

The Female Athlete: Key Strategies for Long Term Success

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The Female athlete: Through the life cycle

Strategies for long-term success

- Childhood/Adolescence
 - Benefits of participation
 - Concerns: Menstrual irregularities, Disordered Eating, Bone Density, Female Athlete Triad
- Pregnancy
 - Benefits of exercise in pregnancy
 - Concerns: Specific limitations, thermoregulation, preterm labor, preeclampsia
- Aging/Menopause
 - Benefits: prevention/treatment osteoporosis, reduction CV risk
 - Concerns: Injury Risk

Female Athletes in Childhood



Childhood/Adolescence

Benefits: Bone Density

- Peak bone mass is achieved at 16-20 in girls (20-25 in young men)
- Young women (and men) who exercise generally achieve a greater peak bone mass than sedentary comparisons
- Exercise prior to pubertal growth spurt stimulates bone growth and muscle hypertrophy
 - In particular study of early pubertal girls (tanner stage 1 to 3, age 9-11) circuit training three times per week gained 1.5%-3.1% more bone mass at femoral neck and lumbar spine vs control group. (exercise group = 87 girls, control=90 girls)
 - (MacKelvie, 2001)
- Bone is a living tissue that responds to exercise stressors by becoming stronger



Childhood/Adolescence

Benefits: Cardiovascular Health

- Cardiovascular disease is a leading cause of death in Canadian women.
- From ages 12 to 50 estrogen is protective
- The risk rises dramatically after menopause.
- Establishing heart healthy behaviours in childhood is paramount.
- Studies show those who are obese as children/adolescents are more likely to remain obese as adults leading to significant risk of heart disease, stroke, and diabetes.

Childhood/Adolescence

Benefits: Reduction rates of Obesity

- Canadian children are getting larger and less active
- Obesity rates have tripled over the last 30 years
- 1 in 4 children/youth are overweight or obese
- Less than 10% children meeting recommended 60 minutes of moderate-to vigorous-intensity physical activity each day
- Obese children are also subject to bullying, depression, anxiety, low-self-esteem



Child/Adolescent Athletes

Closing The Gender Gap

- Female youth participate in physical activity less than males
- Participation rates decline over time and this trend is more pronounced in young females
 - By age 15, 75% of youth no longer participate
- Benefits: improved cardiovascular fitness, reduction rates of obesity, reduce risk of cardiovascular disease and diabetes
 - *reduction in major lifestyle diseases of our culture

Child/Adolescent Athletes

Benefits to Mental Health & Academics

- Sport participation builds confidence, self-esteem, decreases rates depression, anxiety, builds skills such as goal-setting, teamwork, improved concentration
 - * Systematic review revealed cognitive performance is associated with vigorous physical activity
 - * Academic performance is related to general physical activity but mainly in GIRLS.
 - * This association could be mediated by some psychological factors (e.g. self-esteem, depression).
 - Esteban-Cornejo L, Tejero-Gonzalez CM, Sallis JF, Veiga OL. Physical activity and cognition in adolescents: A systematic review. J Sci Med Sport. 2014. Jul 24



Primary Care Professionals: Assessment of Sport Readiness

- 20th Century: free play gave way to organized sports. Benefits: supervision, coaching, safety, motor skills, social interaction, creativity, enjoyment, peer group.
- Potential for demands/expectations that may exceed child's readiness.
- Sport readiness: The child's motor development matches the sports requirements.
 - In order to minimize feelings of frustration/failure
- Choosing the sport and timing of participation should be individualized to child's strengths/development



Early Childhood (2-5)

- Dramatic improvement gait
- Straightening of infant bow legs
- Body fat % decreases, and increase fat free mass, increase in energy expenditure
- Emphasis: acquiring skills of running, throwing, tumbling, and catching
- Encourage fun, playfulness, exploration, experimentation
- 15-20 mins structure, 30 mins free play
- Show and tell may be more helpful than verbal instruction
- Competition discouraged



Middle Childhood (6-9)

- Aerobic and Anerobic capacity both increase slowly
- Growth continues but at a slower rate
- Attention spans still short – instructional sessions brief
- Emphasis on developing transitional skills
- Encouraging factors: strong leadership, fun, success, family participation, variation, peer support
- Discouraging factors: failure, embarrassment, regimentation, competition, injuries
- Rules should be flexible with minimal competition
- Entry-level activities could include: soccer, baseball, swimming, running, skating, gymnastics, dancing, riding a bicycle, martial arts, racquet sports



Late Childhood (10-12)

- Girls temporarily taller and heavier, earlier onset of puberty. Strength diverges but minimal differences.
- Master complex motor skills and play combinations.
- Attention spans increase but m/b selective
- Encourage skill development with increasing emphasis on strategy and more complex play
- Football, basketball, ice hockey



Early Adolescence (13-15)

- More drastic growth: increase muscle mass, strength and cardiopulmonary endurance
- Girls increase fat mass at a greater rate
- Girls increase muscle mass (slower rate than boys)
- Girls mature at different rates – girls with slower maturation (narrow hips/waists) may be well suited for gymnastics



Late Adolescence (16-18)

- Girls continue to increase fat mass
- Muscular strength and aerobic capacity increase into adulthood
- All sports fair game – enjoyment and success being primary determinants for choice of sport
- Benefits: identify with a peer group, increase social interaction, develop independence

Specific Concerns with Adolescent Athletes



Menstrual Irregularities

- Incidence of female athletes with menstrual disorders: *34.5% esthetic sports, 30.9% endurance sports, 23.5% weight class sports
- Exercise alone does not induce amenorrhea – associated with type (running, ballet, gymnastics, figure skating) and amount of exercise and rapid increases (i.e. training before competition)
- Low body weight alone is not sufficient to explain the onset of amenorrhea, more likely to be associated with relative caloric deficiency d/t inadequate intake vs expenditure

Menstrual Irregularities

- Long-term negative energy balance, inadequate nutrient intake dangerous in peak bone building years
- Significantly decreased BMD in athletes with menstrual irregularities
- Athletes with amenorrhea had increase LDL and total cholesterol vs athletes and sedentary women with normal cycles

Menstrual Irregularities

Effect on HPO axis

- Female athletes with amenorrhea: decr GnRH induced LH secretion (amplitude and frequency). Female athletes with normal cycles have similar decrease but less.
- Exercising women with menses have decr progesterone during luteal phase
 - luteal phase defect



ACSM: Female Athlete Triad

- The Triad: Energy availability, menstrual function and BMD. May result in clinical: amenorrhea, osteoporosis, eating disorders.
- Energy intake may be insufficient to meet training demands: unintentionally, purposefully to 'lean up' for an event, or related to psychological factors/disordered eating
- Effects on HPO and BMD occur $< 30\text{kcal/kg}$ fat free mass

Female Athlete Triad: ED's

- Anorexia <15% below expected weight for age/height maybe in restricting/purging subtype. Amenorrhea is part of the diagnostic criteria.
- Bulimia nervosa normal weight range repeat cycles of over-eating and purging and/or other compensatory behaviours (fasting, excessive exercise).

ACSM Definition: low BMD

- History of nutritional deficiencies, hypoestrogenism, stress fractures and/or other secondary clinical risk factors for fracture with BMD Z-score -1.0 to -2.0
- Osteoporosis clinical risk factors for fracture with BMD Z-score <2.0

The Triad: Health Consequences

- ED's may be assoc w anxiety, depression, low self-esteem
- Amenorrheic women are infertile but may resume ovulation prior to return of menses resulting in unexpected pregnancy
- Impaired endothelium-dependent vasodilation – reduces perfusion of working muscles including skeletal muscle oxidative metabolism and heart. May also have vaginal dryness, and elevated LDL.
- As number of missed cycles increases loss of BMD decreases proportionately and may be irreversible.
- Stress fractures 2-4 times more common in amenorrheic athletes than eumenorrheic athletes.

Triad screening

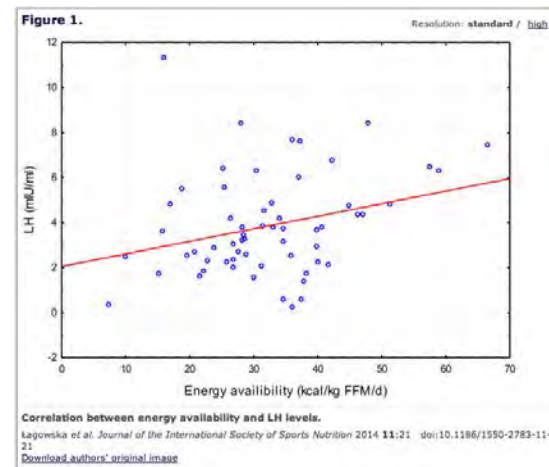
- Amenorrhea – beta-hcg, LH/FSH, PL, free test or DHEA – basically ruling out organic causes. No specific test for HPO amenorrhea
- Labs – electrolytes, CBC w diff, U/A, thyroid
- DEXA – indicated in 6 months or more of hypoestrogenism, disordered eating and/or history stress fractures

Treatment of the Triad

- First goal of therapy – modify diet and/or exercise. Increase caloric intake to 30-45 kcal/kg FFM/d. Best evidence for restoration of menstrual cycle and BMD.
- Ensure dietary intake of essential nutrients (cal, mag, vit D, vit K, iron). Supplementing Calcium and Vit D likely necessary.
- Co-treatment approach – coaches, medical professionals, eating disorders counseling if applicable (CBT, family therapy)
- Athletes with ED's who do not comply may need restriction from training/competition

Effects of Dietary Intervention on Menses

- Kagowska et al. Effects of dietary intervention in young female athletes with menstrual disorders. JISSN. 2014 11(21).
- N=45 female professional athletes with menstrual irregularities, age=18.1 +/- 2.6 y
- 3 months dietary intervention resulted in significant increase calories, improved energy balance, no significant change BMI and body comp however significant increase LH and LH:FSH
- Calories 30-45 kcal/kg FFM/d. Protein 1.2-1.6 g/kg, carbs >55%, calcium 1000-1400mg, Vit D (400-800IU)
 - If serum 25(OH) Vit D low – higher doses may be necessary
- Evidence for the calorie deficit being at the root cause, further studies needed for long-term restoration BMD and menses



Infertility in HPO dysfunction athletes

- GnRH pulse def and subsequent decr LH surge
- Increased caloric intake to within 95% ideal BMI
- Conventional treatment luteal phase support progesterone
 - Vitex agnus-castus

Pregnancy & Athletics



Benefits of Exercise during pregnancy

- Sedentary lifestyle and excessive gestational weight gain are major contributing factors to the obesity epidemic in western countries
- Exercise may help prevent excessive gestational weight gain
- Regular aerobic exercise during pregnancy can maintain physical fitness
- Can reduce symptoms of low back pain
- May reduce risk of gestational diabetes and preeclampsia
- Moderate exercise is not linked with any adverse pregnancy outcomes



Exercise Recommendations During Pregnancy

- In the absence of medical and/or obstetrical complications women should be advised to continue exercise routine throughout pregnancy
- The Canadian Society for Exercise Physiology (CSEP) recommends adults get 150 mins mod-vigorous aerobic exercise per week and strength training (muscle and bone building) at least twice per week and that these guidelines may be appropriate during pregnancy
- The Center for Disease control and prevention (CDC) and the American College of Sports Medicine (ACSM) have similar guidelines to the CSEP. With an elaboration that women who engage in vigorous aerobic activity or who are highly active can continue throughout pregnancy under supervision.



Exercise Recommendations During Pregnancy

- The Royal College of Obstetricians and Gynecologists (RCOG) suggest that all pregnant women participate in aerobic and strength-conditioning as part of a healthy lifestyle during pregnancy.
- Previously sedentary – begin with 15mins continuous exercise, three times per week, gradually increasing frequency to daily, and duration to 30 mins.
- Physically active women should maintain their fitness level without striving to reach peak fitness or train for athletic competition.



Physiology of Exercise during Pregnancy

- Transient maternal hypoxia can cause transient fetal tachycardia and increase in blood pressure – compensatory to facilitate oxygen transfer and decrease CO₂ tension across the placenta
- Fetal heart rate (FHR) responses – 10-30 bpm increases in response to maternal exercise
- No adverse effects noted and determined to be compensatory to maintain fetal oxygenation



Physiology of Exercise during Pregnancy

- Link between deficient diets, strenuous physical activity and lower birth weights
- Strenuous third trimester exercise associated with newborns delivered 200-400 g's smaller
- However a meta-analysis found minimal birth weight difference between mothers that exercised during pregnancy vs controls
- No risk preterm delivery, rather a minor protective role.

Contraindications to exercise during Pregnancy

Contraindications to aerobic exercise in pregnancy

Absolute contraindications
Significant cardiac disease
Restrictive lung disease
Cervical insufficiency
Multiple gestation
Placental abruption
Placenta previa
Premature labor
Ruptured fetal membranes
Preeclampsia, gestational hypertension
Relative contraindications
Severe anemia
Unevaluated arrhythmia
Bronchitis
Poorly controlled diabetes, primary hypertension, seizure disorder, or thyroid disease
Extreme obesity, malnutrition, or eating disorder
Sedentary lifestyle
Fetal growth restriction
Heavy smoking

Adapted from: ACOG Committee opinion. Number 267, January 2002 *Obstet Gynecol* 2002; 99:171 (reaffirmed 2009). and *Exercise in Pregnancy* (RCOG Statement 4) <http://www.rcog.org.uk/womens-health/clinical-guidance/exercise-pregnancy>. (Accessed on June 10, 2013).



Swimming/Aquafitness

- Water is a preferred medium for exercise:
 - Heat is dissipated
 - Balance and falling are non-issues
 - Non-weight bearing, minimizing joint stress
 - Edema reduced
 - Weightless feeling well tolerated



Activities/Sports to avoid

- Scuba – risk decompression sickness in fetus
- Activities with high risk falls and/or abdominal trauma/contact (soccer, hockey, basketball, horseback riding, downhill skiing/boarding)
- Due to joint laxity avoid rapid changes in movement, pivoting, rapid decelerations



Activities/Sports to avoid

- Avoid exercise in supine position in 2nd half of pregnancy
- Thermoregulation is challenged in pregnancy (increase BMR and heat production) and fetus unable to thermoregulate – avoid dehydration, extreme heat, over-heating
- Altitude is not recommended – avoid high intensity activity above 6000ft



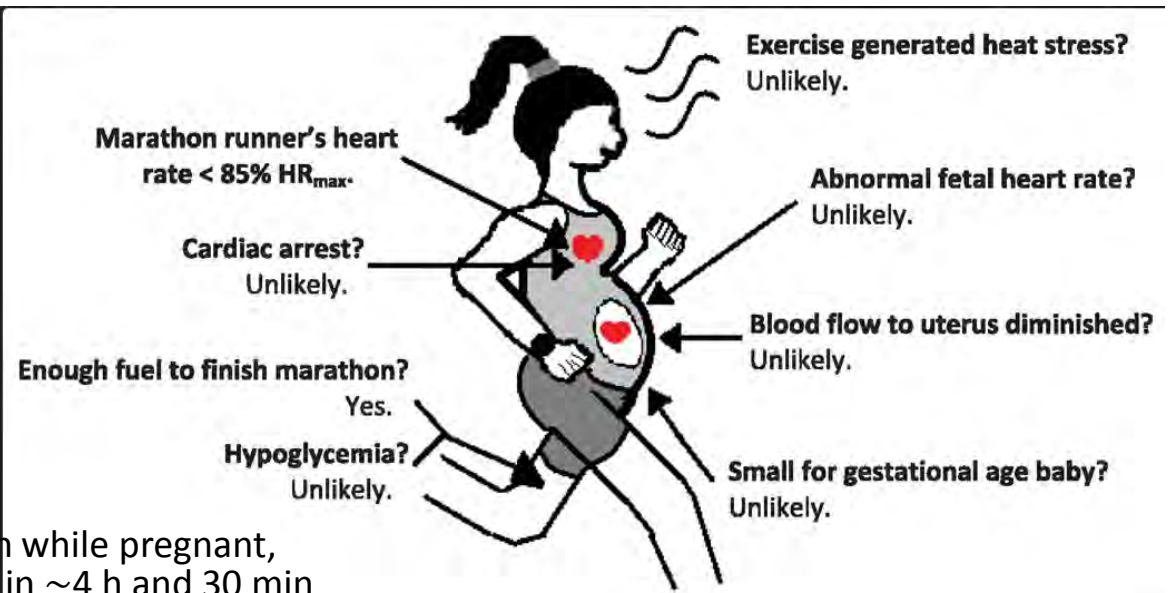
Elite Athletes & Pregnancy

- Pregnancy – increased weight, changed in center of gravity, pelvic instability, relaxation ligaments. Physiologic anemia of pregnancy may affect cardiovascular performance
- Fluid balance and thermoregulations of specific concern
- No evidence for strenuous activity causing preterm labor



Elite Athletes & Pregnancy

- Most elite athletes will decrease pace & intensity of training during pregnancy
- Greater risk of thermoregulatory complications – maintain adequate hydration
- Weigh athlete before and after exercise.
- 1 lb weight loss = 1 pint fluid and must be made up before next training event
- Physical exercise associated with small uterine contractions, no risk preterm delivery
- Tend to gain less weight than average pregnant woman, and lower birth weight fetus related to lower fat percentage.



- Concerns of completing a marathon while pregnant, debunked. Completing a marathon in ~4 h and 30 min or better elucidates an average heart rate that is 82 to 84% of maximum (10, 15, 22). As such, fetal heart rate is unlikely to be abnormal when maternal heart rate is below 90% of maximum (20). Blood flow to the uterus and umbilical oxygen delivery is minimally affected below the ventilatory threshold (7). At this marathon pace or slower, the major fuel source is intramuscular triglycerides and plasma free fatty acids, not muscle glycogen (18). As such, hypoglycemia is unlikely (5). Exercise-generated heat stress is doubtful as the body is built to prevent catastrophic failure of homeostasis (13, 16). Cardiac arrest during a marathon is improbable as the incidence is miniscule (0.00016%) (9). Finally, women who exercise regularly while pregnant should not worry about having a small for gestational age infant, as their infant's weight at birth is usually similar to the weight of infants born from women who do not exercise throughout their pregnancy (6). Figure created by Allison M. Straub.

Zavorsky GS, Longo LD. Viewpoint: Are there valid concerns for completing a marathon at 39 weeks of pregnancy? *Journal of Applied Physiology*. 2012. 113: 1162-1165.



Obstetrical Risks and Exercise

- Gestational Diabetes – improved glycemic control with exercise
- Obesity – exercise and restrict weight gain
- Preeclampsia – exercise contraindicated as it may exacerbate uteroplacental insufficiency
- Women at risk for preterm delivery – although exercise does NOT cause pre-term delivery, the current position is to avoid exercise in high-risk cases in 2nd and 3rd trimester



Postpartum Exercise

- The competitive athlete without complications can return to exercise soon after delivery
- No maternal complications associated with resuming training
- Decreased frequency of post-partum depression in women who return to exercise
- Diet and physical exercise assist weight loss which may reduce obesity related complications



Postpartum exercise

- Breastfeeding: encourage feeding before exercise to reduce discomfort of engorged breasts and reduce the accumulation of lactic acid in milk
- Meta-analysis (4 trials, n=170 women, 3-16 weeks post-partum) found maternal exercise programs in breastfeeding moms did not reduce infant weight gain vs controls
- Encourage adequate fluid intake to maintain milk supply in exercising breastfeeding mothers

Menopausal Athletes

Menopausal Athletes: Benefits to CV Health

- Greater exercise capacity, larger SV, LV volume and LA volume in post-menopausal former elite endurance athletes

Hagmar M et al. 2005. Clin J Sport Med July; 15(4): 25-62

- Improved endothelial function measured using flow-mediated vasodilation (FMD) as well as lower levels of cholesterol, low-density lipoprotein (LDL) and lower percentage of fat-mass in post-menopausal elite athletes vs age-matched sedentary controls. No further improvement with HRT.

Hagmar M et al. 2006. Clin J Sport Med. May; 16(3):247-52

***small sample size (n=20 elite athletes vs n=19 sedentary age-matched controls)

Menopausal Athletes: Benefits to BMD

- Bone Mineral Density (BMD) significantly higher in former elite athletes than in sedentary age-matched controls indicated physical activity in youth may have a beneficial effect on bone mass through aging
- Andreoli et al. 2012. Eur J Clin Nutr Jan; 66(1): 69-74.
- *** $n=48$



Menopausal Athletes:

Benefits to BMD

- The National Health and Nutrition Examination Survey I (NHANESI) – women who reported high amounts recreational exercise had a 47% lower risk for hip # than women with little
- The Nurses Health Study (NHS) - 55% lower risk of hip # in acgtive women with at least 24 METs-hours/week vs 3 METs-hours/week
- The Study of Osteoporotic Fractures (SOF) – 30% decrease in risk of hip # in women who systematically walked for exercise vs women who did not.
- Leisure World Study – Moderate exercise associated with 30% decrease in hip # risk

Osteoporosis

- Loss bone mass, enhanced fragility, increased fracture risk
- Osteoporotic fractures associated with great morbidity and mortality and although both men and women are at risk the disease is much more common in women
- Functional loading through forces applied during exercise has a positive impact on bone mass. Through aging, loss of strength, flexibility and decreased cardiovascular fitness can make it difficult to provide the stimulus to maintain bone mass.



Osteoporosis guidelines

- Aerobic exercise with strength training and balance training to reduce fall risk
- Vitamin D – 1000IU per day <50 non-osteoporotic females with no malabsorption issues. For Canadian women over 50 >2000IU can be safely recommended without medical supervision
 - Serum 25(OH) Vit D to guide therapy in osteoporotic women
 - <30nmol/l deficient, 30-50 nmol/l inadequate in some, >50nmol/l sufficient for almost the whole population
 - National Osteoporosis Society Vit D Guideline summary

Osteoporosis Guidelines

- Adequate caloric intake
- Supplemental Calcium 500-1000mg/day total calcium intake 1200mg/day
- CV risk of calcium supplements!
- Meta-analysis (13 trials) of po Vitamin K supplementation (phytonadione and menaquinone) – both increased BMD. Menaquinone in 7 studies shown to reduce vertebral, hip and all non-vertebral fractures.

Osteoporosis Epidemiology

Source: Osteoporosis Canada

- *Fractures from osteoporosis are more common than heart disease, stroke, breast cancer combined*
- At least 1 in 3 women (1 in 5 men) will suffer an osteoporotic fracture in their lifetime
- 28% women (37%) men who suffer a hip # will die the following year and result in more hospital days than stroke, diabetes or heart attack
- Over 80% fractures in 50+ d/t osteoporosis
- Cost: >2.3 billion (2010)/year treating osteoporosis and related fractures

Osteoporosis screening

- Risk factors: Advanced age, previous #, glucocorticoid use, cigarette smoking, low body weight, family hx hip #, excess EtOH
- FRAX assessment
- DEXA scan

The screenshot shows the FRAX (World Health Organization) osteoporosis risk assessment questionnaire. At the top, it indicates the country as "Canada" and has a field for "Name/ID:". A link "About the risk factors" is visible in the top right. The questionnaire is titled "Questionnaire:" in red. It contains 12 numbered questions, each with a radio button for "No" or "Yes". Questions 1 through 9 are on the left, and questions 10 through 12 are on the right. Question 1 asks for age or date of birth. Question 2 asks for sex. Question 3 asks for weight in kg. Question 4 asks for height in cm. Question 5 asks about previous fractures. Question 6 asks about a parent's fractured hip. Question 7 asks about current smoking. Question 8 asks about glucocorticoid use. Question 9 asks about rheumatoid arthritis. Question 10 asks about secondary osteoporosis. Question 11 asks about alcohol consumption. Question 12 asks for femoral neck BMD. Below the questions, there is a "Select BMD" dropdown menu, a "Clear" button, and a "Calculate" button.

Country: **Canada** Name/ID: [About the risk factors](#)

Questionnaire:

1. Age (between 40 and 90 years) or Date of Birth
Age: Y: M: D:

2. Sex ☐ Male ☐ Female

3. Weight (kg)

4. Height (cm)

5. Previous Fracture ☒ No ☐ Yes

6. Parent Fractured Hip ☒ No ☐ Yes

7. Current Smoking ☒ No ☐ Yes

8. Glucocorticoids ☒ No ☐ Yes

9. Rheumatoid arthritis ☒ No ☐ Yes

10. Secondary osteoporosis ☒ No ☐ Yes

11. Alcohol 3 or more units/day ☒ No ☐ Yes

12. Femoral neck BMD (g/cm²)
Select BMD



Female Injuries

- Studies suggest that healthy masters athletes have low risk of injury that does not increase with age (Ganse et al, 2014)

High Performance Athletes

- Specific Nutrient Deficiencies
 - Iron, Vitamin D, Magnesium, Zinc, and Electrolytes
- Specific Diets
 - Plants based, gluten free, paleo and low carb/high fat
- Performance Enhancers
 - Beta Alanine, D-Ribose, HMB, Creatine, CoQ10, EAAs, Beetroot, Caffeine, L-Arginine, L-Carnitine, Rhodiola, L-Glutamine, Sodium Bicarbonate, and RIPC
- Over Training Syndrome
 - Symptoms, monitoring, athlete pressure, and imagery

High Performance Athletes

Specific Nutrient Deficiencies



Iron

Why are endurance athletes more prone to iron deficiency?

- Dietary iron recommendations are 1.3 to 1.7 times higher for endurance athletes than non-athletes. The body adapts to a high training load by increasing the total amount of red blood cells and the accompanying need for more iron.

Iron

Why are endurance athletes more prone to iron deficiency?

- There is also a phenomenon called “foot-strike hemolysis”, where repeated jarring foot-strikes can physically break down red blood cells
- Increased body temperature associated with exercise or muscle contraction acidosis can damage RBC
- Additional contributing factors are heavy sweating, minor gastrointestinal bleeding from intestinal lining damage (common with strenuous exercise) and menses

Iron

Common symptoms of iron deficiency and iron deficiency anemia in athletes are:

- Loss of endurance
- Chronic fatigue
- High exercise heart rate
- Low power output
- Frequent injuries
- Low immunity
- Irritability

Iron

Testing

- Only test when healthy - a false positive can result from stress, surgery, infections, injuries, or asthma
- Taking iron when not iron deficient can increase inflammation, raise cholesterol, decrease cardiovascular health, and may even predispose an individual to cancer

Iron

Heme Sources:

3.5 milligrams or more per serving, include:

- 3 ounces of beef or chicken liver
- 3 ounces of clams, mussels, or oysters

2.1 milligrams or more per serving, include:

- 3 ounces of cooked beef
- 3 ounces of canned sardines, canned in oil
- 3 ounces of cooked turkey

0.7 milligrams or more per serving, include:

- 3 ounces of chicken
- 3 ounces of halibut, haddock, perch, salmon, or tuna
- 3 ounces of ham
- 3 ounces of veal

Iron

Non-Heme Sources

3.5 milligrams or more per serving, include:

- One cup of cooked beans
- 1 ounce of pumpkin, sesame, or squash seeds

2.1 milligrams or more per serving, include:

- One-half cup of canned lima beans, red kidney beans, chickpeas, or split peas
- One cup of dried apricots
- One medium baked potato
- One medium stalk of broccoli
- One cup of cooked enriched egg noodles
- One-fourth cup of wheat germ

0.7 milligrams or more, include:

- 1 ounce of peanuts, pecans, walnuts, pistachios, roasted almonds, roasted cashews, or sunflower seeds
- One-half cup of dried seedless raisins, peaches, or prunes
- One cup of spinach
- One medium green pepper
- One cup of pasta
- One slice of bread (preferable gluten free)
- One cup of rice

Iron

Supplementation: Non-Heme Source

- Ferrous fumarate, ferrous sulphate, and ferrous gluconate
- Poorly absorbed
- Side effects include constipation, nausea, cramping and diarrhea

Iron

Supplementation: Heme Source

- Preferred choice
- Best absorbed and less side effects than iron salts
- Special note on Proferrin: Non-medical ingredients are Cellulose, Croscarmellose Sodium, Sucrose, Polyvinyl Alcohol, Titanium Dioxide, PEG-3350, Talc, Chlorophyllin, Povidone, Protease, Hydrogenated Vegetable Oil, Calcium Stearate, Food Glaze, Silicon Dioxide



Iron

Ferrous bisglycinate chelate supplementation

- 2nd best source next to heme derived
- Low-molecular weight mineral compound that passes easily through intestinal wall
- Does not react with other nutrients and has fewer gastric side effects than other iron compounds
- Works with vegans and vegetarians



Vitamin D

Important role in performance, injury and immunity

- Researchers have shown that 25-OH Vitamin D levels of 135 nmol/L are associated with peak athletic performance.
- Coincidentally, this ideal level is also associated with preventing certain types of cancer, type II diabetes, hypertension, cardiovascular disease, influenza, multiple sclerosis, major depression, and cognitive impairments



Vitamin D

Important role in performance, injury and immunity

- A surprising amount of athletes fall well below this mark – even in outdoor sports.
- Some evidences suggests that a higher degree of inflammation is inversely proportional to Vitamin D status



Vitamin D

Important role in performance, injury and immunity

- Most effective when supplemented in Vitamin D deficient athletes (no beneficial evidence in vitamin D sufficient athletes)
- Recent study showed pre-exercise serum concentrations of serum 25(OH)D influenced the rate of recovery of skeletal muscle strength after an acute bout of intense exercise.



Vitamin D

Important role in performance, injury and immunity

- The identification of the Vitamin D receptor (VDR) in muscle tissue provides a direct pathway for Vitamin D to impact upon Skeletal Muscle structure and function
- Vitamin D has shown to increase the size and number of Type II (fast twitch) muscle fibers when deficiency is corrected.

Vitamin D

Testing and Dosage

- Best time to test is early spring – when vitamin D levels are lowest
- While blood levels change according to season, a suggested year-round range is 125-200 nm/L for maximum benefit
- How much vitamin D needed to keep within the ideal range is individual, and testing every 3 months while assessing dosage is suggested
- If an athlete is under 75 nm/L, a good starting point is 5000IU qd (may need to work with an MD regarding prescription)
- Gluten sensitivity and intolerance should also be considered when assessing low vitamin D status

Zinc

Role in Performance

- Helps wounds and injuries heal properly, including the cellular micro-damage caused by extensive daily exercise
- Co-factor in testosterone production
- Lost in sweat (most electrolyte drinks do not include zinc)
- Endurance athletes who limit or avoid meat, as well as those restricting their calories and/or fat intake, will likely be the most deficient

Zinc

Supplementation

- *A rudimentary, but accurate measure of zinc deficiency is to simply do a zinc taste test
- If taste is undetectable, supplement with 25-30mg/day (in addition to dietary sources)
- Re-test in 3 months. If still un-detectable, add Cu supplementation (Zn depletes Cu) and increase dosage to 50-60mg/day. Re-test in 3 months

Magnesium

Role in Performance

- Involved in more than 300 essential metabolic reactions, including metabolism of carbohydrates, fats, proteins, and ATP synthesis
- Deficiency can result in muscle cramping, excessive soreness, inadequate force production, disrupted recovery and sleep, immune system depression and potentially heart arrhythmias during intense exercise



Magnesium

Several studies have shown Mg to be effective for:

- Buffering lactic acid
- Enhancing peak oxygen uptake and total work output
- Reducing heart rate and CO₂ production during intense exercise
- Improving cardiovascular efficiency
- Elevating testosterone levels and muscle strength

Magnesium

- Majority of athletes will be deficient. Mg from seeds, nuts, grains, and vegetables are not enough, and athlete will likely have to supplement
- Use Oral Mg Bisglycinate daily (450-750mg) and transdermal for recovery post workout/competition
- Transdermal can be 2-4 cups Epsom salts (MgSO_4) or 1-3lbs MgCl crystals (500mg dose) dissolved in bath tub
- MgCl also available in spray or lotion for localized application
- Tip: Give MgCl cream/oil to the massage therapist. A Mg massage can assist with the body's natural recovery process and speed healing from a workout or injury, as well as help prevent future injuries from sore and stiff muscles

Suggested Lab Work for Elite Athletes

CBC, Thyroid Panel, Ferritin, B12, RBC folate, 25-OH Vitamin D, kidney function, liver function, lipid panel, calcium, total protein, total and free testosterone, calcium, total protein, amylase, RBC magnesium, AM cortisol, hs-CRP

CCES's Position on IV Therapy

“The Canadian Centre for Ethics in Sport (CCES) would like to alert the sport community that intravenous infusions are prohibited in sport, except as a legitimate medical treatment. Some reports suggest that some non-medical athlete support personnel may be administering an intravenous infusion to athletes for recuperation during training. This practice is a prohibited method under the World Anti-Doping Agency (WADA) Prohibited List. ”

CCES's Position on IV Therapy

“Most athletes and support personnel are aware of the various categories of prohibited substances, but may be less familiar with prohibited methods. Confusion may arise around the infusion of a blend of vitamins and minerals known as a Myers Cocktail: the ingredients might not be on the Prohibited List, but when administered intravenously for non-medical reasons, it is a prohibited method.”

CCES's Position on IV Therapy

“The CCES emphasizes that **both** the athlete support personnel and athletes would be subject to an anti-doping rule violation for this practice. All high-level sport participants are responsible for knowing what is on the Prohibited List, and the CCES would like to make this issue clear: Intravenous infusions should **only** be administered to athletes under the prescription and supervision of qualified medical personnel, and **only** for legitimate medical treatment.”

Dehydration

- Most critical physiologic change that occurs during prolonged exercise is fluid loss
- For optimal exercise performance, body temperature must be tightly controlled
- In cycling, excess body heat can be dissipated by convection, which occurs when cool air moves over the surface of the body
- During swimming, excess body heat can be dissipated by the transfer of heat to the water by conduction
- However, direct transfer to environment is generally not an efficient means of dissipating heat

Dehydration

- Primary means of heat dissipation is by sweat evaporation (80% of total heat lost during exercise)
- As body water is lost, blood volume declines, which limits the capacity of the circulatory system to carry oxygen and nutrients to and remove metabolic byproducts such as lactic acid as well as heat from muscles
- Compounding the problem is electrolyte imbalances

Dehydration

- Very hard to adequately compensate for fluid loss when sweat is excessive
- According to the American College of Sports Medicine, as little as 1% body weight loss (aprox 1.5 lbs in 150 lbs athlete) can impact mental and physical performance by significantly reducing blood volume and disruption of electrolyte balance
- Reduced strength, endurance, fine motor skills and mental alertness

Dehydration

Self Check

- Take weight before and after workouts – particularly with extreme heat
- Urine should be pale yellow or clear (unless taking B vitamins)
- To ensure adequate hydration before training sessions/competition, measure specific gravity of first morning urine. This will allow time to correct hydration status before training session/competition

Sports Drinks and Electrolyte Replacement

Home Made Electrolyte Recipe

- 1 tsp honey or maple syrup
- Juice of 1/4 - 1/2 lemon
- 1/4 tsp of baking soda
- 1/4 tsp of sea salt
- 1 1/2 cups (375mL) of water

High Performance Athletes

Specific Diets

Plant Based Diet

- Very difficult for elite athletes to be exclusively plant based and to be the best in the world
- Depends on sport and food sensitivities. For example, if you're sensitive to grains and legumes – an exclusive plant based diet is not a good idea
- Only 5 Olympic medalists since 2000 are exclusively plant based
- This is out of a possible 4,813 medals to be won, making 0.1% of the medal winners exclusively plant based eaters

Plant Based Diet

*Education is key for the athlete. If they are not careful, gaping nutritional holes can result

Common mistakes Include:

- Not eating a wide variety of color in whole plant foods
- Not eating enough calories
- Not supplementing with vitamins, fatty acids, amino acids, minerals and micronutrients that are notoriously missing from a plant-based diet

Plant Based Diet

Top 10 strategies if athlete chooses a plant-based diet:

1. Eat real food: avoid Frankenfoods such as fake meats, textured vegetable proteins and processed soy products (can compound estrogen dominance in women and testosterone deficiencies in men)
2. Avoid high intake of inflammatory Omega 6 rich vegetable oils: Instead use coconut, olive, avocado, and macadamia nut oil. Also include algae-based DHA supplements, as well as rich ALA foods like ground chia, hemp and flax

Plant Based diet

3. Supplement with vitamin K2: Crucial for a healthy heart and skeletal system. Take 100mcg/day with a generous amount of natto (goes well with avocado, sea salt, and EVOO for breakfast)
4. Supplement with Vitamin D3: important hormone and steroid precursor. Garden of Life has a vegan D3 source. Take 35IU/lbsBW

Plant Based diet

5. Get Vitamin A: the body does not convert beta-carotene from plants very efficiently. Improve conversion by eating beta-carotene rich foods with fat. Also get enough iron and zinc, which helps with conversion
6. Properly prepare grains, legumes, and nuts: soak, sprout, and/or ferment to neutralize anti-nutrients and mineral-binding compounds

Plant Based Diet

7. Maximize iron absorption: Combine foods such as swiss chard, spinach, beet greens, lentils, beans, and quinoa with foods high in vitamin C like tomatoes, bell peppers, lemon juice, strawberries, kiwis, oranges, etc. Also moderate black tea and coffee consumption

8. Use Iodine: Common iodine deficiencies can be negated with sea vegetables. Consider taking a daily dose of 6mg of liquid iodine qd

Plant Based Diet

9. Take vitamin B12: prevent deficiency and high homocysteine with 10mcg of a highly absorbable liposomal vitamin B12 qd (sublingual)

10. Supplement with taurine: only found in animal foods and body may not make enough from cysteine or methionine. Take 1g/day. “Now Foods” makes a vegan taurine powder

**Bottom line: Ideally the athlete would consider adding eggs, fish, and possibly dairy if tolerant*

Plant Based Diet

Example Diet (Rich Roll: ultra-runner)

- Pre-workout morning smoothie: kale, beets, chia seeds, hemp seeds, macca, orange, flax seeds, rice/pea vegan protein powder
- During workout: on bike/run – coconut water
- Post-workout: coconut water, cold quinoa with coconut or almond milk, berries, udo's oil, and hemp seeds
- Lunch: salad with mixed veggies and vinaigrette or brown rice, beans, greens and hemp seeds
- Snack: Smoothie with rice/pea protein, almond milk, cacao, almonds, and walnuts
- Dinner: lentils over brown rice with beet greens and avocado, arugula salad, and sweet potatoes
- Dessert: Coconut milk ice cream or chia seed pudding

Gluten Free Diet

- Gut permeability is naturally increased with exposure to heat and during intense exercise
- Anyone with a gliadin sensitivity can increase this permeability
- Theoretically performance should be enhanced by minimizing inflammation, preventing leaky gut and increasing nutrient absorption
- However, properly controlled studies are lacking to date and evidence is only anecdotal

Gluten Free Diet

- Due to caloric and carbohydrate needs, many athletes will get more gluten in 1 day, than a non-athlete consumes over a 3 day period
- At the very least, every athlete could probably benefit from reducing gluten content in diet

Gluten Free Diet

Replace gluten load with higher-nutrient, high carbohydrate foods such as:

- sweet potatoes, yams, winter squash (such as acorn), other root veggies
- quinoa, GF oats, whole-grain rice and wild rice blends, muffins and other baked goods made out of nutrient-packed gluten-free grains (look for amaranth, buckwheat, sorghum, or teff flours).
- dried fruit
- legumes

Paleo Diet

- Not for everyone, but some athletes may really benefit – particularly if they're sensitive to grains and legumes
- Best advice would be to strictly adhere to diet for 1 month (in the off season), and add foods back in to assess reaction
- Carbohydrate sources can easily replace grains and legumes with foods like bananas (27 g CHO), yam or sweet potato (38g/cup), dried dates (18 g CHO each), large, fresh figs (12 g CHO each) and raisins (31g/0.25 cup)



LCHF Diet

- Contrary to mainstream beliefs, some emerging research suggests endurance athletes may benefit from using fat as an energy source
- The higher the sugar and starch intake, the higher the blood triglycerides, and greater the inflammation

LCHF Diet

- Consequently, sleep, ideal body fat percentage, and performance may be compromised
- Maintaining high blood sugar and “topping off” storage carbohydrate levels to fuel the body for optimal performance may not actually be worth the health trade-off – especially if the result can be attained with less starch and sugar

LCHF Diet

Benefits:

- Eating fewer CHO allows that body to efficiently burn fat, which can help attain a lower body fat percentage (advantageous in some endurance sports).
- Eating fewer CHO can increase health and longevity. Glucose for energy can produce a lot of free radicals, which can cause cellular damage

LCHF Diet

Benefits:

- Eating fewer CHO can increase energy stability and eliminate gastrointestinal distress while training or racing (some athletes are extremely sensitive to fluctuations in blood sugar caused by CHO intake)
- Consuming a sports drink, bar or gel can cause a sharp and drastic drop in energy after the short-lived initial increase in energy levels

LCHF Diet

Benefits:

- Calories from fats and proteins are utilized at a far steadier rate than CHO sugar, resulting in more stable energy levels
- Uncomfortable amounts of gas and bloating can be a result of high bacterial activity caused by CHO fermentation in the GI tract

Note: Adaptation from CHO to fat burning takes about 4 weeks



LCHF Diet

Summary of performance enhancement

1. Increase activity of the biological mechanisms responsible for building and repairing lean muscle mass
2. Increase the ability to preserve and ration valuable CHO stores
3. Increase fat utilization during exercise
4. Increase activity of enzymes responsible for metabolizing CHO during high intensity exercise, such as racing
5. Increase ability to recover faster
6. Increase health and longevity

LCHF Diet

- Replace nutrient void carbohydrate sources like granola and energy bars, pasta, whole wheat bread, cereal and muesli with nutrient-dense and healthy fats, proteins, and vegetables.

LCHF Diet

This diet is not for everyone, and concrete evidence is still being evaluated. This diet is especially not to be used for:

1. Endurance athletes in the heat of competition: during an ironman, the athlete will need a higher carbohydrate intake than on an easy training day. Some research suggests this may be more to stave off neural fatigue than a direct CHO need of the muscles
2. Athletes doing an extremely heavy block of training that is higher load than they are accustomed
3. Individuals with diseases or conditions that prevent them from properly metabolizing fats and proteins (ex: gall bladder removal)

Avoiding Runners Diarrhea

GI concerns with long distance running

Causes:

- Shift in intestinal fluid
- Lack of blood flow (reduced splanchnic blood flow)
- High fructose gels/electrolytes
- Mechanical vibration
- Hormonal changes (increased gastrin and motilin) – related to insulin/glucose balance and stress.

Solutions:

- Keep very well hydrated
- Find a product with low fructose
- Repair intestinal damage with L-glutamine post runs (5g in recovery drink)
- 4-5 days low residue/bland diet leading into competition.
- Stress reduction
- Worse comes to worse, you can experiment with Imodium (obviously try it in practice first).
- Permanently avoiding gluten can also be helpful

Performance Enhancers

- Beta alanine
- D-Ribose
- HMB
- Creatine
- CoQ10
- Essential Amino Acids
- Beet Root Juice
- Caffeine
- L-Arginine
- L-Carnitine
- Rhodiola
- L-Glutamine
- Sodium Bicarbonate



Beta Alanine

Common Uses

- Increase muscle hypertrophy
- Increase muscle strength
- Increase muscle power output
- Proton buffering
- Anti-catabolic

MOA: increases carnosine levels and buffers rise in H^+ concentrations

Beta Alanine

Dose:

- Week 1: take 1 level teaspoon with your recovery drink immediately following training – 2000mg/day
 - Week 2-4: take 1 level teaspoon at breakfast and 1 level teaspoon in your recovery drink immediately following training – 4000mg/day
 - Week 5-10: take 1 level teaspoon at breakfast and lunch, and 1 level teaspoon in your recovery drink immediately following training – 6000mg/
- *Take with CHO to increase absorption



D-Ribose

Common uses:

- Increase muscle power
- Increase muscle strength
- Increase muscle hypertrophy
- Improve exercise recovery
- Increase energy
- Increase muscular endurance

MOA: Increases ATP re-synthesis

Dose: 100-500mg/kgBW/d. Consume with CHO



Beta-Hydroxy-Beta-Methylbutyrate (HMB)

Common Uses:

- Anti-catabolic
- Increase muscle hypertrophy
- Improve exercise recovery
- Increase muscle strength
- Increase protein synthesis

MOA: Up-regulates IGF-1 and promotes protein synthesis

Dose: 3g pre-workout and 3g post-workout

*effects increased when taken with creatine



Creatine Monohydrate

Common Uses

- Increased muscle mass and strength
- Increase single and repetitive sprint performance
- Enhance glycogen synthesis
- Enhance aerobic capacity
- Increase work capacity
- Enhance recovery
- Greater training tolerance

MOA: Recycles ADP back to ATP

Dose: Short term: Loading dose of 25g/day with CHO (post workout) for 7 days, followed by 5g/d. High dose will cause H₂O wt gain. Caution w/ weight class athletes.

Long term: 5g/d with CHO post workout



CoQ10

Common Uses

- Increase energy
- Increase endurance performance
- Antioxidant
- Improve exercise recovery
- Support heart health

MOA: Aids in production of ATP and mitochondrial antioxidant

Dose: 200mg/day (use phospholipid encapsulated gel caps or take w/ fat source)



Essential Amino Acids

Common Uses

- Increase protein synthesis
- Increase muscle hypertrophy
- Increase muscle strength
- Anti-catabolic
- Improve exercise recovery
- Increase energy/delay muscle fatigue
- Insulin mimetic
- Supports mitochondrial growth
- Increase immune support

MOA: Modulation of skeletal muscle turnover

Dose: Depending on brand ~15g bid (divided pre and post workout, can take in 1 dose on non-workout days)

*Unlike BCAAs which only enhances anabolism, EAAs also prevent catabolism



Beet Root

Common Use:

- Increase oxygenation of muscles

MOA: increases serum NO

Dose: Start 3 days out of competition, 2 doses/day. Take the last dose 6 hours before competition. The idea behind dosing is to get NO levels high in blood.

Recommend “Beet It” concentrated shots (0.4g Nitrate) or “AOR Stamina Shot”. Try in training first because can cause mild GI upset



Caffeine

Common Uses

- Reduces perception of pain
- Delays time to fatigue

MOA: blocks adenosine receptors in brain

Dose: 1-3mg.kg BW 30-60min b/f competition. If regular coffee drinker, must have 5d wash out period d/t habituation.

*Highly suggest trying in training session b/f competition.
Caffeine pills more accurate to dose than coffee



L-Arginine

Common Uses

- Increase NO
- Increase vasodilation
- GH secretagogue
- Increase protein synthesis
- Anti-catabolic
- Increase immune function
- Treat erectile dysfunction

MOA: NO precursor

Dose: Exercise Recovery: 8g/d post exercise

Endurance Performance: 8-21g pre exercise

GH secretagogue: >250mg/kgBW/d 30 min b/f bedtime and/or exercise



L-Carnitine

Common Uses

- Fat metabolism (glycogen sparing)
- Decreased heart rate and lactic acid production
- Increased maximal oxygen uptake
- Muscle recovery

MOA: carrier molecule in the transport of long chain fatty acids across inner mitochondrial membrane

Dose: 1-2 g/d



Rhodiola

Common Uses

- Increase oxygen uptake and utilization
- Increase energy
- Delay muscle and mental fatigue
- Increase muscular endurance
- Increase muscle power
- Improve exercise recovery
- Improve acclimatization
- Stimulate fat loss
- Antioxidant
- Support general health
- Increase fertility

MOA: modulation of monoamines and opioid peptides

Dose: Daily – 200mg 30-60 min before training session

Competition – 400mg 30-60 min before race or game

*standardized to 3% rosavin



L-Glutamine

Common Uses

- Anti-catabolic
- Increase muscle hypertrophy
- Increase cell volumization
- Improve immune function
- Improve gut integrity
- Increase glycogen re-synthesis
- Improve exercise recovery

MOA: balances pro-inflammatory and anti-inflammatory cytokines that mediate immune response

Dose: 5g post workout in recovery drink



Sodium Bicarbonate

Common Uses

- Delay muscle fatigue
- Reduce lactic acid
- Increase endurance performance
- Increase power output
- Increase training volume
- Improve bone health

MOA: increases plasma bicarbonate, buffers excess hydrogen ion concentration, and raises blood pH

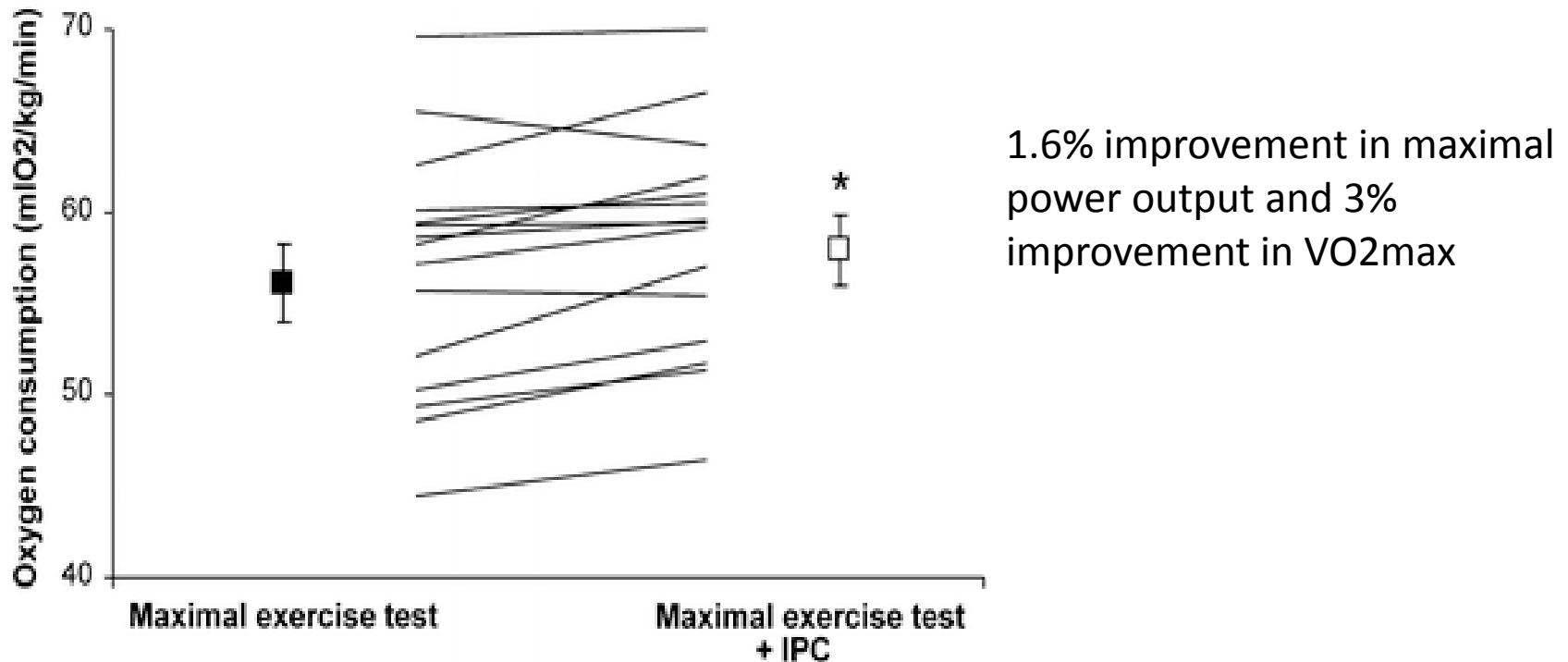
Dose: To delay anaerobic muscle fatigue: 300mg/kgBW/d diluted in 1L H₂O; consume 1-2 hrs b/f exercise or competition



Remote Ischemic Pre-Conditioning (RIPC)

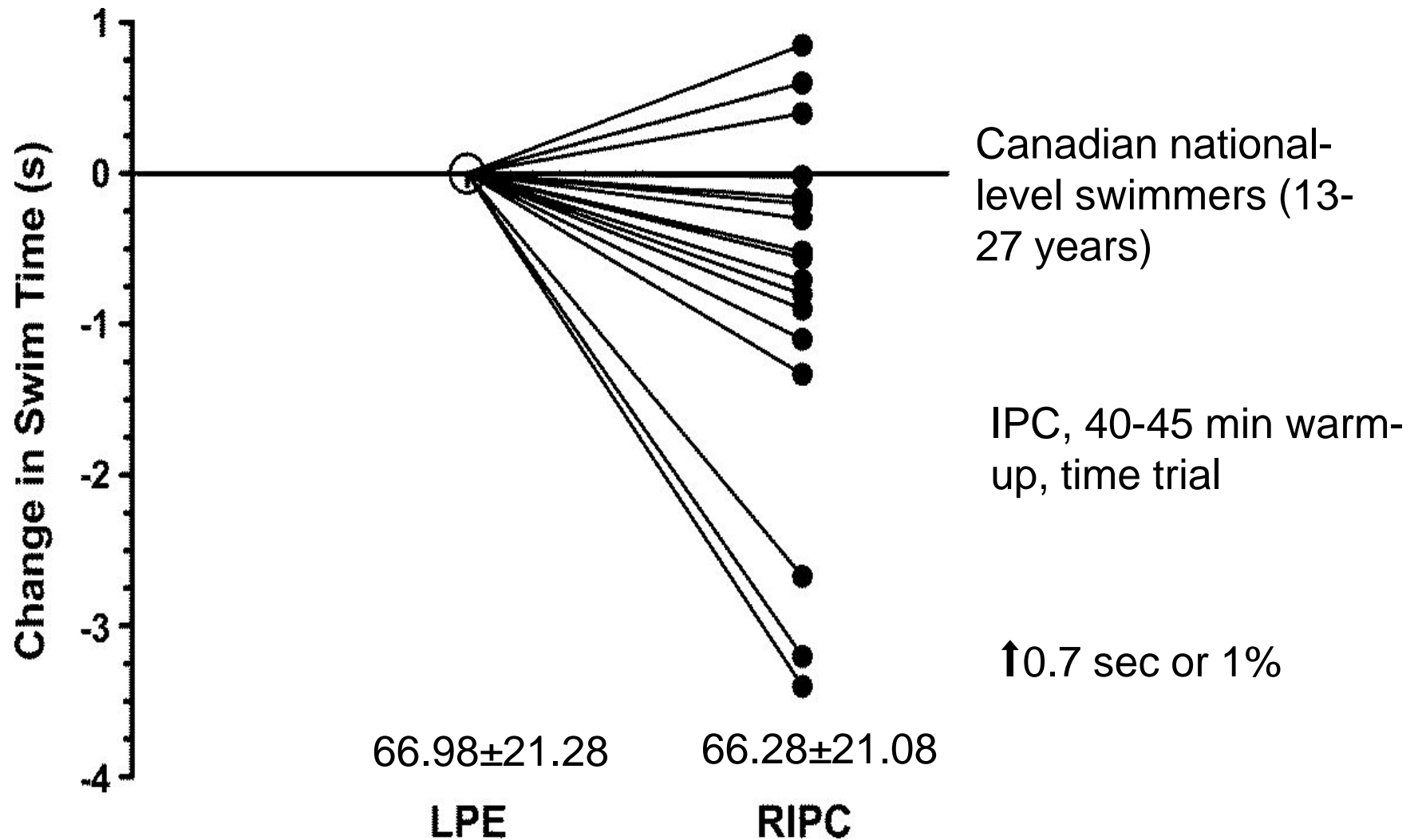
- Involves occluding the blood supply to a limb for a temporary period of time (5min on, 5min off x 4 = 35min total). Do right before warm up to competition.
- Once blood flows back around the rest of body it carries some 'protective factors' that result in muscles and organs utilizing less oxygen
- More than likely works by both releasing nitric oxide(same as beetroot) and also effecting how 'sensitive' the body is to that nitric oxide
- Works well when combined with beetroot shots

Ischemic Preconditioning and VO2max



Individual and mean maximal oxygen consumption (VO2max in ml/min/kg) during the maximal exercise test without (black square) and with ischemic pre-conditioning (IPC, open square). N = 15. Error bars represent SE. *P < 0.003)

Ischemic Preconditioning and 100m Swimming Performance



Over Training Syndrome

- Athlete trains above the ability of the body's recovery rate
- Threshold is individualistic, and can be related to age, sex, nutrient deficiencies, inflammation, food sensitivities and external stressors

Over Training Syndrome

Common Symptoms

- Washed-out feeling, tired, drained, lack of energy
- Mild leg soreness, general aches and pains
- Pain in muscles and joints
- Sudden drop in performance
- Insomnia
- Headaches
- Decreased Immunity
- Decrease in training capacity / intensity
- Moodiness and irritability
- Depression
- Loss of enthusiasm for the sport
- Decreased appetite
- Increased incidence of injuries.
- Compulsive need to exercise

Over Training Syndrome

Ways to monitor

- First morning HR: Want increase under 5% (“Instant Heart Rate” by Azumio app)
- Orthostatic HR test: Want an initial high peak, with an average difference between 15-20 bpm (“Instant Heart Rate” by Azumio app)

Over Training Syndrome

Ways to monitor

- HRV: If low consistently for 3 days, then likely over-training (“Stress Check” by Azumio app)
- Training log or daily questionnaire: Assess mood, irritability, sleep, motivation, energy, etc

Over Training Syndrome

Injury Prevention

Athlete Pressure

- All high performance athletes will have some form of repetitive stress
- The athlete needs to learn specific cues before injuries begin, and be astute to the signs of over training syndrome
- Fear of losing a position on a team, guilt about missing a practice, or a coach bullying an athlete into training to the point of injury is unfortunately all too common.
- Younger athletes are prone to these pressures, while mature athletes will hopefully learn from experience.



Over Training Syndrome

Imagery for Stress Management

- Current research indicates athletes who regularly perform relaxation and imagery sessions, have less anxiety and better rehab outcomes
- These athletes also showed to have higher levels of overall positive mood and perceived readiness to return to their sport