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Performance Nutrition for Elite and Non-Elite CrossFit & Hyrox Athletes

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Questions We'll Be Answering Today

- What are CrossFit and Hyrox?
- What are the physiological demands?
- How do the sports & athletes compare?
- What role do macronutrients play in each sport?
- What could a typical day of nutrition look like?
- How to adapt nutrition for competition
- Which supplements could offer performance benefits?

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CrossFit

Introduction, Elite Standards

What is CrossFit?

"Eat meat and vegetables, nuts and seeds, some fruit, little starch and no sugar. Keep intake to levels that will support exercise but not body fat"

Founded in ~2000 in the U.S.
A test to find the all-round fittest individuals on earth

Powerlifting, Olympic Weightlifting
Gymnastics, Endurance

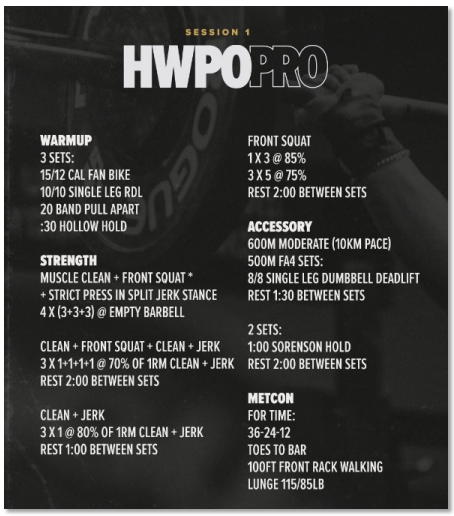
5-6 days per week

Short & intense, mix and combine all elements
Routine is the enemy

CrossFit Elite Standards & Example Workout

- **Eligibility for HWPO Pro:**
- Open ☑ > Quarter Finals ☑ > Top 5%

- Train 2x/day for ~4 hrs total
- Snatch: Men >111KG, Women >70KG
- Clean + Jerk: Men >125KG, Women >84KG
- Back Squat: >165KG Men, Women >130KG
- Minimum 10+ Unbroken Ring Muscle-Ups
- Proficient at Handstand Walks



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Hyrox

Introduction & Elite Standards

What is Hyrox?

"Accommodating both professional athletes and everyday fitness enthusiasts looking to take their training to the next level, HYROX is the sport for everybody"

Fitness Race Founded in Germany, 2017

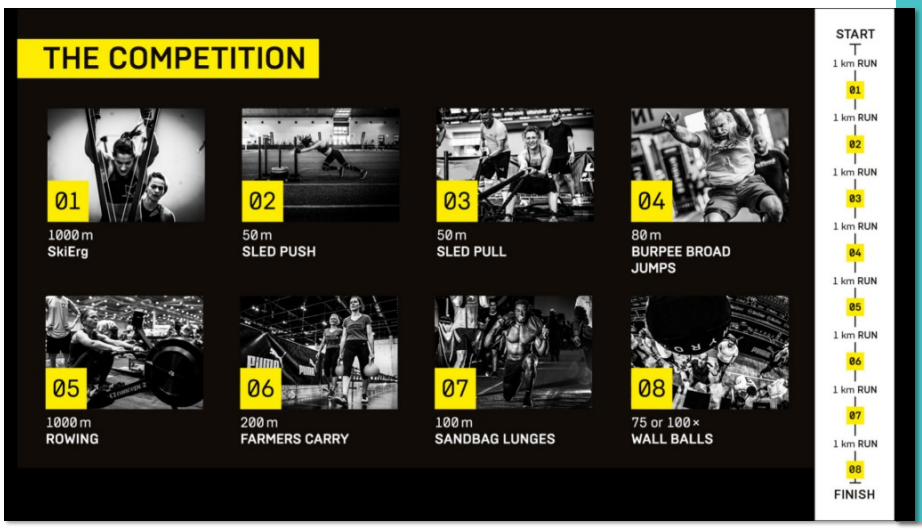
Always the same format
(~50% Running, Ski Erg, Sled Push & Pull, Burpee Broad-Jumps, Farmers Carry, Sandbag Lunges & Wallballs)

Training culture & community - Replicated CrossFit

Average finish time ~1h 30

The Fitness Race | HYROX

Hyrox Elite Standards & Workout



Hyrox Pro Weights
(Female/Male):

Sled Push:
152kg / 202kg

Sled Pull:
103kg / 153kg

Farmers Carry:
2x24kg / 2x32kg

Sandbag Lunges:
20kg / 30kg

Wall Balls:
6kg / 9kg

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What are the differences?

Comparing Physiology & Athlete Profiles

Key Differences Between Sports

	CROSSFIT
Competition Duration	**Multiple Events / Days:** 3s (1RM Snatch) Most = 5-20 min 180min (Marathon Row)
Event Predictability	Low
Skill Requirement	High
Weight Categories	None

Adapted from D'Hulst (2024)

Physiological Differences

Hyrox Athletes: World's Best 15

CrossFit Athletes Inclusion Criteria: Top 5% in the Open

	CrossFit Men (n=30)	CrossFit Women (n=30)	Hyrox Men (Elite 15)	Hyrox Women (Elite 15)
Age	27.6	29.1	34	33
Height (cm)	176.3	165.5	*~182*	*~169*
Body mass (kg)	85.9	65.9	84	62
BMI	27.6	24.1	*~25*	*~22*
VO2 Max (mL/kg/min)	53.3	48.4	Male Champion Endurance Athletes = 70-85 Females ~10% lower	
Back Squat 1RM	178kg	115kg	*~140kg*	*~87kg*
Deadlift 1RM	212kg	138kg	*~180kg*	*~120kg*
Bench Press 1RM	128kg	72.5kg	*~108kg*	*~70kg*
Avg. Run Times (5k, Marathon)	18:14 (2023 5k @ CF Games)	19:40 (2023 5k @ CF Games)	15:50 (5k), 02:45 (Mar)	18:42 (5k), 03:12 (Mar)

D'Hulst et al. (2024); Cheuvront et al. (2005)

Differences in Athlete Profiles

CrossFit

- Generally, favours shorter individuals with shorter limb lengths
  - Specifically in the Open
- Large amounts of strength & muscle mass required to lift the weights required in elite competition

Mat Fraser - 5'7
Tia-Clair Toomey-Orr - 5'2

Hyrox

- Stations favour larger & taller athletes
- However - Running is 50% of event
- Less overall strength & muscle mass required & may slow athletes down on the run if carrying too much mass

Hunter McIntyre - 6'2
Alexandar Roncevic - 6'0

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Physiological demands

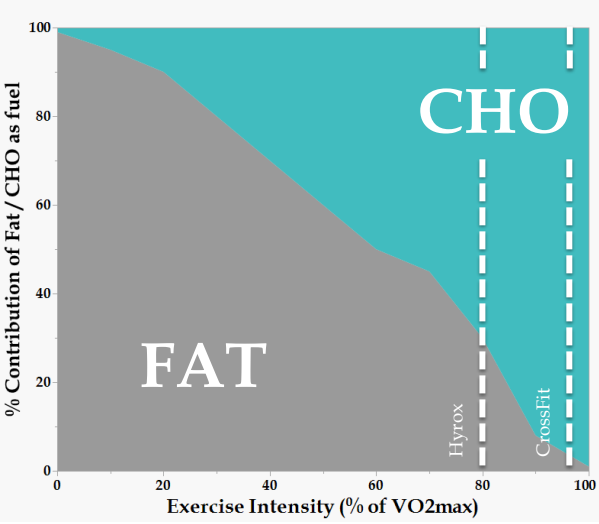
Deep-dive into CrossFit vs. Hyrox

Overview of Energy Production in the Body

System	Duration	Requires Oxygen?	Substrate	Sport
Phosphocreatine (alactic) (PCr)	Seconds	No	Muscle ATP / CP stores	CF
Anaerobic Glycolysis (Lactic)	Minutes	No	Muscle & Liver Glycogen	CF
Aerobic Glycolysis	Hours	Yes	Muscle & Liver Glycogen	Hyrox
Aerobic Lipolysis	Hours	Yes	Fatty Acids	Hyrox

Adapted from Gastin (2001); Murray & Rosenbloom (2018)

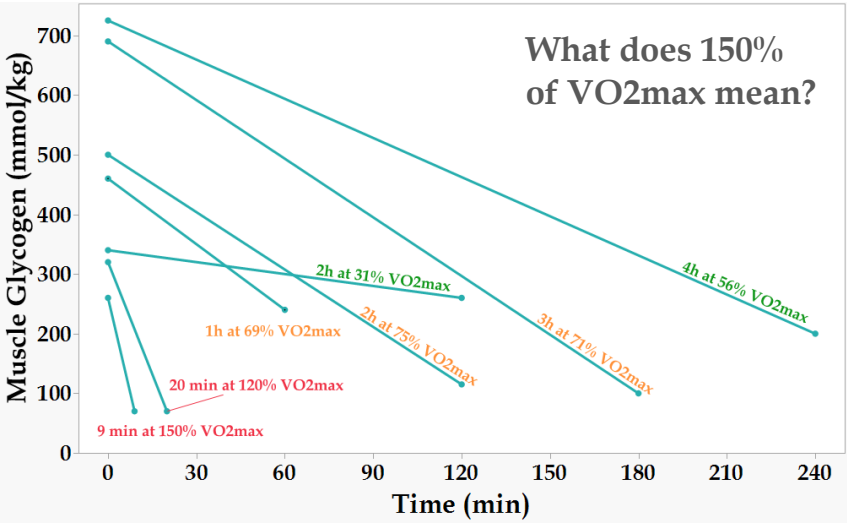
Fuel Source is Determined by Intensity



- All Energy Systems are working all the time
- Ratios change based on:
  - Exercise Intensity
  - Demand for ATP

Adapted from Jeukendrup - "*The myth of switching to fat metabolism*"

Glycogen Depletion Rates Correlated with Exercise Intensity



Data compiled from cycling exercise only, representing glycogen use in the vastus lateralis muscle
Adapted from Impey et al. (2018)

Energy Contributions During CrossFit Workout: Fran

21 - 15 - 9 Reps

Adapted from Rios et al. (2023); Rios et al. (2024)

Summary

- CrossFit and Hyrox are distinct sports
- CrossFit relies less on the aerobic energy pathways and heavily on the anaerobic pathways
- Hyrox relies more on the aerobic energy pathways with high-intensity so that most of the fuel will be coming from CHO
- Both sports are different BUT heavily reliant upon glycogen

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Real World Example

Given the importance of CHO in high-intensity exercise, how do World Champion CrossFit Athletes compare with other sports?

Fuelling Performance: Cyclist vs. CrossFitter

World-champion Cyclist

- Isotonic Sports Drink (50g Carbs)
- 3x Energy Bars (90g Carbs)
- 2x Energy Gels (75g Carbs)
- 1 Bag Haribo (85g Carbs)
- 2 Chocolate Bars (40g Carbs)
- 2.5L Orange Soda (180g Carbs)
- 1 Can of Fanta + 1 Can of Coke (50g Carbs)

~570g Total Carbohydrates
~80g Carbs per hour = ~1.2g/kg/hr

World-champion CrossFitter

- 2% Fat Greek yoghurt, Blueberries, Raspberries & Banana (~35g Carbs)
- Plate full of Prawns + 1 Apple (~20g Carbs)


~55g Total Carbohydrates
~14g Carbs per hour = ~0.17g/kg/hr

CrossFit nutrition is often focussed on 'health' rather than performance

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Macronutrients

Deep-dive into CrossFit vs. Hyrox for Elites & Non-Elites

Recap

- CrossFit and Hyrox are two different sports
  - Both heavily reliant on CHO as a substrate to fuel their high intensities
- General nutrition guidelines are therefore similar for both sports
- The difference in nutrition arises from training status: Elite or non-elite?
  - How many training sessions are you doing per week?
  - How long do your typical workouts last?
  - What intensity is your workout going to be?

Fat & Fibre

For Performance Optimisation

- Let fat intake be what remains after optimising CHO + PRO intake
- Minimise fat & fibre intake in your pre-workout meal & between sessions (elites)
  - Slows gastric emptying
  - Delays glycogen resynthesis
- May then need to front-load or back-fill these in the day

For Competition

- Potential ~2% bodyweight reduction with 4-day, very low fibre diet of <10g
  - Spares muscle glycogen
- May improve power-to-weight ratio
  - Consideration for taller / heavier athletes during the open / quarter finals etc.
- Not much research in this area, it's mostly hypothetical

Follow general health-promoting behaviours
Consider your preferences & over-arching health / body composition goals

Arenceta & Perez-Rodrigo (2012); SACN (2015); Foo et al. (2022)

General Daily Protein Intake

1.6 ← **2.0** → **2.4**

g/kg/d

Grams per kilogram total bodyweight per day

Non-Elite Athlete
Higher Bodyfat Percentage
Lower Training Volume
Not in Weight / Fat Loss Phase
Hyrox

Elite Athlete
Lower Bodyfat Percentage
Higher Training Volume
Weight / Fat Loss Phase
CrossFit

Morton et al. (2020); Hector & Phillips (2018)

Generalised Daily CHO Needs for Fuel & Recovery

Training Volume		Target Carbohydrates (80kg individual example)
Light	- Training 1x/d ~1h **OR** - Weight Loss Phase	**3-5g/kg** (240g - 400g)
Moderate	- Training 2x/d **OR** - Training for ≥2hrs	**5-7g/kg** (400g - 560g)
High	**Elite Athletes** - Highest Volume/Intensity Pre-Comp	**6-10g/kg** (480g - 800g)
Very High	- **All athletes** Pre- & During Competition	**8-12g/kg** (640g - 960g)
Fine-tune with individual total energy needs, training needs and feedback from training performance		

Adapted from Burke et al. (2011)

'Train Low' - Beneficial for Performance?

- Training with reduced carbohydrate availability
- Pro's:
  - Potentially improves training adaptations related to mitochondrial function/muscle physiology
  - Commonly used by endurance athletes training at low-intensity
    - Fat oxidation can produce most of the energy required ('Zone 1' & 'Zone 2' workouts)
- Con's:
  - Reduces efficiency at utilising **CHO** as fuel with high-intensity exercise
  - Reduces the quality of long /intense/skill-based training sessions
  - Immune status can be impaired when training with low CHO/energy availability

Hawley & Burke (2010); Lane et al. (2015)

‘Train Low’ - Beneficial for Performance?

- Training with reduced carbohydrate availability

✖ CrossFit

- Adequate CHO required to maximise skill acquisition & for WODs

✔ Hyrox

- Train low approach may be incorporated before ‘easy’ workouts due to lower intensity

Hawley & Burke (2010); Lane et al. (2015)

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For a range of situations

Example of a Daily Schedule

Non-Elite Athletes Training **After** Work

HIGH MEDIUM LOW

07:30	08:00	12:00	16:00	18:00	20:00	23:00
PROTEIN	0.4-0.6g/kg	0.4-0.6g/kg	0.3-0.4g/kg		0.4-0.6g/kg	
	0.5-1g/kg	1-1.5g/kg	1.5-2g/kg		0.5-1g/kg	
FAT	~40% of total	~30% of total	Minimal		~30% of total	

Non-Elite Athletes Training **Before** Work

HIGH MEDIUM LOW

05:00	05:01	06:00	08:30	13:00	18:00	21:00
PROTEIN	0.2-0.3g/kg		0.4-0.6g/kg	0.4-0.6g/kg	0.4-0.6g/kg	
	≤1g/kg		1.5-2g/kg	0.5-1g/kg	0.5-1g/kg	
FAT	Minimal		~30% of total	~30% of total	~40% of total	
	3-6 mg/kg					

Elite Athlete Example (CHO): Optimal, Not Practical

	First Meal	During Session #1	Post Training / Second Meal	During Session #2	Final Meal
Day 1: Rest Day No Training	0-1g/kg CHO	No Training	1g/kg CHO	No Training	3g/kg CHO
Day 2: 2 x High-Intensity Sessions (4h)	2g/kg CHO	30 - 60g CHO / hr	1 - 1.2g/kg/hr CHO (first 4h PWO)	30 - 60g CHO / hr	0-1G/KG CHO (low CHO to compensate for high intake earlier in day)
Day 3: 2 x High-Intensity Sessions (4h)	2g/kg CHO	30 - 60g CHO / hr	1 - 1.2g/kg/hr CHO (first 4h PWO)	30 - 60g CHO / hr	0-1G/KG CHO (low CHO to compensate for high intake earlier in day)
Day 4: 1 x AM-High (2h)	3g/kg CHO	30 - 60g CHO / hr	1g/kg CHO	No Training	1g/kg CHO
Day 5: 1 x Recovery (1h easy)	None (Train Low)	None	1g/kg CHO	No Training	3g/kg CHO

Adapted from Impey et al. (2018) *"Fuel for the Work Required"*

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How to manage nutrition during competition

Commonalities & Differences in Hyrox Vs. CrossFit

Recap

- CrossFit and Hyrox differ in competition in two ways:
- Hyrox is a single event lasting ~1-2hrs
  - Pre-Event Nutrition
  - During Event Nutrition
- CrossFit competitions are always multiple events
  - Non-Elite competition is usually a single day with 3-5 events
  - Elite competition is 2-4 days with 2-5 events per day
  - Focus is on pre & between event nutrition
- In all cases:
  - Day before competition = CHO loading 8-12g/kg

Improve Performance Through Rapid Weight Loss?

Dieting Down to 'Race Weight'

- Especially common with taller & heavier athletes
- These athletes will restrict caloric intake leading up to competition to:
  - Lose bodyweight
  - Increase power to weight ratio

Randomised, Single-blinded Crossover Study in Female Triathletes

- 14 days of optimal energy availability (OEA) diet (50kcal × kg FFM × day)

OR

- 14 days of Low energy availability (LEA) diet (22kcal × kg FFM × day) followed by 3 days of OEA

20 Minute Time Trial Performance:

Total power output reduced by **7.8%** after LEA & still **6.7%** lower after refuelling
Power output ***relative*** to body mass was **4.3%** lower after LEA & still **4.1%** lower after 3 days refuelling

Jeppesen et al. (2024)

How to Deal With Muscle Cramping in Competition: Ironman

What Is Often Blamed For Cramping

- Sodium/electrolyte concentrations
- Dehydration
- **No** relationship between serum electrolyte disturbances or dehydration and the development of cramps in Ironman Race

What The Research Shows

Cramping is a complex syndrome, related to fatigue. The main factors affecting cramping during Ironman:

- **Overall race time**
  (Faster = More cramping = high intensity)
- **No. Cramps in past 10 Races**
  (Training Vs. Comp volume/intensity?)

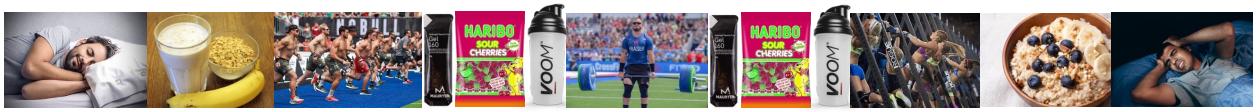
Takeaways:

Competition simulations & appropriate training volume/intensity are key to managing cramping
Try to match the event volume, intensity & environmental conditions as closely as possible
Likely that individuals will compete at a higher-intensity than they do in training

Schwellnus et al. (2011)

CrossFit Competition Nutrition Example

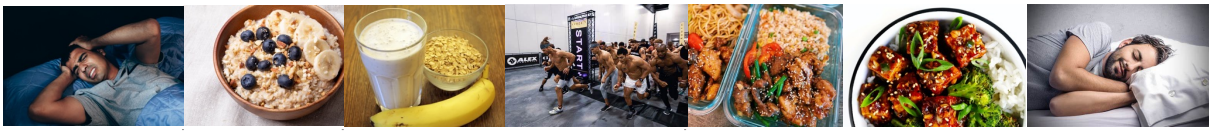
HIGH MEDIUM LOW



05:30	06:00	09:00	09:30	13:00	13:45	17:30	18:30	21:30
	0.2-0.3g/kg	Event #1	0.2-0.3g/kg	Event #2	0.2-0.3g/kg	Event #3	0.6-1g/kg (back-fill)	
	3g/kg Simple (2:1 Glu:Fruc /Gal)		1–1.2g/kg /h Simple		1–1.2g/kg /h Simple		3g/kg Complex	
	Minimal		Minimal		Minimal		Back-fill if possible	

Hyrox Competition Nutrition Example

HIGH MEDIUM LOW



07:30	08:00	12:00	15:00	17:00	20:00	22:30
	0.2-0.3g/kg	0.2-0.3g/kg	Race Start	0.4-0.6g/kg	0.5-1g/kg	
	3g/kg Simple (2:1 Glu:Fruc/Gal)	3g/kg Simple	30-60g CHO/h (gels) (the longer your expected race time, the more CHO required)	2g/kg	1g/kg	
	Minimal	Minimal		~40% of total	~60% of total	

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Applicable to both Hyrox & CrossFit

Supplements

Risk Vs. Benefit - Supplements

- Does the athlete need to supplement?
  - Experience, goals…
- Is the supplement effective for intended use?
  - Anecdotal evidence or established scientific "track-record"?
- Is the product safe?
  - Adverse reactions? Medication interactions?
  - Contamination - banned substances (WADA)?
  - Is product third-party tested (Elites)
- Is the supplement affordable?
- Did you test the supplement?
  - During competition simulation & general training

Year-Round Supplements for All

	Why?	When?	How Much?
Creatine	↑ PCr stores ↑ Anaerobic threshold ↑ Aerobic endurance ↑ Strength & FFM ↑Recovery from intense exercise	Once daily. Timing irrelevant. Consistency is key	0.03 - 0.05 grams per kg BW. Takes ~4 weeks to fully saturate PCr stores
Caffeine	↓ Rate of Perceived Exhaustion (RPE) in CrossFitters ↑ Ergogenic Aid: Strength/power, endurance, intermittent exercise, sport-specific skills, cognition	60 mins pre-exercise. No benefit to splitting doses pre/during	3-6 mg/kg body mass Smaller "Top-ups" for multiple-events
Beta Alanine	↑ Muscle carnosine levels buffers pH ↓ Exercise fatigue when producing H+ ions via anaerobic glycolysis Best results seen in exercise lasting 30s - 10 minutes	≥200g over 4-10 weeks in split doses	e.g. 3 x 3.3g/d x 4wks then ~2g daily (split dose)
CHO Gels / Drinks	Optimise glycogen availability during relevant training sessions	During Hyrox event simulations & high-intensity exercise >1hr	30 - 60g hr

All of these supplements likely provide long-term benefit by improving training session quality

Wax et al. (2021); Tallis et al. (2022); Ziyaiyan et al. (2023); Conway et al. (2003); Ojeda et al. (2020)

Supplements for Event Simulation & Competition

	Why?	When?	How Much?
Sodium Bicarbonate	↑ Temporary increase blood bicarbonate ↑ Extra-cellular buffering of H+ ions from muscle. ↓ Exercise fatigue when producing large amounts of H+ ions via anaerobic glycolysis ↑ +6% rep improvement in Fight Gone Bad (CrossFit)	Incremental loading is advised From ~10d pre comp & ~1.5hrs pre event	0.15 - 0.3 grams per kg body mass (G.I distress is very common!!) Split dosage into 2-3
Nitrates	↑ Nitric oxide production from nitrate ↑ ~3% Exercise economy & capacity in events causing acidosis/hypoxia. Most effective in high-intensity events 4- 15 minutes	3-5 days before event + 2-3.5h pre-event	8-25mmol nitrate in beetroot juice (or as sodium nitrate)
Tart Cherry Juice	High antioxidant content ↓ Reactive oxygen species (ROS) ↓ DOMS from muscle damaging exercise? ↑ Recovery?	2xd for 4-5 days before event & 2-3d after to promote recovery	250-350ml (30ml if concentrate)
Ice Slurry?	↑ Thermoregulation ↑ Power output & endurance capacity	30-60 mins before event in hot / humid environments in fluid of choice	7-10 grams per kg body mass

Grgic et al. (2021); Senefeld et al. (2020); Tanabe et al. (2022); Gopathi et al. (2023)

Effects of Combining Supplements

Na Bicarb + Caffeine

- GI symptoms associated with both supplements
- Co-ingestion may increase the risk of gut side-effects and may impair performance

Nitrates & Na Bicarb

- Bicarb supplementation may limit the conditions where nitrate supplementation is most useful (plasma acidosis)

Na Bicarb + Beta-alanine

- Potential additive benefits
- Combination of extra- & intra-cellular buffering may synergistically increase total buffering capacity

Takeaways:

For Hyrox – Must vigorously test combinations of CAFF + Bicarb/Beta Alanine during simulations

For CrossFit – Multiple day competition? Caffeine during **AM** events & possibly Bicarb/Beta-alanine combo without caffeine in **PM**

Burke (2017)

SUMMARY

- CrossFit and Hyrox are serious sports with real athleticism
- Carbohydrate is key to performance in both sports
- CrossFit competitions are multiple-event, often multiple-days
  - Nutrition should focus on pre & between events, not during
- Hyrox is a single race - focus on pre- & during- nutrition
- Supplements have the potential to improve both training and performance (consider pros vs. cons)
- Proper event nutrition simulations are critical to achieving your full potential at competition

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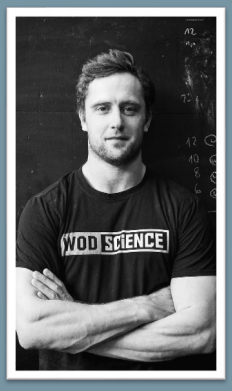

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Further Reading

- Document will be made available with all references incase you want to read further