Nutrition for Divers
Live stream with
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Introduction: Common Components of Diving Training Programs

- Fulltime training=40 hr/wk
- Young competitive divers = 6 to 9 diving training sessions/wk by age of 12.
- Typical Training Day
  - 2 training sessions. In each…
    - 1 hr 'dry-land'
    - 1.5 hr diving
      - Springboard divers:
        - 50-100 dives per day
        - 50-100 summersaults as part of dry-land per day
      - Platform divers:
        - 50-100 dives per day

- The origins of modern diving can be traced to European venues where, by the mid to late 1800's, diving from great heights with acrobatic feats that included somersaults and twists was described as "fancy diving".
- The first diving rules were adopted in 1891, with England starting the first diving association in 1901.

Aileen Riggin (USA) 1920 Olympic Games Platform Gold Medal. 4'5" (135cm); 61.5 lb (28 kg)

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Concern: Age Appropriate Training

- IOC Consensus on Elite Child Athlete (Mountjoy 2008)
  - Should be:
    - Age appropriate
    - Pleasurable
    - Fulfilling
- Concern that these IOC guidelines are not universally followed in diving. (Zimmermann 2013)

Ideal lifecycle of competitive divers:
- Begins in pre-pubertal years
- 14 yr divers may compete in senior international competitions

Warnings that accelerated training in young divers may create high risk of physical and psychological injury. (Raspopova 2005)

- Mountjoy et al. (2008) IOC consensus statement: Training the elite child athlete. *Br J Sports Med* 42: 163-164.
- Zimmermann (2013) Medical aspects of competitive diving. In: Diving research worldwide, Pages: 66-72.
- Raspopova et al. (2005) Morphofunctional monitoring of young athletes as criterion of optimization or the training process. *Children's coach*, Moscow.

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There Is An Interaction Between Physical Activity and Nutrition

- Altered Energy Requirements
- Altered Energy Substrate Requirements
- Altered Vitamin requirements
- Altered Mineral Requirements
- Altered Fluid Requirements

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All physical activity results in an…

- Increased ***rate*** of energy expenditure
- Increased ***rate*** of body fluid loss

Major Issues in Sports Nutrition

Findings of surveys:

- Physically active people don't eat enough and they don't drink enough
- Tend to supply needed energy and fluids *after* they needed them

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Nutrition Issues in Divers

- Pressure to achieve weight and body composition consistent with competitive expectations.
  - Energy restriction
  - Eating disorders
  - Fad Diets
  - Psychological pressure
  - Pubertal changes impact nutrient/energy intakes
  - **Weight** rather than body composition orientation

Benardot D, Zimmermann W, Cox GR, and Marks S. Nutritional recommendations for divers. Int J Sport Nutrition and Exer Metab 2014 (24): 392-403.

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Misperception: Weight Appropriate Metric To Determine Competitive Readiness

The critical issue: **What** constitutes weight.

5 lbs (2.27 kg) of muscle
5 lbs (2.27 kg) of fat

Weight may come from…
- **Lean Mass** (more=good)
- **Bone Mass** (more=good)
- **Fat Mass** (more=bad)
- **Body Water** (more=generally good)

Important to help divers do 2 things:
1. Stop doing things that lower metabolic mass
2. Stop doing things that increase fat mass.

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Big Nutrition Issues for Divers

1. Optimally satisfying **energy** needs
   - quantitatively,
   - qualitatively,
   - timing

Better to have 3 of these…

2. Optimally satisfying **fluid** needs
   - Quantitatively
   - Qualitatively
   - Timing)

…than one of these.

3. Optimally satisfying **micronutrient** needs
   - Quantitatively
   - Qualitatively
   - Timing)

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Contributing Factor to Poor Nutrition: Poor Knowledge of Nutrition

- **Inappropriate Modeling:** Copying admired athletes.
- **Belief vs. Science:** Thinking of nutrition as a 'belief' system and not a science.
- **Misattribution of Perceived Benefit:** Consuming certain foods/beverages may not help for the reasons they believe.
- **"Good" and "Bad" Foods:** Oversimplification results in problems
- **Magic Bullet:** Looking for the easy fix.

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Contributing Factor to Poor Nutrition: Sport-Specific Traditions

- **Sport Traditions:** Perpetuation of coach/sport induced nutrition-related problems.
- **Weight Focus:** Excessive focus on "weight", when the focus should be on "body composition" and "strength:weight ratio"
- **Protein Solves Everything:** 'Belief' that high protein intake will successfully resolve all potential nutrition problems.
- **Reliance on Supplements:** Lowers food intake and creates WADA issues

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Contributing Factor to Poor Nutrition: Food Restriction

FOOD RESTRICTION

What you say and how you say it impacts food restriction:
Example 1: Athlete who is told her body fat percent is too high.
Example 2: Same athlete who is told her lean mass percent is too low.

- **Allergies:** Avoidance of foods that cause a potentially life-threatening allergic response.
- **Intolerances:** Avoidance of foods that cause discomfort, typically related to insufficient digestive enzyme, such as lactose intolerance.
- **Sensitivities:** Discomfort, bloating, and various other symptoms from foods, often not well identified, that cause gastrointestinal inflammation.
- **Restrictive 'Weight Loss' Diets:** Athletes assume that lowering food intake will make them thinner. 'Thin' is not the same as 'lean'.

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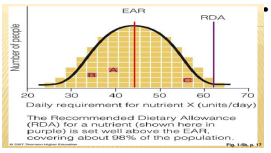
Contributing Factor to Poor Nutrition: Dietary Guidelines Misinterpretation



- **The human system works in real time and does not wait to end of the day to determine the appropriate endocrine response to energy and nutrient consumption.**
- **Important to Ask: How Much and When?**

- The dietary guidelines are general recommendations to help ensure a healthy life. These are generally appropriately used with physically active people, with only a few modifications:
  - (i) sugar-containing sports beverages are appropriate for consumption during bouts of physical activity and
  - (ii) sodium losses through sweat may exceed current intake recommendations, but should be replaced.
- The DRI/RDA value is two standard deviations *above* the average requirement

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Basic Guidelines of Nutrition

More Than Enough is NOT Better Than Enough	• If a small amount of nutrient is needed to ensure optimal health, having more than this amount is not necessarily better and may cause problems.
Eating a WIDE VARIETY of Foods Is Necessary to Ensure Exposure to Needed Nutrients	• There is no such thing as a perfect food that contains all the nutrients in perfect proportion to cellular needs. Consumption of a wide variety of foods is necessary for optimal nutrient exposure.
Eat Enough to Satisfy Energy, Fluid, and Nutrient Needs in REAL TIME	• There should be a *dynamic* relationship between the requirement for energy and nutrients, and the consumption of energy and nutrients. Never overfill the tank, and never let it go empty.

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Misperception-Supplements are an Effective Means of Satisfying Nutritional Needs

Reality: Very high doses of nutrients (think *'supplements'*) lead to lower tissue sensitivity and greater risk of toxicity. **More than enough is not better than enough.**

Equivalent?

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Supplement Issues

More than enough not better than enough!

- Taken in large amounts, some supplements may result in opposite of desired effect.
  - Vitamin E supplement *promotes* lipid peroxidation and inflammation during exercise. Med Sci Sports Exerc 2004; 36(8):1328-1335
  - > 500 mg leucine/kg/d may increase of adverse events. Tolerability of leucine in humans. Branched Chain Amino Acids in Clinical Nutrition: Nutrition and Health 2015. pp 3-13.

15

Other Supplement Problems

Many supplements have banned substances not listed on the label.

- Kwiatkowska D et al. N,N-dimethyl-2-phenylpropan-1-amine – new designer agent found in athlete urine and nutritional supplement. Drug Testing and Analysis. 2015; 7(4): 331-335.
- Maughan R. Quality assurance issues in the use of dietary supplements, with special reference to protein supplements. J Nutrition. 2013. 142: 1843S-1847S.

WADA Investigations result in athlete failure and loss of affiliated institution credibility.

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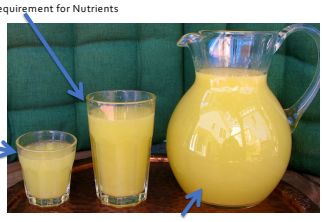
Daily Requirement for Nutrients

Cellular Capacity for Nutrients



Typical Supplemental Nutrient Dose

Unless there is a known biologically assessed nutrient deficiency, taking a pharmacological approach to nutrition does not work.
EAT GOOD FOOD

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Creatine Monohydrate Study

- No difference in first 6 of 10 jumps
- Jump 7, 250 kcal supplement significantly better than all other supplements
- Jump 8 & 9, 250 kcal and creatine supplements better than other supplements
- Jump 10, all supplements better than placebo
- In no case did creatine monohydrate outperform 250 kcal from carbohydrate
- Creatine monohydrate group gained 1.5 kg after 6 days; 250 kcal group gained 0.0kg after 6 days.

[Koenig CA, Benardot D, Cody M, and Thompson W. Comparison of Creatine Monohydrate and Carbohydrate supplementation on Repeated Jump Height Performance. The Journal of Strength and Conditioning Research. 2008; 22(4):1081-1086.]

Interpretation: Give the body enough energy *and* protein, and it can synthesize the required secondary proteins. Give the body **enough protein *and not enough*** energy, and the protein will be used to satisfy the energy requirement, with a failure to synthesize needed secondary proteins.

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Food Variety Important

Color Wheel of Foods & Phytochemicals Source: Dr. David Heber, UCLA Center for Human Nutrition		
Color Group	**Phytochemicals**	**Fruits and Vegetables**
Red	Lycopene Phytoene Phytofluene Vitamin E	Tomatoes Tomato Sauce Vegetable Juice Tomato Soup Watermelon
Green	Glucosinolates Isothiocyanates Indole-3 Carbinol Folic Acid	Broccoli Brussel Sprouts Bok Choy Cauliflower Cabbage
Green/Yellow	Lutein Zeaxanthin	Spinach Avocado Kale Green Beans Green Peppers Kiwi Collard Greens Mustard Greens

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Food Variety Important

Orange	Alpha & Beta Carotene Beta-Cryptoxanthin	Carrots Pumpkins Butternut Squash Mangos Apricots Canteloupe
Orange/Yellow	Vitamin C Flavonoids	Oranges, Orange Juice Tangerines Yellow Grapefruit Peaches, Nectarines Lemons, Limes Papaya, Pineapple
Red-Purple	Anthocyanins Ellagic Acid Flavonoids	Grapes and Grape Juice Cherries, Red Wine Strawberries, Blueberries Blackberries, Raspberries Cranberries,Plums Prunes,Raisins
White/Green	Allyl Sulfides	Garlic, Onion Chives

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Food Variety is Key

In this example, there is NO single food that can supply all the phytonutrients associated with good health.

Focusing on 'Good Foods' while avoiding 'Bad Foods' may create a monotonous diet that is associated with malnutrition.

Only *variety* of intake works:

1. Better assurance of exposing tissues to all nutrients
2. Better assurance of avoiding excess tissue exposure to any nutrient/food substance.

By their very nature, restrictive 'weight loss' intakes limit nutrient exposure.

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Misperception: Common Belief That There Are Perfect Foods

Reality: People who continuously eat the same few foods because they believe these foods are 'healthy' are at risk of malnutrition. **There is no perfect food.**

Sources:
- Guyonnet S, and Rolland Y. Screening for malnutrition in older people. Clinics in Geriatric Medicine. 2015; 31(3): 429-437
- Murray E, and Manary M. Possible role of the microbiome in the development of acute malnutrition and implications for food-based strategies to prevent and treat acute malnutrition. Food and Nutrition Bulletin 2015; 36(1): S72-S75

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Misperception: Only Eating Too Much Will Make You Fat

Reality: Humans are amazingly effective fat manufacturing machines. Eat too much food, you make fat. Eat too little food, you lose lean mass and make fat.

Common Related Misperceptions
- It's all about calories IN vs calories OUT per day (NOT!)
- Eating after 7pm will make you fat (NOT!)
- Intermittent fasting is an effective strategy for achieving the desired body profile (NOT!)
- 3,500 Calories = 1 lb (i.e., lowering food intake by 500 Calories/Day results in a weight loss of 1 lb/week.) (NOT!)

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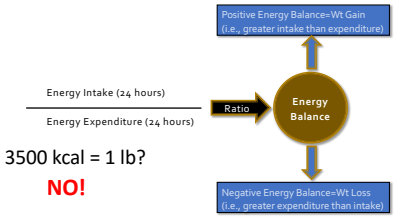
Real Time Food Delivery is Key

Source: Am J Clin Nutr 2012;95:989-94

Traditional Macroeconomic View of Energy Balance



3500 kcal = 1 lb?

NO!

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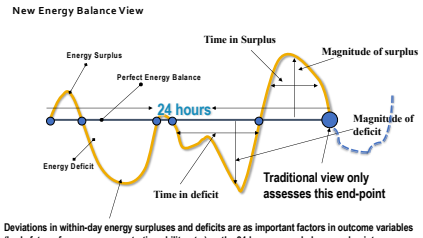
Microeconomic View of Energy Balance



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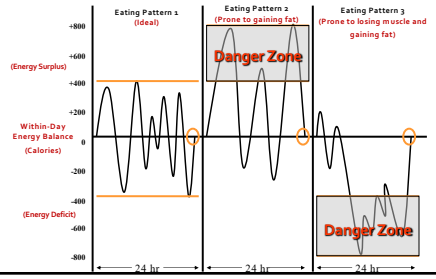
Eating Patterns and Within-Day Energy Balance



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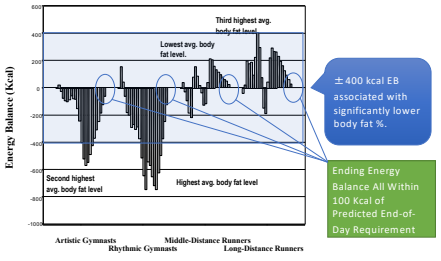
Within-Day Energy Balance & Body Composition in Elite Athletes

Deutz B, Benardot D, Martin D, and Cody M. Relationship between energy deficits and body composition in elite female gymnasts and runners. Medicine & Science in Sports & Exercise 2000; 32(3): 659-668.



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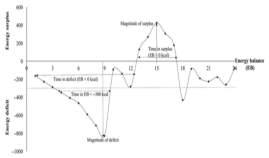
Satisfying Real-Time Energy Need Is Critical



*Fahrenholtz IL, Sjödin A, Benardot D, Tornberg ÅB, Skouby S, Faber J, Sundgot-Borgen J, and Melin A. Within-day energy deficiency and reproductive function in female endurance athletes. Scandinavian Journal of Medicine & Science in Sports 2018: 1-8 doi: 10.1111/sms.13030

*Torstveit MK, Fahrenholtz I, Stenqvist TB, Sylta Ø, and Melin A. Within-day energy deficiency and metabolic perturbation in male endurance athletes. International Journal of Sport Nutrition and Exercise Metabolism 2018: DOI: https://doi.org/10.1123/ijsnem.2017-0337

Recent studies suggest that assessing within-day energy balance provides useful performance- and health-based information for athletes… More time in a severe energy balance deficit results in:

- Female athletes: Significantly higher cortisol and significantly lower estrogen, even when in 24-hour energy balance.
- Male athletes: Significantly higher cortisol and significantly lower testosterone:cortisol ratio, even when in 24-hour energy balance.

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Energy Imbalance Creates Difficulties on Both Sides of the Equation

Hard to find middle

• ENERGY INADEQUACY	• ENERGY EXCESS
• Poor training benefit	• Higher body mass
• Problem maintaining existing lean mass	• Higher body fat percent
• Lowering of metabolic rate	• Cardiac insufficiency
• Increasing difficulty with normal eating	• Higher risk of type II diabetes
• Lower energy / nutrient intake	• Higher risk of hypertension
• Reduction in athletic performance	• Lower disease resistance
• Increased risk of injury	• "Dieting" mediated adaptive energy thermodynamics
• Increased risk of disordered eating/eating disorder	• Increased risk of disordered eating/eating disorder
	• Increased risk of injury
	• Reduced athletic performance

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Misperception: Low Calorie Diets Are An Effective 'Weight Loss' Strategy

Reality: Low calorie diets are doomed to fail. Adaptive thermogenesis leads to same weight on lower energy intake, but the resultant weight has higher fat mass that makes you look bigger and increases cardiometabolic risks.

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Misperception: Diets Help You Lose Body Fat

Reality: The body's reaction to an inadequate energy intake is to lower the tissue that *needs* energy: Lean Mass (...not fat mass).

- The fraction of weight loss as fat-free mass (i.e., muscle and organ mass) *increases*
- Feedback signals from depletion of both fat and FFM through effects on energy intake and adaptive thermogenesis
- A faster rate of fat recovery relative to FFM recovery is a feature of body composition autoregulation
  - High rates of dieting and weight loss recidivism raise concerns..
    - Increased risk for eating disorders
    - Low bone density

Montani JP, Schutz Y, and Dulloo AG. Dieting and weight cycling as risk factors for Cardiometabolic diseases: who is really at risk? *Obesity Reviews.* 2015; 16 (Suppl 1): 7-18.

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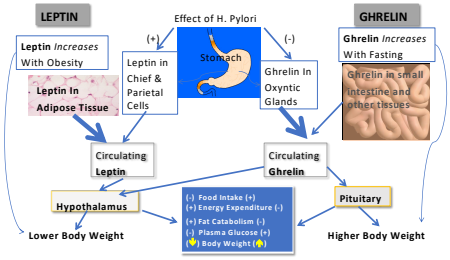
Energy Balance Feedback Mechanisms Following Leptin and Ghrelin



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Poor Within-Day Energy Balance Can Influence Leptin and Ghrelin

- Decreased meal frequency…
  - Correlates with greater daily energy consumption, possibly from up-regulation of appetite and/or tendency toward increased fat intake.
    - Dongen et al., *Journal of Nutrition.* 2008
    - Smith et al., *American Journal of Clinical Nutrition.* 2010
  - The increased energy intake is not matched with higher activity, resulting in higher body fat.
    - Franko et al., *International Journal of Obesity.* 2008
    - Berkey et al., *International Journal of Obesity.* 2003
  - Insulin release typically suppresses ghrelen, which suppresses appetite, but a 6 to 8hr fast may result in hyperinsulinemia and disrupt ghrelin appetite suppression.
    - Anderwald et al., *Diabetes.* 2003
    - Solomon et al., *British Journal of Nutrition.* 2008

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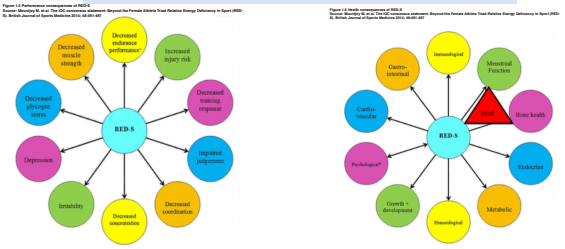
Relative Energy Deficiency in Sport (RED-S)

IOC Consensus Statement, Mountjoy et al., 2014 and 2018, Int J Sport Nutr Exerc Metab.



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Negative Energy Balance and Hormone Changes

Tissue/Organ	Hormone/Compound	Expected Change
Adipocytes & Hypothalamus	Leptin	Decreased
Adrenal	Cortisol	Increased
Gastrointestinal Tract	Ghrelin	Increased
Liver	Plasma Glucose IGF-1[1] IGFBP-1[2]	Decreased Decreased Increased
Pancreas	Insulin	Decreased (Fasting) Increased (Eating)
Thyroid	Total T_3[3]	Decreased

(1) Insulin-like growth factor-1
(2) Insulin-like growth factor binding protein-1
(3) Triiodothyronine

Sources: Stafford DEJ. Treat Endocrinol 2005;4(3):147-154
Laughlin GA & Yen SSC. J Clin Endocrinol Metab. 1996; 81(12): 4301-9
Laucks AB et al. J Appl Physiol 1998; 84(1):37-46
Laucks AB & Callister R. J Appl Physiol 1993; 264: R924-30
Laucks AB & Heath EM. Am J Physiol 1994; 266: R817-23

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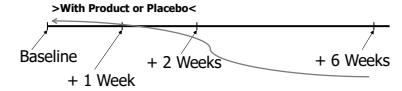
Snack Study

Benardot D, et al. Med Sci Sports Exer. 2005; 37(5): S339.



Measured at each assessment opportunity **(Results: Group provided calories)**

- Body composition (DEXA) — **Significantly lower body Fat %**
- IGF-I (Fasting) — **Higher trend (non-signif. p=.08)**
- POMS — **Significantly more vigorous**
- Performance (Wingate) — **Significantly better power & endurance**
- Diet and Energy Balance — **No change in calories (Wt Stable)**

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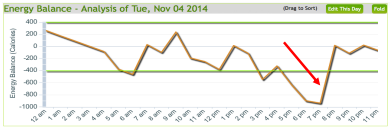
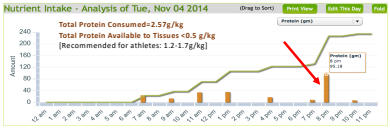
Humans and 'Energy First' Systems

Energy Balance Graph



Protein Intake Graph



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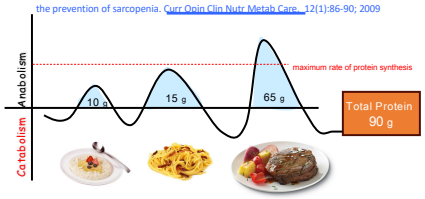
It's Not Just Eating Protein That Matters…It's How The Protein is Eaten!

Source: Paddon-Jones D, Rasmussen BB. Dietary protein recommendations and the prevention of sarcopenia. Curr Opin Clin Nutr Metab Care. 12(1):86-90; 2009



A skewed daily protein distribution fails to maximize potential for muscle growth

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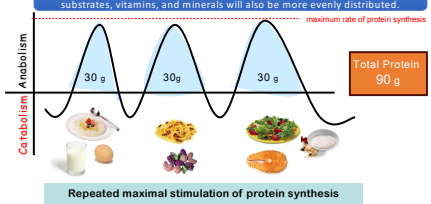
Optimizing Protein Consumption

- Optimal -

Source: Paddon-Jones et al., 2009

Evenly distributing energy intake increases the inevitability that energy substrates, vitamins, and minerals will also be more evenly distributed.



Repeated maximal stimulation of protein synthesis
→ increase / maintenance of muscle mass

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Plan for Recovery

Divers should have an immediately available recovery strategy

- When exercise training is completed, glycogen is at it's lowest point, and glycogen synthase is at its highest point
- Glycogen synthase stays at its peak for only a short time.
- Have the following available:
  - ~20-25 grams high quality protein (80 to 100 kcal from protein)
  - ~25 grams carbohydrate…sugar, bread, pasta all fine (100 kcal from carb)
  - 16 ounces of sports beverage
- ALL ABOVE SHOULD BE CONSUMED IMMEDIATELY AFTER EXERCISE/TRAINING

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Conclusion

Important Factors To Consider

PLAN a 'FOOD FIRST' approach to meeting needs rather than a pharmacological approach to nutrition.

- ***Divers should develop a frequent eating strategy with food that helps them obtain the needed energy and associated nutrients.***
- ***Optimize energy and hydration status before initiating exercise.***
- ***Divers must have a good strategy for fluid consumption during exercise to keep blood volume and blood constituents (i.e., glucose) normal.***
- ***Don't let the diver leave the exercise venue without providing them with appropriate recovery foods/beverages to optimize recovery.***

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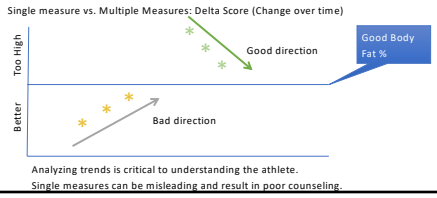
Conclusions

Data Tracking Invaluable for Developing Appropriate Nutrition Intervention



Analyzing trends is critical to understanding the athlete.
Single measures can be misleading and result in poor counseling.

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Summary

Old	New
Sport-associated tradition-based eating	Sport-associated science-based eating
Random food availability	Chronic food/beverage availability
Focus on 'weight' and nutrition strategies for getting to ideal.	Focus on 'weight' constituents, with nutrition strategies for optimizing body composition.
Meeting daily nutrient requirements	Satisfying nutrient requirements to optimize cellular utilization.
Meeting energy requirement on daily basis	Dynamically match energy expenditure and intake to avoid RED-S and large EB deficits
Focus on pre-game meal	Focus on total eating behavior, including pre-game, during-exercise, and recovery nutrition
Incorporation of 'strange' ergogenic aids of questionable value	Scientific use of non-banned ergogenic aids that are sport/activity specific.
No attention to special diet needs	Attention to special dietary needs

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Questions ?

Thank you! Merci!

Nutrition for Divers
Live stream with
Dan Benardot, PhD, DHC, RD, LD, FACSM
Professor, Center for the Study of Human Health
Emory University

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