Injury Prevention and Recovery: All About Dosage

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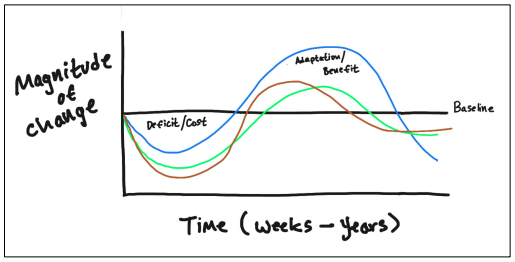
1

Load management: It's more than your training load.

- ✓Non-linear relationship (too simple)
- ✓Two athletes (days) = two outcomes
- ✓Lots of assumptions (complex systems)
- ✓Goal is to navigate better
- ✓Think long-term sustainability



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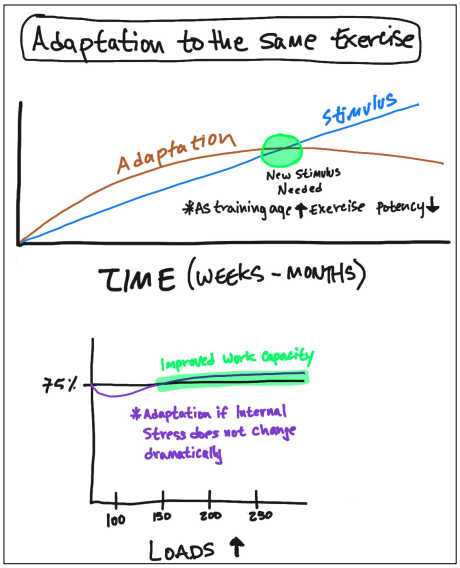
Tracking external loads

- ✓Percentage of 1-repetition maximum
- ✓Percentage of intent (how hard are they trying)
- ✓Percentage of possible repetitions per set (measure of effort)
- ✓Overall time of contraction (time under tension)
- ✓Distance (# clips, # hand moves, distance etc.)
- ✓Speed of movement (power output)

How much you've done in the past *should* help predict what you can do in the future.



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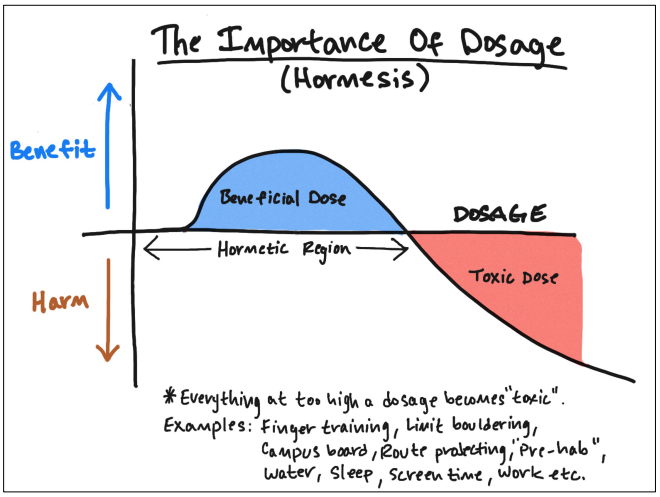
Hormetic response

- ✓Low doses of training induce an adaptive benefit
- ✓High doses of training pose a risk
- ✓Major health benefits of **strength training** (in general)
  - Up-regulate antioxidant defense
  - Mitochondrial biogenesis
  - Improve muscle health
  - Prevent injuries (we don't know why)
  - *Everything* has a threshold



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"All models are wrong, but some are useful"

Things that help us understand an individuals response to load

- ✓Previous exposure (training history) – **ACWR** (acute/chronic workload)
- ✓Internal states – **HRV**/RHR/HRR, *hormone profile*, sleep & dietary ***habits***
- ✓External stressors – training, environmental, living space etc.
- ✓Biomechanics – anthropometrics, storage of elastic energy (skills), rate of force development etc.
- ✓Psychological profile – **injury history**, motivations, intentions with training

Stress is not good (or) bad

- ✓**All about dosage**
- ✓Eustressor – good stress (adaptive)
- ✓Distressor – bad stress (maladaptive)

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Guiding theme | Published: 06 November 2019

Sports climbing, bouldering and associated injuries in childhood and adolescence

Sport climbing, bouldering and associated injuries in childhood and adolescence

Injuries

The injuries occur frequently on the upper extremity, with the fingers being the most affected. Acutely traumatic lesions such as distortions, fractures or ligament lesions are significantly less common than overloads caused by repetitive and highly stressful climbing movements. The most common injury is not - as in adults - the ring ligament rupture, but the epiphyseal joint stress fracture of the pelvic base, which practically only occurs in climbing. Although this injury can be treated conservatively, it takes a long healing time of around 8 months. However, if treatment is missed, joint mismatch and osteoarthritis can result.

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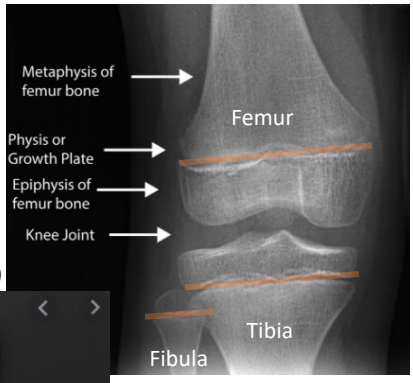
High repetitive stress to the growth plate.

- (AKA) epiphyseal plate
  - ✓hyaline cartilage plate at the end of each long bone in kids.
  - ✓where new bone growth takes place (bone is living tissue)
  - ✓maintenance remodeling
  - ✓how bones grow longer
- Only found in children and adolescents
- Complete fusion
  - ✓12–18 for girls (15-16 avg)
  - ✓14–19 for boys (18-19 avg)



Right knee (anterior view)

Left ant. (dorsal view)

***Epiphyseal plate is much more likely to be injured in the youth climbers finger than the annular pulleys are.**

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- Most predictive for re-injury
  1. Younger athletes
  2. Faster return to sport
- 1 in 4 young athletes will sustain another ACL injury at some point
  - ✓in the return-to-play period
- 30 to 40 times > risk of an ACL injury compared with uninjured athletes.
- What can you do?
  - ✓Activity modification (variation)
  - ✓improved rehab and return-to-play guidelines
  - ✓**use of integrative strength training**

Review > Am J Sports Med. 2016 Jul;44(7):1861-76. doi: 10.1177/0363546515621554. Epub 2016 Jan 15.

Risk of Secondary Injury in Younger Athletes After Anterior Cruciate Ligament Reconstruction: A Systematic Review and Meta-analysis

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Incidence, mechanism and risk factors for injury in youth rock climbers

Kaikanani Y Woollings[1], Carly D McKay[1], Jian Kang[1], Willem H Meeuwisse[1, 2], Carolyn A Emery[1, 3, 4]

Author affiliations +

3 Risk Factors

1. Older age (15-19)
2. Another type of sports injury
3. Preventive taping

Strain = muscle/tendon
Sprain = ligament

Methods Youth (n=116) were recruited from climbing facilities across Alberta, Canada. Participants completed an anonymous questionnaire from October 2012 to March 2013. Climbing injury incidence proportions and incidence rates (IR) were calculated. ORs with corresponding 95% CIs were estimated for possible risk factors.

Results The injury IR was 4.44 injuries/1000 climbing hours (95% CI 3.74 to 5.23). Sprains (27%) and strains (26%) were the predominant injury types, and repetitive overuse was the primary mechanism of injury (42%). Hands and fingers were the most commonly injured locations (21%). Exploratory analyses showed three risk factors for injury: older age (15–19 vs 11–14 years; OR=11.30, 95% CI 2.33 to 54.85), injury in a sport other than climbing (OR=6.46, 95% CI 1.62 to 25.68) and preventive taping (OR=5.09, 95% CI 1.44 to 18.02).

Conclusions Injury risk is high in youth climbers. Findings are consistent with the reported rates, types and mechanisms in adults. Modifiable risk factors warrant further investigation to inform the development of injury prevention strategies, targeting high-risk climbers including adolescents and those with previous injury.

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Review > Phys Sportsmed. 2016 Sep;44(3):257-62. doi: 10.1080/00913847.2016.1177476. Epub 2016 May 3.

Youth Sports Specialization and Musculoskeletal Injury: A Systematic Review of the Literature

- The primary evidence that currently exists with regard to early sport specialization is scarce, retrospective, and shows only modest associations between early sports specialization and overuse injury.
- **Transition to intensive, high level training is infrequently initiated by the youth athlete, with up to 75% feeling pressure from coaches and/or parents**
- Most comprehensive **definition** being offered by Jayanthi et.al.: "year-round intensive training in a single sport *at the exclusion of other sports*"

"Despite the recent negative medical and lay press surrounding early youth sports specialization, the primary evidence supporting increased risk of overuse injury is modest and has been shown in only a limited body of primary research consisting of two retrospective cohort studies and one case-control study. Further prospective comparative research would have great impact on furthering our understanding of the consequences of youth sports specialization, and is needed to answer these questions before evidence based recommendations can be made by governing bodies concerning the risks, and or benefits, of early youth sport specialization."

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Human tendon adaptation in response to mechanical loading: a systematic review and meta-analysis of exercise intervention studies on healthy adults. Bohm et al. Sports Medicine- Open (2015)

Based on the results of the present meta-analysis, we can conclude that

1. **high magnitude loading** (i.e., muscle contraction intensity) is most effective to elicit tendon adaptation
2. **Longer intervention durations** (>12 weeks) are beneficial compared to shorter ones.
3. The effect of **muscle contraction type** (isometric, concentric-eccentric, or isometric) seems **insignificant**
4. Plyometric training may not be optimal to facilitate tendon adaptation.

WHY?

Key points

- Tendons are highly responsive to increased mechanical loading and adapt through changes of their mechanical, material, and morphological properties.
- Changes in tendon stiffness seem to be more attributed to adaptations of the material rather than morphological properties.
- An effective training intervention for the tendon should apply a high loading intensity over a longer intervention duration (>12 weeks).

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Human Tendon Loading

Most commonly used protocol

- 5 sets
- 30-45 seconds each set
- 2-min rest between
- 75% MVIC
- Multiple times / day (2-3)
- 4-6 hours apart
- Must progress to dynamics

“Focus on the donut, not the hole”

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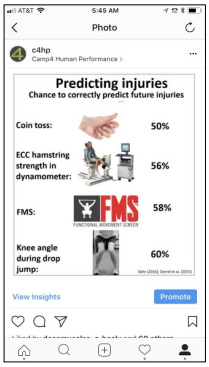
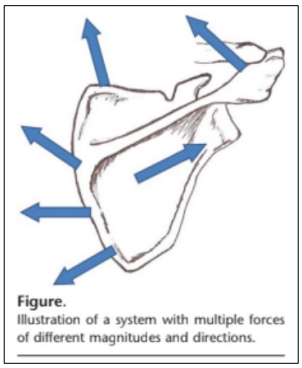
What about screening athletes?

- Movement is variable between individual athletes
  - ✓Genetics
  - ✓Limb length
  - ✓Joint architecture
  - ✓Ligament stiffness
- ***The only predictive metric is previous injury.***
- This does not mean screening is useless per-se.
- It does mean that it isn't predictive.





"Whether the focus is core stabilization for the spine or scapular stabilization, clinicians and trainers alike have endorsed these programs, largely on the basis of conceptual theory and anecdotal experience. As of yet, there is no established way to measure scapular stability"

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It is not the exercise, it is the application

@donutsunplugged

SCIENCE (principles)

ART (methods)

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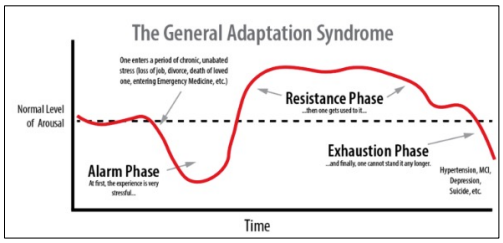
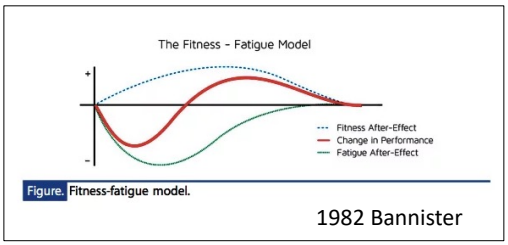
Training is all about forcing adaptation

- GAS states that systems will adapt to *any stressors* they might experience in an attempt to meet the demands of the stressors.
- FFM states an individual's level of **preparedness is a result of the interaction between their level of fitness and the amount of fatigue**.





*All about managing types of *overload* (intensity, volume)

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Session **volume matters most** when preventing injuries

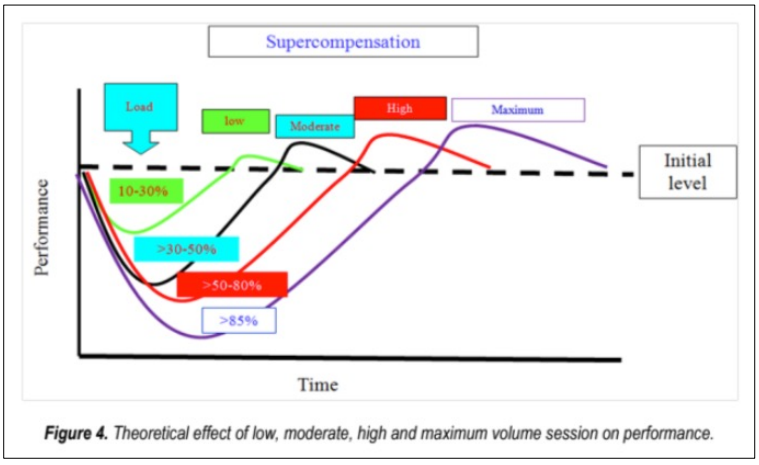

Figure 4. *Theoretical effect of low, moderate, high and maximum volume session on performance.*

*** This does not always mean volume is bad, it just needs to be respected with long recovery times**

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ACWR (Acute:Chronic Workload Ratio)

- Goals: manage training loads to
  - ✓Improve athlete readiness
  - ✓Improve performance
  - ✓Reduce injury risk
- It is the **ratio** between short term (acute) and long term (chronic) workloads
  - ✓Short term: 7 days - *fatigue*
  - ✓Long term: 28 days - *fitness*
- Calculating the rolling average
  - ✓Acute (sum multi-session days)
    - ➢**Session RPE * session duration (min.)**
  - ✓Chronic
    - ➢**28 day (4wk) average**

< .80	Under training and higher relative Injury risk
.80 - 1.3	**Optimal workload and lowest relative Injury risk**
> 1.50	The "danger zone" and highest relative Injury risk

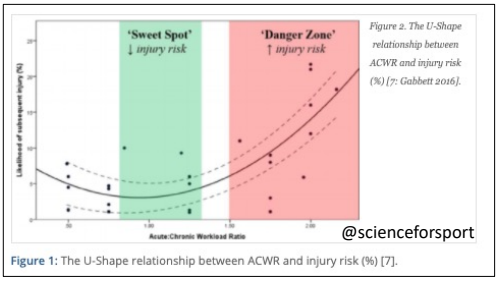

Figure 2. The U-Shape relationship between ACWR and injury risk (%) [7: Gabbett 2016].

Figure 1: The U-Shape relationship between ACWR and injury risk (%) [7].

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Climbing session 1
- ✓ Bouldering session *90-minutes*
- ✓ sRPE of *8/10*
- ✓ ***720 AU*** *(arbitrary units)*

- Later in the day
  - ✓ strength /finger training 60-min
  - ✓ sRPE 8/10
  - ✓ **480 AU**

Daily total = **1200**

Climbing session 2
- ✓ Route session 180-minutes
- ✓ sRPE of 6/10
- ✓ **1,080 AU**

- Later in the day
  - ✓ strength / finger training 60-min
  - ✓ sRPE 6/10
  - ✓ **360 AU**

Daily total = 1440

Climbing session 3
- ✓ Boulder repeats 60-minutes
- ✓ sRPE 9/10
- ✓ **540 AU**

- Later in the day
  - ✓ Power / finger training 45-minutes
  - ✓ sRPE 8/10
  - ✓ **360 AU**

Daily total = 900

ACWR: ATHLETE EXAMPLE

Athlete with *3 double days* training per week

Acute work load calculation = **average of 7 days**
- **(1200 + 1440 + 900) / 3 = 1,180**

Chronic work load calculation – **average 4 weeks**
- **Week 1 = 1180** (example to the left)
- **Week 2 = 1230** (*hypothetical)
- **Week 3 = 1150** (* hypothetical)
- **Week 4 = 1300** (* hypothetical)
  - ✓ **Average = (1180+1230+1150+1300) / 4 =**
  - ✓ **1215**

- **Week 5 avg. hypothetical workloads =**
  - ✓ **990 / 1215 = .81 (underload)**
  - ✓ **1410 / 1215 = 1.16 (optimal range)**
  - ✓ **1850 / 1215 = 1.52 (potential injury)**

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Comparison of Velocity-Based and Traditional Percentage-Based Loading Methods on Maximal Strength and Power Adaptations

The Journal of Strength and Conditioning Research · January 2019

- **16 trained males** (22.8 ± 4.5 years)
  - countermovement jump test (CMJ), and one repetition maximum (1-RM) assessment on back squat, bench press, strict overhead press, and deadlift, before and after six weeks of resistance training.
- load dictated via **real-time velocity monitoring**, as opposed to pre-testing 1-RM data (PBT)
- Training resulted in **significant increases in maximal strength** for back squat, bench press, strict overhead press, and deadlift. **Significant increases in CMJ were witnessed for the VBT group only** (5%).
- **Significant difference was present between the total volume lifted. 50% less volume**

How?

Increase in intent, motivation, motor learning, or some combination of all three in conjunction with physiological changes.

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Chronic Psychological Stress Impairs Recovery of Muscular Function and Somatic Sensations Over a 96-Hour Period
(Stultzs-Kolehamainen et al.2014)

- Non-specific stressors influence training adaptation - *Adaptive capacity*
- To optimally adapt
  - ✓**we need to find ways to measure, assess, and mitigate *extraneous stressors* not dosed into the training program.**
- Collecting subjective information about stressors outside of training is important.
  - ✓Psychosocial well-being, lifestyle are all a part of the training process

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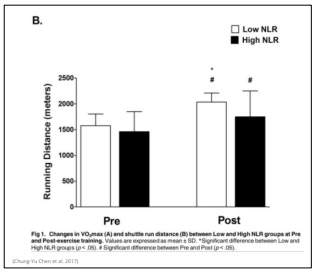
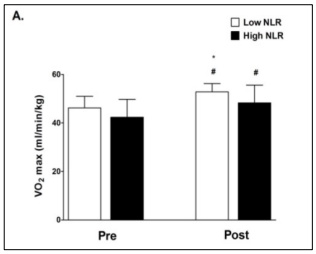
Initial Systemic Inflammatory State Perturbs Exercise Training Adaptations In Elite Taekwondo Athletes (Chung-Yu Chen et al. 2017)

- Internal (non-specific) stressors ***perturb adaptive capacity***
- If the body is already under stress from an external stressor (as measured by initial inflammatory state), then the ability to adapt to a given stressor (training) might be reduced. *We need to account for that*
- This would explain why the *low inflammation group had greater gains*, despite both groups performing the same training.
- Non-specific stressors takeaway from specific gains.
- **The lack of adaptation could be due to a mismatch between adaptive capacity and external load**.





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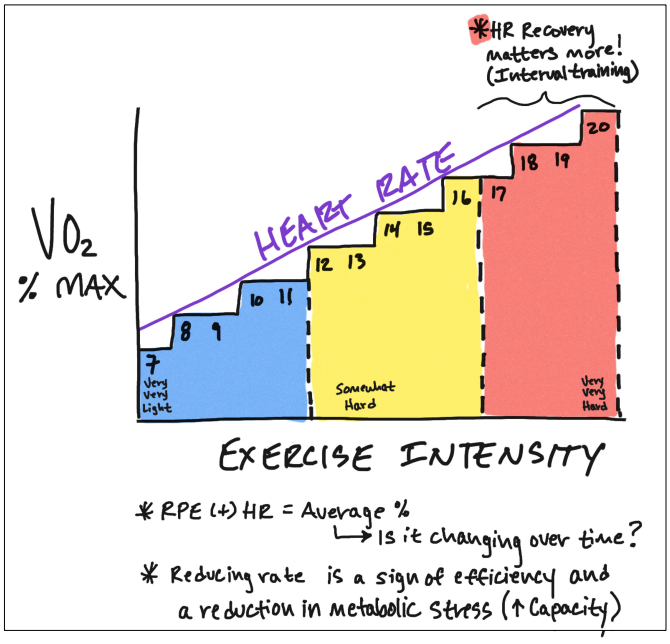
Heart Rate

- Measures metabolic demand
- Reflects magnitude of stressor
- HR/VO2 relates well to BORG scale (original design)
- *Lower % used = less demand*
- *Higher % used = more demand*
- Using the same warm-up (autoregulation)

Variability in HR is *normal



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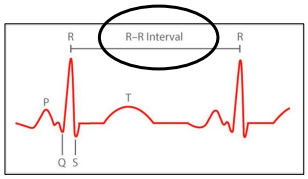
Applications to better understand internal stress (HRV)

WHAT IS IT?

- Heart rate variability is a measure of the variation between heartbeats.
- It measures the consistency between R waves (R-R interval)

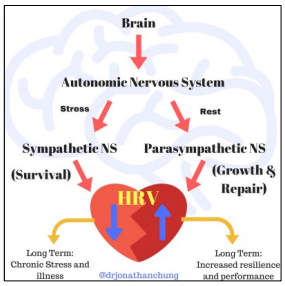


WHAT DOES IT MEAN?

- when the body has less stress and fatigue **the R-R interval has more variation** between heartbeats. This heart beat variation is **very individualized**

HOW DO WE MEASURE IT?

- **You can do it with your smartphone or a heart rate monitor**.
- High-frequency power (**HFP**). These two systems control your hearts rhythm and the application on your phone can measure which one is being dominant.



<u>Increased HRV</u>

- Faster recovery between exercise sessions.
- Body is responding properly to training stress
- You're getting adequate sleep and nutrition
- You're not overtraining

<u>Reduced HRV</u>

- Less recovery between exercise sessions.
- Body is not responding to training stress
- Not likely getting adequate nutrition and rest
- could be overtraining and need time off

** Low HRV indicates the presence of physical and/or mental stress, and thus, incomplete recovery from training*

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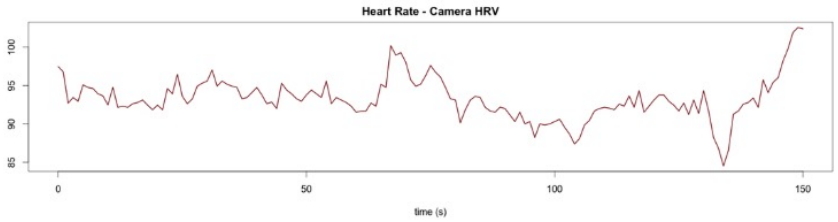

WHICH APPLICATION TO USE?

Like anything there's a few good options. It would be best if your team used the same app that a coach also uses. Here is a good one that uses the rear camera on a smart phone.

- **HRV4Training $9.99** which uses the rear camera to determine your HRV. It also dose all the calculations and tracking over time so you can make predictions on how recovered you are.
- **Guidelines for use**
  - Turn the flash is on
  - Cover the back camera completely. Use same finger
  - Limit the light when measuring. Dark room is best
  - Remove your phone cover
  - Put finger on camera before measurement starts
  - Try not to move finger or change pressure
  - Don't apply too much pressure.
  - No earphones during measurements. Unless wireless

WHEN TO MEASURE HRV

- Daily measurements are best. **2-MINUTES!**
- In the morning right when you get out of bed
- 30-minutes into your practice, at end of warm-up.
- <u>Like training you need consistency in the measurements</u>. If you want to become a better athlete you've got to take it seriously so your coach and parents have good data.
- <u>You need to find somewhere quiet to take these measurements (dark room works great)</u>. You need to find a location to be in a resting and relaxed state: You can use <u>paced breathing</u> and a lying or seated position for 60-seconds.

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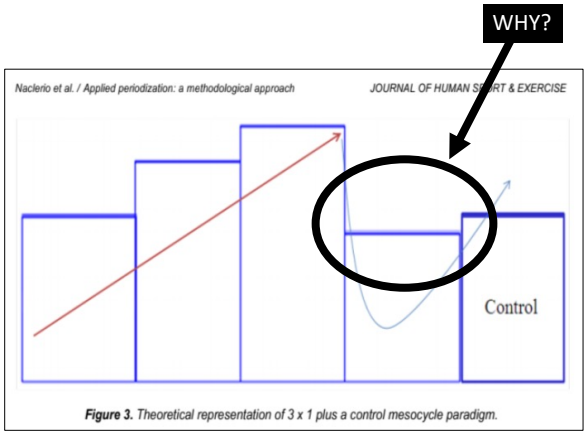

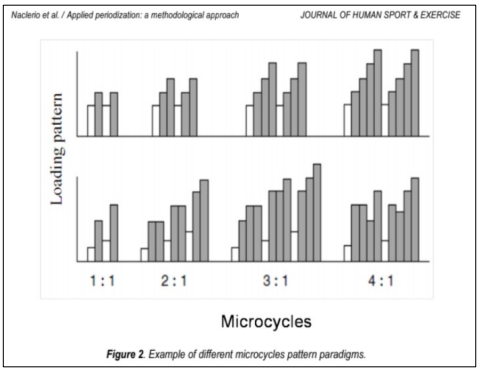

Mesocycles: help identify further training goals, and athlete tolerance based on testing.

Microcycles: where the actual work gets done, and autoregulation guides decisions.

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Sleep hygiene for optimizing recovery in athletes: Review & Recommendations: International Journal of Sports Medicine.

- Poor sleep causes performance reduction and the craving for less nutrient dense foods.
- Elite athletes are the most sleep deprived. It is challenging to self identify a sleeping disorder.
- Most elite athletes get an average of 6.5-6.8.
  - ✓ busy training schedules
  - ✓ travelling time (time zone changes)
  - ✓ media exposure
  - ✓ anxiety & stress prior to competitions
- Sleep deprivation creates an autonomic imbalance
  - ✓ slower and less accurate cognition (reaction time)
  - ✓ altered pain perception
- How to improve sleep hygiene
  - ✓ regular routine (same time in bed, same time awake)
  - ✓ avoid stimulants / distractions prior to bed (blue light)
  - ✓ natural light first thing in the morning to set circadian rhythm

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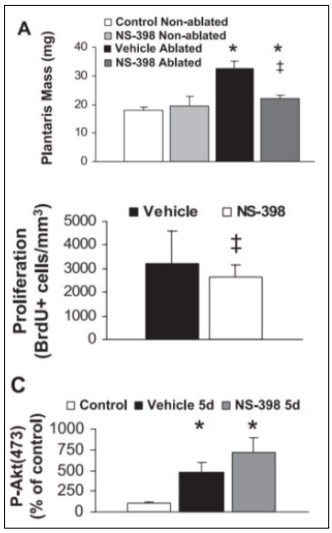
Do I always want to reduce inflammation?

- Acute inflammatory signaling in the muscle is absolutely necessary for maximal skeletal muscle growth from training.
- Acute inflammation is a strong signal to increase muscle mass
- Blocking this signal within a couple of days after training will decrease the effectiveness of training.
- Research suggests that in the off season, we should encourage athletes to *not* use anti-inflammatory methods which dampen the response to training. Research also suggests in season, use of anti-inflammatory methods is slightly different.

COX-2 INHIBITOR REDUCES SKELETAL MUSCLE HYPERTROPHY IN MICE – (Koh et. Al 2009)



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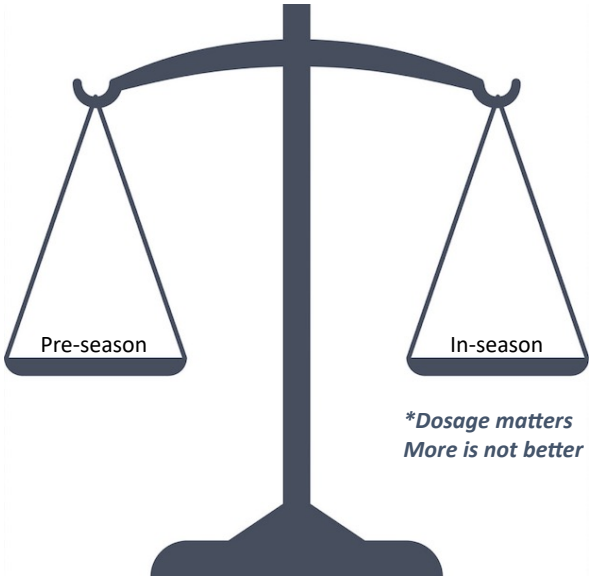
- Inflammation **is needed** for skeletal muscle adaptation and growth.
- **Refrain from** any sort of ice treatment, or pain reliever following exercise.
- Reducing inflammation leads to decreased gains from training



- Inflammation negatively **effects performance**
- Ice baths (or) anti-inflammatory methods/medications **can and should be used** when needed to aid in recovery for competition

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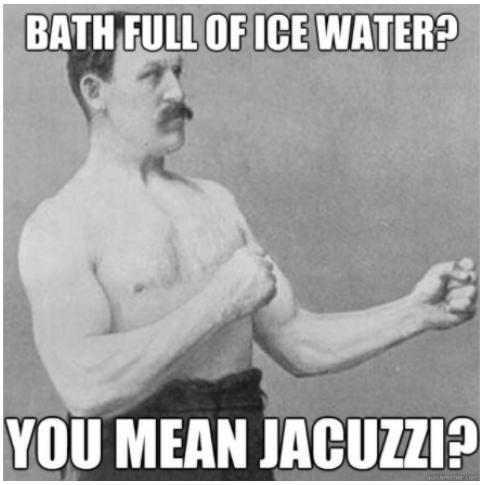
EFFECTS OF COLD-WATER IMMERSION ON THE RECOVERY OF PHYSICAL PERFORMANCE AND MUSCLE DAMAGE FOLLOWING A ONE-OFF SOCCER MATCH – (Magalhaes et al. 2010)

- Lower feelings of muscle soreness 1-2 days after (observed in multiple muscles of the legs).
- Smaller increase in muscle damage markers (creatine kinase, myoglobin, and C-reactive protein)
- Improved neuromuscular function measured as MVIC
- Cold-water immersion decreased the muscle damage and inflammation markers.
- Two different mechanisms on how this could occur. The first is through
  1. Faster repair of the muscle, decreasing damage and inflammation (larger impact of the two)
  2. Increase in circulation, giving lower concentrations at different timepoints.

With only 10-minutes of cold-water immersion, maximal strength was recovered faster.



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REVIEW Open Access

International society of sports nutrition position stand: diets and body composition

1. There are multiple diet types and eating styles
2. All body composition assessment methods have strengths & limitations
3. Diets focused on fat loss are primarily due to a calorie deficit **> 4 weeks**
   - **10-15% calorie deficit is typical.**
   - Weight loss **.5-1% BW / WK** (1-1.5lbs)
   - Higher baseline body fat levels can use more aggressive deficit
4. Diets focused on accruing **more lean mass are driven by a calorie surplus** to aid in additional resistance training demands. Highly individual
5. LCHF as well as HCLF have been shown to be effective – **hinging on #3**
6. Hypocaloric **protein consumption to preserve LM can be 2.3-3.1 G/KG** fat free mass
7. Intermittent caloric restriction not > than daily caloric restriction for improving body composition
8. Long term success with diets is about **compliance** and circumventing adaptive thermogenesis
9. **Less research on women** and elderly populations
10. Behavioral and lifestyle modifications poorly understood

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What diets are out there?

Table 2 Diet categories

Diet	Composition	Strengths	Limitations
Low-energy diets (LED)	LED: 800–1200 kcal/day VLED: 400–800 kcal/day	Rapid weight loss (1.0–2.5 kg/week, diets involve premade products that eliminate or minimize the need for cooking and planning.	VLED have a higher risk for more severe side-effects, but do not necessary outperform LED in the long-term
Low-fat diets (LFD)	LFD: 25–30% fat VLFD: 10–20% fat	LFD have the support of the major health organizations due to their large evidence basis in the literature on health effects. Flexible macronutrient range. Does not indiscriminately vilify foods based on CHO content.	Upper limits of fat allowance may falsely convey the message that dietary fat is inherently antagonistic to body fat reduction. VLFD have a scarce evidence basis in terms of comparative effects on body composition, and extremes can challenge adherence.
Low-carbohydrate diets (LCD)	50–150 g CHO, or up to 40% of kcals from CHO	Defaults to higher protein intake. Large amount of flexibility in macronutrient proportion, and by extension, flexibility in food choices. Does not indiscriminately prohibit foods based on fat content.	Upper limits of CHO allowance may falsely convey the message that CHO is inherently antagonistic to body fat reduction.
Ketogenic diets (KD)	Maximum of ~50 g CHO Maximum of ~10% CHO	Defaults to higher protein intake. Suppresses appetite/controls hunger, causes spontaneous reductions in kcal intake under non-calorically restricted conditions. Simplifies the diet planning and decision-making process.	Excludes/minimizes high-CHO foods which can be nutrient dense and disease-preventive. Can compromise high-intensity training output. Has not shown superior effects on body composition compared to non-KD when protein and kcals are matched. Dietary extremes can challenge long-term adherence.
High-protein diets (HPD)	HPD: ≥ 25% of total kcals, or 1.2–1.6 g/kg (or more) Super HPD: > 3 g/kg	HPD have a substantial evidence basis for improving body composition compared to RDA levels (0.8 g/kg), especially when combined with training. Super-HPD have an emerging evidence basis for use in trained subjects seeking to maximize intake with minimal-to-positive impacts on body composition.	May cause spontaneous reductions in total energy intake that can antagonize the goal of weight gain. Potentially an economical challenge, depending on the sources. High protein intakes could potentially displace intake of other macronutrients, leading to sub-optimal intakes (especially CHO) for athletic performance goals.
Intermittent fasting (IF)	Alternate-day fasting (ADF): alternating 24-h fast, 24-h feed. Whole-day fasting (WDF): 1–2 complete days of fasting per week. Time-restricted feeding (TRF): 16–20-h fast, 4–8-h feed, daily.	ADF, WDF, and TRF have a relatively strong evidence basis for performing equally and sometimes outperforming daily caloric restriction for improving body composition. ADF and WDF have ad libitum feeding cycles and thus do not involve precise tracking of intake. TRF combined with training has an emerging evidence basis for the fat loss while maintaining strength.	Questions remain about whether IF could outperform daily linear or evenly distributed intakes for the goal of maximizing muscle strength and hypertrophy. IF warrants caution and careful planning in programs that require optimal athletic performance.

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Table 1

Nutrition points for the performance of rowing athletes.

Periods	Nutrition Points
Before training or competition	• In rowing training or competition, both anaerobic and aerobic metabolism are used, and glycogen is utilized as a very important energy substrate. • In general, the average calorie intake of a rowing athlete is between 2600 kcal and 4900 kcal (possible intake up to 7000 kcal). - Carbohydrate intake is about 4.6–6.3 g/kg. • Carbohydrate intake can be varied depending on the intensity, duration, and type of training. - Low-intensity training or a skill-based activity: 3–5 g/kg/day - 1–3 h training with moderate–high intensity: 6–10 g/kg/day - 4–5 h training with moderate–high intensity: 8–12 g/kg/day • In case of insufficient carbohydrate intake at regular meals, it is possible to replenish easily digestible carbohydrates 30-60 min before training or competition.
During training or competition	• Rowing athletes can consume carbohydrates in various forms such as glucose, sucrose, maltose, and maltodextrin. • In general, sports drinks and gel or low-fat, low-protein, and low-fiber solid bars can be consumed for supplementation. • Sometimes, carbohydrate mouth rinse can be applied. - This method can be effective in high-intensity training performed within 1 h. - After taking a sip of sports drink or maltodextrin, rinse in the mouth for 5–10 s and spit it out again. - In this way, carbohydrate mouth rinse is performed every 10–15 min.

Table 3

Nutrition points for the recovery of rowing athletes.

Components	Nutrition Points
Refueling	• The most important goal is the carbohydrate intake for glycogen replenishment. • Timing of carbohydrate intake: Immediately after the training or competition (the sooner the better). • Type of carbohydrate intake: High glycemic index (GI) carbohydrate. • Carbohydrate form: Liquid or solid form or as a meal or a snack. • Amount of carbohydrate intake: 1.2g/kg.
Rehydration	• The most important goal is ensuring sufficient fluid intake. • Timing of fluid intake: Immediately after the training or competition. • The weight loss after the training reflects the loss of fluid (Monitoring of weight change is required). • Amount of fluid intake: 1.5-times the amount of weight loss. • Sports drinks or food with sodium (Na^+) and water can be consumed.
Repair	• The most important goal is to facilitate muscle protein synthesis. • Protein type: Whey protein (easy digestion and absorption, rich in essential amino acids and leucine). • Amount of protein intake: From about 20–25 g to 40 g; relative value of the intake is about 0.3–0.4 g/kg. • Protein intake distribution: Intake of every 3–5 h is recommended. • To promote recovery, approximately 40 g of casein protein can be consumed 30 min before sleep.

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Thank you

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