and elderly people

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[Aims] Dietary fat and energy intake affect accumulation of visceral fat. However, the associations between dietary pattern and abdominal obesity are not well defined. Therefore, we aimed to examine the association between major dietary patterns and abdominal obesity in middle-aged and elderly people. [Methods] A total of 385 people aged 40-79 years participated in the WASEDA’S Health Study. Dietary patterns were derived by using principal component analysis of the consumption of 52 food and beverage items, which were assessed by a validated diet history questionnaire. Abdominal obesity was assessed by magnetic resonance imaging of the visceral fat area (VFA), abdominal obesity is defined as >= 100 cm² of VFA. Odds ratios and 95% confidence intervals for the prevalence of abdominal obesity were obtained using a logistic regression model. The participants were divided into tertiles depending on the factor scores of each dietary pattern. [Results] The first dietary pattern (healthy Japanese pattern) characterized by vegetables, seaweeds, soybean, and mushrooms was inversely associated with the prevalence of abdominal obesity in middle-aged and elderly people, after adjustments for covariates (odds ratio of the highest tertile vs the lowest, 0.55; 95% confidence interval: 0.29-0.83; p for trend = 0.082). [Conclusions] These results suggest that a healthy dietary pattern is associated with a lower prevalence of abdominal obesity in middle-aged and elderly people.

Keywords: diet, nutrition, abdominal fat

Keywords: Energy balance, Physical activity level, Older people
241. Effects of taheebo polyphenol on endurance capacity and skeletal muscle adaptation
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Taheebo polyphenol (TP) has several beneficial effects such as antioxidant, anti-inflammation and anti-cancer effect. However, the effects of TP on exercise performance are not clear. The aim of this study was to investigate the effects of TP on endurance performance and its mechanism. Male C57BL/6J mice (10 weeks old) were randomly divided into 4 groups: sedentary (Sed) group, TP supplemented (TPS) group, exercise (Ex) group and Ex plus TPS group. Mice in TPS and Ex plus TPS group were given TP (200 mg/kg weight) with a feeding needle at one hour before the start of exhaustive treadmill exercise. Mice in Sed and Ex group were given water. One hour after the TP or water supplementation, mice in Ex and Ex plus TPS group exercised until exhaustion. Immediately and four hour after the treadmill running, all mice were sacrificed and blood, gastrocnemius muscle and liver were removed. Running times for Ex plus TPS group mice were significantly longer compared with Ex group mice. TP reduced exhaustive exercise-induced decrease of blood glucose and skeletal muscle glycogen concentration. Gene expression of SIRT1 and cytochrome c expression for Ex group were not changed while significantly higher compared with TPS group. However, SIRT1 and cytochrome c expression for Ex group were not change compared with con group. In conclusion, the supplementation with TP increased endurance capacity and reduced exhaustive exercise-induced decrease of blood glucose and muscle glycogen concentration. Moreover, TP supplementation increased expression of SIRT1 and cytochrome c.

Keywords: polyphenol, endurance capacity, mitochondrial biogenesis

242. Does carbohydrate ingestion before endurance exercise really cause hypoglycemia?
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[Aims] The purpose of this study was to investigate whether high carbohydrate intake before an endurance exercise induces hypoglycemia in Japanese men. We also investigated whether the results were affected by eating breakfast before high carbohydrate intake.

[Methods] Fifteen subjects completed 2 trials in a random order. After overnight fast (fasted) or eating breakfast 3 hours before exercise (fed), subjects ingested 150 g of glucose in 500 mL solution 30 min before exercise. The exercise trial was 60 min of cycling exercise at a workload equivalent to 75% VO2max. Blood samples were obtained before and during exercise for determination of plasma glucose and serum insulin levels. Hypoglycemia was defined as blood glucose less than 70 mg/dL. [Results] Although plasma glucose levels rapidly decreased after 15 min of exercise in both trials, the mean concentrations were above 70 mg/dL. Five subjects (fasted) and 7 subjects (fed) showed hypoglycemia at 15 min of exercise, respectively. Insulinogenic index (fasted) and VO2max (fed) were negatively correlated with plasma glucose levels at 15 min of exercise, respectively. [Conclusions] Carbohydrate ingestion before exercise might occur hypoglycemia in Japanese men regardless of feeding status. A high insulin secretion capacity might play an important role in the occurrence of hypoglycemia in the fasted state. On the other hand, a high endurance capacity might be a determinant of hypoglycemia in the fed state.

Keywords: hypoglycemia, carbohydrate, endurance exercise

243. Effect of nutrition education on high school cross-country athletes
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[Aims] Athletes from Aomori Prefecture have shown top-level performance in the cross-country winter sports. In order to sustain these top-class results, nutritional management is required. [Aim] This study aimed to examine the effect of nutrition education by examining diet, body composition, and health.

[Methods] Food intake, body composition, blood biochemical levels, and consciousness towards diet and diet changes were examined pre-season (before nutrition education) and during the season (after nutrition education) among 8 male and 2 female high school students in the Aomori Prefecture cross-country club.

[Results] Energy intake was insufficient. Intake of grains, compared to pre-season, was significantly reduced. Regarding consciousness of diet, an unchanged 70% said they ate breakfast every day. A total of 60% of athletes were not interested in their diet pre-season. This was reduced to 50% during the season.

[Conclusions] To ensure satisfactory energy intake, consumption of grains is considered highly important. Continuous guidance for athletes is suggested, because meals are skipped, and attention towards diet improvement is low. Considering the situation among athletes, it is important to develop an education programme to develop self-management skills for an appropriate diet.

Keywords: cross-country skiing, nutrition education, diet

244. The longitudinal study of dietary intake between different percent body fat groups in elementary school children
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[Aims] The purpose of this study was to investigate the differences in dietary intake between higher body fat (H-fat) and lower body fat (L-fat) groups in elementary school children. [Methods] This was a longitudinal study with a hundred-four children, 44 boys and 64 girls aged 8-9 years old at their 3rd grade, measured height, body weight and body fat percentage. Subjects were divided by body fat percentage into two groups, H-fat and L-fat, according to gender. The subjects’ dietary intake was assessed by using self-reported three-day food records. Two years later, a follow-up investigation was conducted when the subjects were in the 5th grade. The differences between means of groups were tested using an unpaired t-test and the significance level was p<0.05. [Results] Body weight and body fat percentages even when they were in the 3rd grade were higher in H-fat than in L-fat in both genders. H-fat in boys consumed larger amounts of dietary fat and eggs at the 3rd grade. The follow-up data showed that H-fat in boys had significantly reduced intakes of dietary fat, calcium and milk & milk products compared to L-fat in boys within two years period. H-fat in girls also had significantly reduced intake of milk & milk products in two years’ time. Reducing intake of milk & milk products in H-fat groups in both genders was thought to be causally related to children’s and parental consciousness of overweight. [Conclusions] Different body fat percentage groups in elementary school children had some important trends in dietary intake and higher body fat percentages were possibly formed in early school year.

Keywords: school children, food records, body fat
Post-exercise nutrient timing: effects on gastrointestinal blood flow and motility
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[Aims] It is a well-known strategy that protein ingestion immediately after exercise greatly stimulates muscle protein synthesis during the post-exercise (PE) recovery phase. However, immediately after strenuous exercise, gastrointestinal injury is frequently caused by hypoperfusion, possibly resulting in impaired gut-function (e.g. gastric emptying, GE). The aim of this study was to examine the effect of timing of a PE recovery drink on gastrointestinal blood flow and GE.

[Methods] Eight healthy young subjects performed an intermittent supramaximal cycling exercise for 30 min which consisted of 120% of VO2 peak for 20 seconds and then 20 W for 40 seconds. Subjects ingested 300 mL of nutrient drink containing carbohydrate protein at a timing of either 5 min (PE5) or 30 min (PE30) after the cessation of exercise. For the study controls (Con), the same drink was ingested but without exercise. The blood flows of the celiac (CABF) and superior mesenteric arteries (SMA) and GE were assessed by ultrasonography. [Results] Before drink ingestion in PE5, the CABF significantly decreased from baseline, whereas in PE30 it returned to baseline. In PE5, CABF did not change from baseline but significantly increased in PE30 and Con. In PE5, SMABF significantly increased later than Con and PE30. GE was consistently slower in PE5 than PE30 and Con. [Conclusions] The timing of PE nutrient ingestion might influence the following GE and gastrointestinal BF responses, and consequently affect the digestive/absorptive function.

Keywords: gut blood flow, gut function, nutrient timing

How can elite Kenyan distance runners obtain their specific muscle-tendon architecture?
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[Aims] The purpose of this study was to compare musculoskeletal characteristics between different age Kenyan and Japanese populations in order to clarify the attainment process of the specific musculoskeletal characteristics for elite Kenyan distance runners (ELITE).

[Methods] Three Kenyan groups (ELITE: n=18, competitive male runners (RUNNERS): n=34, general adult males (CTRL): n=34) were recruited and then compared. In addition, the musculoskeletal properties were compared with the entire groups from the children to young adults between in Kenyans (n=192) and in Japanese (n=481). The measurements included the following parameters: Achilles tendon (AT) length and AT moment arm (MAAT), foot lever ratio as well as the muscle fascicle length of medial gastrocnemius muscles (LFa) were measured with ultrasonography. [Results] The results showed that the AT length, MAAT, the foot lever ratio and LFa did not show any significant differences between ELITE, RUNNERS and CTRL. In the comparison between Kenyan and Japanese groups, Kenyan groups showed significantly longer AT length and MAAT than Japanese groups and shorter LFa, and lower in Kenyan than in Japanese groups, respectively. [Conclusions] The specific musculoskeletal characteristics of lower-leg for ELITE can be the common characteristics between Kenyans.

Keywords: Kenyan runner, moment arm, Achilles tendon

Effect of differential sweet taste sensations in oral cavity on gastric emptying
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[Aims] Gastrointestinal (GI) distress often occur during high intensity exercise. The faster gastric emptying (GE) of carbohydrate solutions may increase digestion and absorption, and probably prevent GI distress. The present study determined the effects of different oral sweet taste sensations on GE. [Methods] 8 subjects rested for 5 min then consumed 300 g of a solution containing 50 g maltodextrin (M), on 5 separate study days. The oral taste sensations were provided by 4 different sweet solutions (glucose, fructose, sucrose and aspartame) at same sweetness intensity and distilled water. Subjects were instructed to hold 15 ml of the solution in their mouths for 8 s. This was repeated 5 times with the same solution over 1 min every 5 min after ingesting the M solution. During each trial, GE was measured in the pyloric antrum area using ultrasonography. In addition, subjects were asked the sweetness intensity, taste preference and appearance using visual analog scale just after each sweet taste sensation. [Results] Sweetness intensity of aspartame was significantly lower than glucose. Taste preference of sucrose was significantly higher than aspartame. GE was significantly accelerated by glucose and fructose compared with other sweet solution. [Conclusions] Oral sweet taste sensation by glucose and/or fructose induce the faster digestion of gastric residual and may prevent GI distress during intense exercise.

Keywords: sweet taste sensation, gastric emptying, gastrointestinal distress

Observation of secretory glands in aqueous solution by ASEM

[Aims] There are three pairs of major salivary glands (SG) in mammals, the parotid glands, submandibular glands and sublingual glands. These glands secrete serous, mucous or mixed saliva via the proper excretory ducts connecting the glandular bodies with the oral cavity. The hallmark characteristic of Sjögren’s syndrome is diminished secretory production from the primary exocrine gland and the lacrimal glands (LG) or SG resulting in symptoms of dry eye and mouth, by poorly understood mechanisms. Gland-related diseases have been studied by optical microscopy, and at higher resolution by transmission electron microscopy of Epon embedded samples, which necessitates hydrophobic sample pretreatment. [Methods] We report the direct observation of tissue in aqueous solution by atmospheric scanning electron microscopy (ASEM). SG and LG were fixed, sectioned into slabs, stained with phosphotungstic acid (PTA), and inspected in radical scavenger D-glucose solution from below by an inverted scanning electron microscopy, guided by optical microscopy from above to target the tissue substructures. A 2 to 3 μm specimen thickness was visualized by the SEM. [Results] In SG and LG, secretory vesicles and other organelles were clearly imaged at higher resolution, and the former could be classified according to the degree of PTA staining. [Conclusions] The results suggest the use of in-solution ASEM for histology and to study vesicle secretion systems. Further, the high-throughput of ASEM makes it a potential tool for the diagnosis of exocrine-related diseases.

Keywords: salivary glands, atmospheric scanning electron microscopy, dry mouth