**Formador:**

Prof.º Dr.º Rui Jorge

FORMAÇÃO (EAD)

# Nutrição e Suplementação no Exercício Físico

Prof.º Dr.º Rui Jorge

---

## Necessidades Energéticas

Necessidades Energéticas Totais

- Metabolismo basal (60 a 80% sedentários) (35 a 50% atletas)
- Dispêndio facultativo com a atividade física (muito variável)
- Termogénese induzida pelos alimentos (5-10%)



Necessidades Energéticas Totais

- **Metabolismo basal (60 a 80% sedentários) (35 a 50% atletas)**
- Dispêndio facultativo com a atividade física (muito variável)
- Termogénese induzida pelos alimentos (5-10%)

# Equação de Harris-Benedict (1919)

Homem:

M.B.= 66,47 + 13,75 x peso (kg) + 5 x estatura (cm) - 6,76 x idade (anos)

Mulher:

M.B.= 665,1 + 9,56 x peso (kg) + 1,85 x estatura (cm) - 4,68 x idade (anos)

- **Indica a taxa de metabolismo basal.**
- **Considera o sexo, idade, peso e estatura.**
- **Para obter as necessidades energéticas totais tem que se multiplicar pelo fator de atividade física adequado.**



# Equações de Schofield (1985)

| Homens | | |
|---|---|---|
| Idade (anos) | Metabolismo Basal (kcal) | Erro padrão (kcal) |
| 10-17 | 17,7 x Peso(kg) + 657 | 105 |
| 18-29 | 15,1 x Peso(kg) + 692 | 156 |
| 30-59 | 11,5 x Peso(kg) + 873 | 167 |

| Mulheres | | |
|---|---|---|
| Idade (anos) | Metabolismo Basal (kcal) | Erro padrão (kcal) |
| 10-17 | 13,4 x Peso(kg) + 692 | 112 |
| 18-29 | 14,8 x Peso(kg) + 487 | 120 |
| 30-59 | 8,3 x Peso(kg) + 846 | 112 |

# Equação de Mifflin-St.Jeor (1990)

Homem:

M.B.= 9,99 x peso(kg) + 6,25 x estatura (cm) – 4,92 x idade (anos) + 5

Mulher:

M.B.= 9,99 x peso(kg) + 6,25 x estatura (cm) – 4,92 x idade (anos) – 161

- **Indica a taxa de metabolismo basal.**
- **Considera o sexo, idade, peso e estatura.**
- **Para obter as necessidades energéticas totais tem que se multiplicar pelo fator de atividade física adequado.**



Qual a diferença do MB estimado para estes dois indivíduos usando as equações anteriores?


25% MG

31 anos; 1,75 m; 78 kg

9% MG

## Equações que consideram a massa isenta de gordura

### Katch and McArdle (1973)

M.B.= 370 + 21,6 x massa isenta de gordura (kg)

### Cunningham (1980)

M.B.= 500 + 22 x massa isenta de gordura (kg)

### Owen (1987)

Homem: M.B.= 290 + 22,3 x massa isenta de gordura (kg)



Necessidades Energéticas Totais

- Metabolismo basal (60 a 80% sedentários) (35 a 50% atletas)
- **Dispêndio facultativo com a atividade física (muito variável)**
- Termogénese induzida pelos alimentos (5-10%)

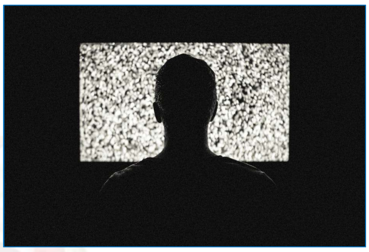
# Physical Activity Level (OMS, 1998)

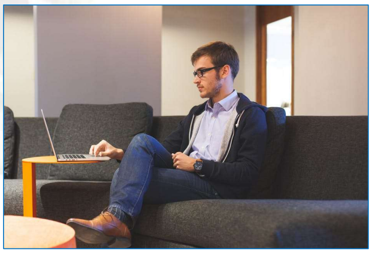
| PAL | Sexo: Fator |
|---|---|
| Sedentário | H: 1,40<br>M: 1,40 |
| Leve | H: 1,55<br>M: 1,56 |
| Moderado | H: 1,78<br>M: 1,64 |
| Intenso | H: 2,10<br>M: 1,82 |

Como determinar que valor utilizar?



# Como considerar os "comportamentos sedentários"?

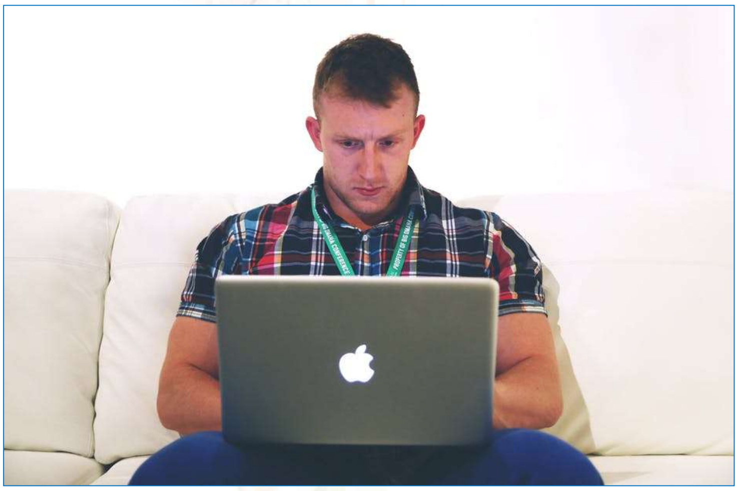




"Atividade na **posição sentada ou reclinada** realizadas pelo indivíduo, enquanto **acordado** e que envolve um **baixo dispêndio energético** (1-1,5 METs)"

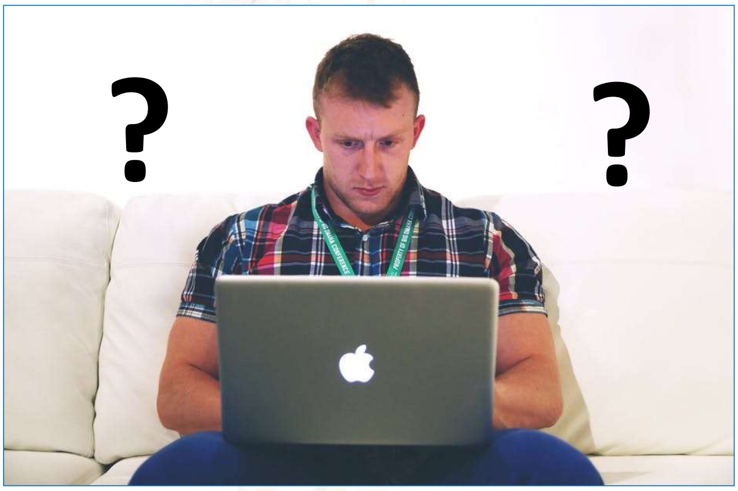
Ainsworth BE, et al. Compendium of physical activities: A second update of codes and MET values. Med Sci Sports Exerc. 2011

E os indivíduos "muito ativos" que passam a maior parte do dia em "comportamentos sedentários"?





Imaginem que estamos perante um indivíduo que **treina todos os dias 2 h**, mas **passa 10 a 12 h/dia sentado**



# Physical Activity Level (OMS, 1998)

| PAL | Sexo: Fator |
|---|---|
| Sedentário | H: 1,40<br>M: 1,40 |
| Leve | H: 1,55<br>M: 1,56 |
| Moderado | H: 1,78<br>M: 1,64 |
| Intenso | H: 2,10<br>M: 1,82 |

Que PAL escolhiam?



Há equações para "todos os gostos", situações e contextos.

E cada vez serão mais, é uma área de investigação que continua em desenvolvimento.

# IOM (2002) - Normoponderais

Homem:

EER = 662 – (9,53 x Idade) + [FA x (15,91 x Peso + 539,6 x Estatura)]

Mulher:

EER = 354 – (6,91 x Idade) + [FA x (9,36 x Peso + 726 x Estatura)]

Onde FA é o coeficiente de atividade física e é assim determinado:

Nível atividade física (NAF) para determinação do coeficiente de atividade física (FA), para faixa etária de 19 a 60 anos.

| Se o nível de atividade física (NAF) estimado for: | Coeficiente de atividade física (FA) Masculino | Feminino |
|---|---|---|
| 1,0 < 1,4 (Sedentário) | 1.00 | 1.00 |
| 1,4 < 1,6 (Atividade Leve) | 1.11 | 1.12 |
| 1,6 < 1,9 (Atividade Moderada) | 1.25 | 1.27 |
| 1,9 < 2,5 (Atividade Intensa) | 1.48 | 1.45 |

Idade: **anos**
Peso **kg**
Estatura: **m**



# IOM (2002) – Excesso de peso e obesidade

Homem:

EER = 864 – (9,72 x Idade) + [FA x (14,2 x Peso + 503 x Estatura)]

Mulher:

EER = 387 – (7,31 x Idade) + [FA x (10,9 x Peso + 660,7 x Estatura)]

Onde FA é o coeficiente de atividade física e é assim determinado:

Nível atividade física (NAF) para determinação do coeficiente de atividade física (FA), para faixa etária de 19 a 60 anos.

| Se o nível de atividade física (NAF) estimado for: | Coeficiente de atividade física (FA) Masculino | Feminino |
|---|---|---|
| 1,0 < 1,4 (Sedentário) | 1.00 | 1.00 |
| 1,4 < 1,6 (Atividade Leve) | 1.12 | 1.14 |
| 1,6 < 1,9 (Atividade Moderada) | 1.27 | 1.27 |
| 1,9 < 2,5 (Atividade Intensa) | 1.54 | 1.45 |

Idade: **anos**
Peso **kg**
Estatura: **m**

Physical activity (PA) is defined below.

| | |
|---|---|
| 1.0-1.39 | Sedentary, typical daily living activities (e.g., household tasks, walking to bus) |
| 1.4-1.59 | Low active, typical daily living activities plus 30-60 min of daily moderate activity (e.g., walking at 5-7 km/h) |
| 1.6-1.89 | Active, typical daily living activities plus 60 min of daily moderate activity |
| 1.9-2.5 | Very active, typical daily activities plus at least 60 min of daily moderate activity plus an additional 60 min of vigorous activity or 120 min of moderate activity. |

Onde FA é o coeficiente de atividade física e é assim determinado:

Nível atividade física (NAF) para determinação do coeficiente de atividade física (FA), para faixa etária de 19 a 60 anos.

| Se o nível de atividade física (NAF) estimado for: | Coeficiente de atividade física (FA) Masculino | Feminino |
|---|---|---|
| 1,0 < 1,4 (Sedentário) | 1.00 | 1.00 |
| 1,4 < 1,6 (Atividade Leve) | 1.11 | 1.12 |
| 1,6 < 1,9 (Atividade Moderada) | 1.25 | 1.27 |
| 1,9 < 2,5 (Atividade Intensa) | 1.48 | 1.45 |

?



## Qual o problema comum a todas as equações apresentadas até agora?

PAL 1,4 !? 31 anos; 1,75 m; 78 kg PAL 2,1 !?

## Será que este indivíduo é um sedentário com um PAL de 1,20 ou de 1,40?

ESPAP

Nutrição e Suplementação no Exercício Físico

Prof.º Dr.º Rui Jorge

## Será que este indivíduo tem um nível de atividade física de 1,9 ou de 2,5?

ESPAP

Nutrição e Suplementação no Exercício Físico

Prof.º Dr.º Rui Jorge

# MET (Metabolic Equivalent of Task)

| Atividade | MET |
|---|---|
| Dormir | 1 |
| Estar sentado | 1,3 |
| Corrida a 8 km/h | 8,3 |
| Estar em pé a ler | 1,8 |
| Comer sentado | 1,5 |

**Como utilizar?**

Tabela completa em: http://download.lww.com/wolterskluwer_vitalstream_com/PermaLink/MSS/A/MSS_43_8_2011_06_13_AINSWORTH_202093_SDC1.pdf



Metabolic Equivalents (METS) in Exercise Testing, Exercise Prescription, and Evaluation of Functional Capacity

M. Jetté, K. Sidney,* G. Blümchen†

Department of Kinanthropology, School of Human Kinetics, University of Ottawa, Ottawa, Canada; *Present affiliation: Laurentian University, Sudbury, Ontario, Canada †Klinik Roderbirken, Leichlingen, Federal Republic of Germany

**Definition**

A MET is defined as the resting metabolic rate, that is, the amount of oxygen consumed at rest, sitting quietly in a chair, approximately 3.5 ml $O_2$/kg/min (1.2 kcal/min for a 70-kg person).

Cada litro de $O_2$ consumido corresponde a uma produção energética entre 4,7 a 5 kcal (média **4,85 kcal**) ⟶ **4,85 kcal/L**

Assim, um homem de **70 kg** ao consumir **3,5 ml $O_2$/kg/min** vai consumir um total de 0,245 L de $O_2$/min, logo ≈**1,2 kcal/min** que são **72 kcal/hora** ou **1728 kcal/dia** (TBM média considerada para um indivíduo com 70 kg).

Energia gasta com uma atividade (e.g. homem de **70 kg** correr **4 km em meia hora** a ritmo constante):

**MET** da atividade **correr a 8 km/h é 8,3**

Se em repouso consome **3,5 ml de $O_2$/kg/min**, nesta atividade gasta 8,3 vezes mais, logo, **8,3 (METs) x 3,5 (ml $O_2$) x 70 (kg) x 4,85 / 1000 = 9,86 kcal/min** que durante 30 min correspondem a **295,8 kcal**.

**kcal/min** = METs x 3,5 x peso (kg) x 4,85/1000

ou

**kcal/min** = METs x 3,5 x peso (kg)/206 (aproximadamente igual a multiplicar por 4,85 e dividir por 1000)



Exemplo:

Individuo de 78 kg numa bicicleta estática a pedalar a uma potência de 235 watts durante 15 minutos?

-Quantos METs tem a atividade?

**14,0 METs** (valor tabelado)

-Qual o valor energético gasto nessa atividade?

14 x 3,5 x 78 x 4,85 /1000 x 15 = **278 kcal**

-Qual o volume relativo de $O_2$ consumido nessa atividade?

14 x 3,5 = **49 ml $O_2$/kg/min**

-Qual o volume absoluto de $O_2$ consumido nessa atividade?

49 x 78 / 1000 = **3,822 L $O_2$/min**

3,8 x 15 = **57,33 L $O_2$** (57,33 L de $O_2$ x 4,85 = 278 kcal)

# MET (Metabolic Equivalent of Task)

| Atividade | MET |
|---|---|
| Dormir | 1 |
| Estar sentado | 1,3 |
| Corrida a 8 km/h | 8,3 |
| Estar em pé a ler | 1,8 |
| Comer sentado | 1,5 |

**Como fazer?**

Tabela completa em: http://download.lww.com/wolterskluwer_vitalstream_com/PermaLink/MSS/A/MSS_43_8_2011_06_13_AINSWORTH_202093_SDC1.pdf



**2011 Compendium of Physical Activities: A Second Update of Codes and MET Values**

BARBARA E. AINSWORTH[1,2], WILLIAM L. HASKELL[3], STEPHEN D. HERRMANN[1,2], NATHANAEL MECKES[1,2], DAVID R. BASSETT JR.[4], CATRINE TUDOR-LOCKE[5], JENNIFER L. GREER[1,2], JESSE VEZINA[1,2], MELICIA C. WHITT-GLOVER[6], and ARTHUR S. LEON[7]

| | | |
|---|---|---|
| 5.0 | sports | rock climbing, rappelling |
| 4.0 | sports | rodeo sports, general, light effort |
| 5.5 | sports | rodeo sports, general, moderate effort |
| 7.0 | sports | rodeo sports, general, vigorous effort |
| 12.3 | sports | rope jumping, fast pace, 120-160 skips/min |
| 11.8 | sports | rope jumping, moderate pace, 100-120 skips/min, general, 2 foot skip, plain bounce |
| 8.8 | sports | rope jumping, slow pace, < 100 skips/min, 2 foot skip, rhythm bounce |
| 8.3 | sports | rugby, union, team, competitive |
| 6.3 | sports | rugby, touch, non-competitive |
| 3.0 | sports | shuffleboard |
| 5.0 | sports | skateboarding, general, moderate effort |
| 6.0 | sports | skateboarding, competitive, vigorous effort |

| Horas | MET | Atividade |
|---|---|---|
| 1 | 1 | Dormir |
| 2 | 1 | Dormir |
| 3 | 1 | Dormir |
| 4 | 1 | Dormir |
| 5 | 1 | Dormir |
| 6 | 1 | Dormir |
| 7 | 1 | Dormir |
| 8 | 2,5 | Conduzir |
| 9 | 2,5 | Conduzir |
| 10 | 1,3 | Estar sentado |
| 11 | 1,3 | Estar sentado |
| 12 | 1,3 | Estar sentado |
| 13 | 1,3 | Estar sentado |
| 14 | 1,3 | Estar sentado |
| 15 | 1,3 | Estar sentado |
| 16 | 1,3 | Estar sentado |
| 17 | 1,3 | Estar sentado |
| 18 | 1,3 | Estar sentado |
| 19 | 2,5 | Conduzir |
| 20 | 2,5 | Conduzir |
| 21 | 10 | Jogar futebol |
| 22 | 1 | Dormir |
| 23 | 1 | Dormir |
| 24 | 1 | Dormir |
| | **1,74** | PAL |

## TABLE D-3. Approximate Energy Requirements in METs for Horizontal and Grade Walking

| % Grade | mi·h⁻¹ → | 1.7 | 2.0 | 2.5 | 3.0 | 3.4 | 3.75 |
|---|---|---|---|---|---|---|---|
| | m·min⁻¹ → | 45.6 | 53.6 | 67.0 | 80.4 | 91.2 | 100.5 |
| 0 | | 2.3 | 2.5 | 2.9 | 3.3 | 3.6 | 3.9 |
| 2.5 | | 2.9 | 3.2 | 3.8 | 4.3 | 4.8 | 5.2 |
| 5.0 | | 3.5 | 3.9 | 4.6 | 5.4 | 5.9 | 6.5 |
| 7.5 | | 4.1 | 4.6 | 5.5 | 6.4 | 7.1 | 7.8 |
| 10.0 | | 4.6 | 5.3 | 6.3 | 7.4 | 8.3 | 9.1 |
| 12.5 | | 5.2 | 6.0 | 7.2 | 8.5 | 9.5 | 10.4 |
| 15.0 | | 5.8 | 6.6 | 8.1 | 9.5 | 10.6 | 11.7 |
| 17.5 | | 6.4 | 7.3 | 8.9 | 10.5 | 11.8 | 12.9 |
| 20.0 | | 7.0 | 8.0 | 9.8 | 11.6 | 13.0 | 14.2 |
| 22.5 | | 7.6 | 8.7 | 10.6 | 12.6 | 14.2 | 15.5 |
| 25.0 | | 8.2 | 9.4 | 11.5 | 13.6 | 15.3 | 16.8 |



## TABLE D-4. Approximate Energy Requirements in METs for Horizontal and Uphill Jogging/Running

| % Grade | mi·h⁻¹ → | 5 | 6 | 7 | 7.5 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|
| | m·min⁻¹ → | 134 | 161 | 188 | 201 | 214 | 241 | 268 |
| 0 | | 8.6 | 10.2 | 11.7 | 12.5 | 13.3 | 14.8 | 16.3 |
| 2.5 | | 9.5 | 11.2 | 12.9 | 13.8 | 14.7 | 16.3 | 18.0 |
| 5.0 | | 10.3 | 12.3 | 14.1 | 15.1 | 16.1 | 17.9 | 19.7 |
| 7.5 | | 11.2 | 13.3 | 15.3 | 16.4 | 17.4 | 19.4 | |
| 10.0 | | 12.0 | 14.3 | 16.5 | 17.7 | 18.8 | | |
| 12.5 | | 12.9 | 15.4 | 17.7 | 19.0 | | | |
| 15.0 | | 13.8 | 16.4 | 18.9 | | | | |

## Então mas depois de isto tudo qual a equação ideal?

Dependerá de diversos fatores:

- **Características do indivíduo** (sedentário, atleta, com obesidade, etc.);
- **Objetivos do indivíduo** (perda de peso, aumento da massa muscular, performance, etc.)
- **Validações disponíveis para as diferentes situações** (área em desenvolvimento e constante atualização);
- **Dados disponíveis e passíveis de serem obtidos** (MIG; PAL);
- **Material de suporte** (computador, folhas de cálculo, calculadora, etc.);
- **Tempo disponível** (do profissional e do cliente!).

IEPAP Nutrição e Suplementação no Exercício Físico Prof.º Dr.º Rui Jorge

## Então mas qual a equação que devo usar em atletas?????

IEPAP Nutrição e Suplementação no Exercício Físico Prof.º Dr.º Rui Jorge

OPEN ACCESS Freely available online PLOS ONE

# Resting Energy Expenditure Prediction in Recreational Athletes of 18–35 Years: Confirmation of Cunningham Equation and an Improved Weight-Based Alternative

**Twan ten Haaf**[1], **Peter J. M. Weijs**[1,2,3]*

1 Department of Nutrition & Dietetics, School of Sports and Nutrition, Amsterdam University of Applied Sciences, Amsterdam, The Netherlands, 2 Department of Nutrition & Dietetics, Internal Medicine, VU University Medical Center, Amsterdam, The Netherlands, 3 EMGO+ Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands

**Abstract**

***Introduction:*** Resting energy expenditure (REE) is expected to be higher in athletes because of their relatively high fat free mass (FFM). Therefore, REE predictive equation for recreational athletes may be required. The aim of this study was to

Cunningham (1980)

T. M. B. = 500 + 22 x massa isenta de gordura (kg)

X

Physical Activity Level

Cunningham equation. Since body composition measurement is not always possible, and other generally used equations fail, the new weight-based equation is advised for use in sports nutrition.

**Citation:** ten Haaf T, Weijs PJM (2014) Resting Energy Expenditure Prediction in Recreational Athletes of 18–35 Years: Confirmation of Cunningham Equation and an Improved Weight-Based Alternative. PLoS ONE 9(10): e108460. doi:10.1371/journal.pone.0108460

OPEN ACCESS Freely available online PLOS ONE

# Resting Energy Expenditure Prediction in Recreational Athletes of 18–35 Years: Confirmation of Cunningham Equation and an Improved Weight-Based Alternative

**Twan ten Haaf**[1], **Peter J. M. Weijs**[1,2,3]*

1 Department of Nutrition & Dietetics, School of Sports and Nutrition, Amsterdam University of Applied Sciences, Amsterdam, The Netherlands, 2 Department of Nutrition & Dietetics, Internal Medicine, VU University Medical Center, Amsterdam, The Netherlands, 3 EMGO+ Institute for Health and Care Research, VU University Medical Center, Amsterdam, The Netherlands

**Abstract**

***Introduction:*** Resting energy expenditure (REE) is expected to be higher in athletes because of their relatively high fat free mass (FFM). Therefore, REE predictive equation for recreational athletes may be required. The aim of this study was to validate existing REE predictive equations and to develop a new recreational athlete specific equation.

***Methods:*** 90 (53M, 37F) adult athletes, exercising on average 9.1±5.0 hours a week and 5.0±1.8 times a week, were included. REE was measured using indirect calorimetry (Vmax Encore n29), FFM and FM were measured using air displacement plethysmography. Multiple linear regression analysis was used to develop a new FFM-based and weight-based REE predictive equation. The percentage accurate predictions (within 10% of measured REE), percentage bias, root mean square error and limits of agreement were calculated.

***Results:*** The Cunningham equation and the new weight-based equation $REE(kJ/d) = 49.940 * weight(kg) + 2459.053 * height(m) - 34.014 * age(y) + 799.257 * sex(M=1, F=0) + 122.502$ and the new FFM-based equation $REE(kJ/d) = 95.272 * FFM(kg) + 2026.161$ performed equally well. De Lorenzo's equation predicted REE less accurate, but better than the other generally used REE predictive equations. Harris-Benedict, WHO, Schofield, Mifflin and Owen all showed less than 50% accuracy.

***Conclusion:*** For a population of (Dutch) recreational athletes, the REE can accurately be predicted with the existing Cunningham equation. Since body composition measurement is not always possible, and other generally used equations fail, the new weight-based equation is advised for use in sports nutrition.

**Citation:** ten Haaf T, Weijs PJM (2014) Resting Energy Expenditure Prediction in Recreational Athletes of 18–35 Years: Confirmation of Cunningham Equation and an Improved Weight-Based Alternative. PLoS ONE 9(10): e108460. doi:10.1371/journal.pone.0108460

# Exemplos de boas opções:

Cunningham x PAL;

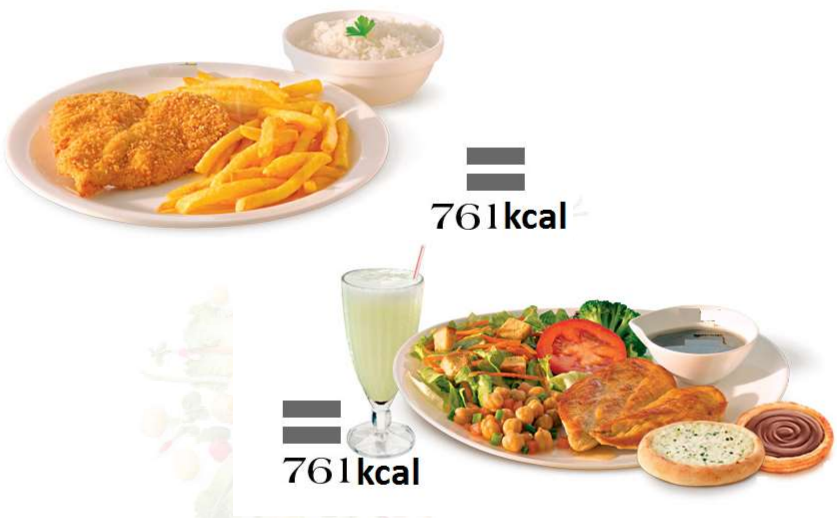
ten Haaf x PAL (com ou sem informação sobre MIG);

-Cálculo do PAL através dos METs médios diários/semanais ajustados às 24h.

Não esquecer que independentemente da equação/método escolhido, o **valor obtido é estimado**. A exatidão dos resultados dependerá da **precisão com que a composição corporal e a atividade física são avaliadas (e reportada no caso da AF)**, das fórmulas em si e do rigor ao efetuar os **cálculos**.



# Importância relativa da energia…



# Necessidades Nutricionais



## Alguns valores de referência para os HC

| Macronutrient | IOM[1] (2002) | EFSA[2] (2017) | WHO[3] (2003) | ATP[4] (2013) |
|---|---|---|---|---|
| **Carbohydrates** | 45 a 65%* | 45 a 60%* | 55 a 75%* | 50 a 60%* |

[1] Institute of Medicine
[2] European Food Safety Authority
[3] World Health Organization
[4] Adult Treatment Panel
* of the Estimated Energy Requirement

## Algumas funções dos HC


Adaptado de Minderico C. Nutrição Treino e Competição. IPDJ, 2016



**TABLE 2.1 Body Stores of Fuels and Associated Energy Availability**

| Location | g | kcal |
|---|---|---|
| **CARBOHYDRATES** | | |
| Liver glycogen | 110 | 451 |
| Muscle glycogen | 500 | 2,050 |
| Glucose in body fluids | 15 | 62 |

*Note*. These estimates are based on a body weight of 65 kg (143 lb) with 12% body fat.

Kenney, W.L., J. Wilmore, and D. Costill, *Physiology of Sport and Exercise*. 6th ed. 2015, United States of America: Human Kinetics Publishers.

## Comparação das reservas de glicogénio e glicose entre um indivíduo sedentário e um atleta

| Indivíduo | Sedentário de 60 kg com 40% MM | | Atleta de 60 kg 50% de MM | |
|---|---|---|---|---|
| Valores de referência para reservas de glicogénio muscular | 10-20 gr/kg MM *(15 para este exemplo)* | | 30-45gr/Kg MM *(35 para este exemplo)* | |
| | Gramas | Kcal | Gramas | Kcal |
| Músculo (Glicogénio exclusivo) | 360 | 1440 | 1050 | 4200 |
| Fígado (Glicogénio universal) | 100 | 400 | 200 | 800 |
| Glicemia sanguínea | 15-20 | 60 | 15-20 | 60 |
| Total | 480 | 1900 | 1270 | 5060 |

Cortesia Michelle Castro



E se treinarmos com baixas reservas de glicogénio?

**Teremos que recorrer mais à gordura como substrato energético, certo?**

**Sim, mas…**

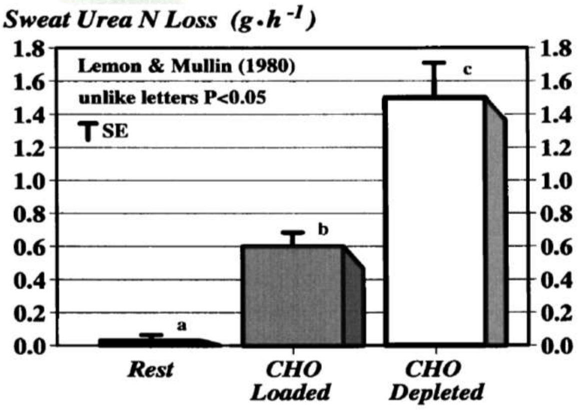



**Fig. 2.** Nitrogen excretion increases with prolonged, moderately intense exercise and especially so when carbohydrate stores are low. (Adapted from [17].)

*Lemon PWR. J Am Coll Nutr. 2000;19(sup5):513S–521S.*



E será que é saudável comer alimentos com hidratos de carbono?

*Review*

# Adherence to Mediterranean Diet and Risk of Cancer: An Updated Systematic Review and Meta-Analysis

Lukas Schwingshackl [1,*], Carolina Schwedhelm [1], Cecilia Galbete [2] and Georg Hoffmann [3]

*Nutrients* **2017**, *9*, 1063; doi:10.3390/nu9101063

| Study or Subgroup | Risk Ratio IV, Random, 95% CI |
|---|---|
| Alcohol (in the range) | 0.89 [0.85, 0.93] |
| Cereals | 1.00 [0.95, 1.05] |
| Dairy | 0.94 [0.87, 1.01] |
| Fish | 0.97 [0.95, 1.00] |
| Fruit | 0.93 [0.89, 0.97] |
| Legumes | 0.97 [0.93, 1.02] |
| Meat | 1.04 [0.98, 1.11] |
| Nuts | 0.97 [0.93, 1.01] |
| Olive oil | 1.00 [0.95, 1.05] |
| Vegetables | 0.96 [0.93, 0.98] |
| Whole grains | 0.91 [0.87, 0.95] |

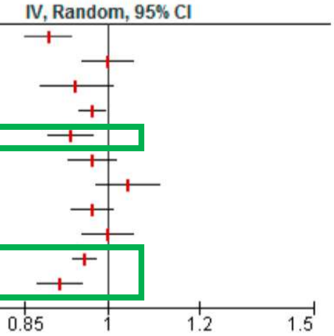



**Figure 1.** Pooled risk ratios of individual Mediterranean diet components and overall cancer risk.

# Os hidratos de carbono não são todos iguais

≠

As necessidade de HC de um indivíduo fisicamente ativo são distintas de alguém sedentário.

As necessidades em hidratos de carbono são distintas para atletas de diferentes modalidades desportivas e até com diferentes particularidades dentro de cada modalidade.



# Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance

March 2016 Volume 116 Number 3 JOURNAL OF THE ACADEMY OF NUTRITION AND DIETETICS

| | | |
|---|---|---|
| Light | • Low intensity or skill-based activities | 3-5 g/kg of athlete's body weight/d |
| Moderate | • Moderate exercise program (eg, ~1 h/d) | 5-7 g/kg/d |
| High | • Endurance program (eg, 1-3 h/d moderate to high-intensity exercise) | 6-10 g/kg/d |
| Very high | • Extreme commitment (eg, >4-5 h/d moderate to high-intensity exercise) | 8-12 g/kg/d |

- Timing of intake of carbohydrate over the day may be manipulated to promote high carbohydrate availability for a specific session by consuming carbohydrate before or during the session, or during recovery from a previous session
- Otherwise, as long as total fuel needs are provided, the pattern of intake may simply be guided by convenience and individual choice
- Athletes should choose nutrient-rich carbohydrate sources to allow overall nutrient needs to be met

# Adequado Aporte de HC

- **Importância dos HC no exercício físico:**
  - Poupam proteínas: se houver reservas de glicogénio muscular (substrato energético) há redução da neoglucogénese a partir de aminoácidos;
  - Permitem treinos mais intensos;
  - Contribuem para o aumento da insulina, que estimula o anabolismo proteico.



# Exigências Metabólicas de Diferentes Modalidades

| | Exigência metabólica principal | | |
|---|---|---|---|
| Desporto | Sistema fosfagénio | Glicólise anaeróbia | Metabolismo aeróbio |
| Basquetebol | Alta | Moderada a alta | |
| Boxe | Alta | Alta | |
| Futebol | Alta | Moderada | Alta |
| Ténis | Alta | | |
| Voleibol | Alta | Moderada | |
| Weightlifting | Alta | | |

Adaptado de Kraemer, W.J. (2000) Physiological adaptations to anaerobic and aerobic endurance training programs, in *Essentials of Strenght Training and Conditioning* Baechle, T.R. and Earle, R.W. (Editors), Champaign: Human Kinetics.

| | |
|---|---|
| 100 metros | Sistema ATP-CP |
| 400 metros | Glicólise anaeróbia |
| Maratona | Sistema oxidativo |

Cortesia Michelle Castro

NATURE METABOLISM | VOL 2 | SEPTEMBER 2020 | 817–828

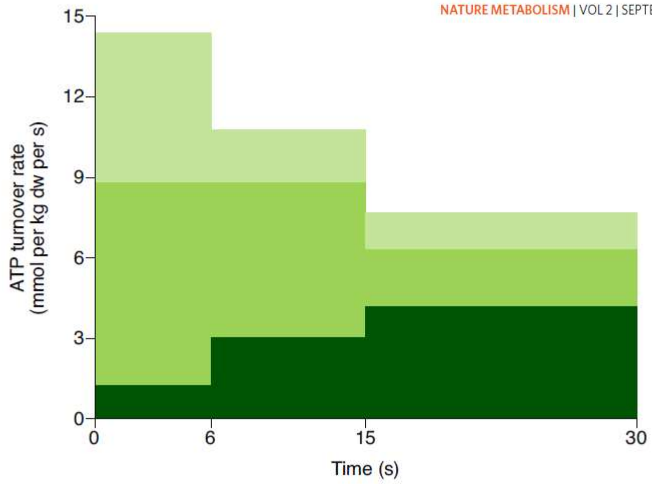
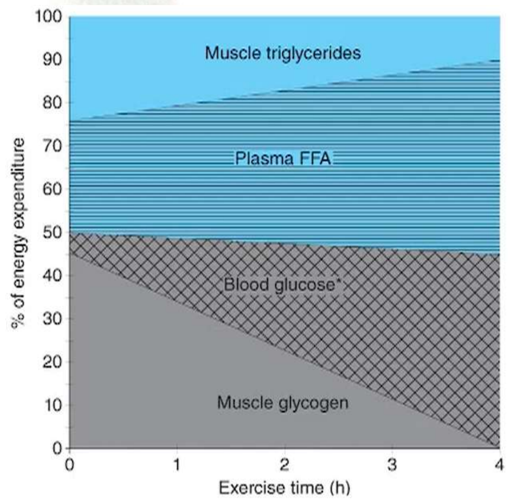



**Fig. 1 | Muscle energy metabolism during intense exercise.** Contributions of PCr (light green), glycolysis (medium green) and oxidative phosphorylation (dark green) to ATP turnover during maximal exercise. Muscle samples were obtained before and during 30 s of all-out cycling exercise. Dw, dry weight. Adapted with permission from ref. [4], American Physiological Society.



## Catabolismo de Glicogénio

- **Glicogénio hepático** – reserva ”universal”;
- **Glicogénio muscular** é apenas utilizável pelo próprio músculo;
- Quanto mais tempo dura a sessão de exercício maior é a preponderância dos hidratos de carbono provenientes da alimentação.






## Consequências de uma baixa ingestão de HC em Atletas com elevados exigências de Treino

- **Fadiga precoce durante os treinos**
- **Dificuldade de concentração**
- **Falta de motivação para treinar**
- **Irritabilidade**
- **Dificuldade em recuperar entre sessões de treino**
- **Perdas de massa isenta de gordura**
- **Menor nível de hidratação intramuscular**
- **Menor imunocompetência**

→ **Treinos menos intensos/eficazes**

↓

**Menos progressos na performance!**

***Lanham-New S, et al; 2013***

***Preexercise Meals***

In general, preexercise meals should be consumed 3 to 4 hours before exercise. Meals should contain between 1 to 4 g CHO/kg or 0.5 to 2 g CHO/lb of body mass (19) (*e.g.*, whole grains, cereals, pasta, rice, potatoes, vegetables, fruit), moderate protein (*e.g.*, chicken, tofu, fish, low fat dairy, eggs), and some fat (*e.g.*, olive



The closer to the start of exercise, the smaller the meal should be. Individuals may benefit from consuming CHO such as fresh fruit or fruit compote; half a bagel with a little almond or peanut butter and jam; cereal with milk and fruit; a CHO sports bar; or 8 oz of a sport drink (≤1 hour before exercise). Although consuming CHO in the hour before exercise can result in hyperglycemia (*e.g.*, high blood glucose), often followed by a rapid decrease in blood glucose concentration (also called rebound hypoglycemia) at the onset of exercise, these metabolic challenges show no negative performance impact (10). Additionally, research has shown that consuming a small snack or drinking a sport drink before the exercise session may be a good approach to aid with glucose delivery to both muscle and the brain, especially if the last meal was consumed more than 3 to 4 hours before exercise or if clients are hungry or tired.

The closer to the start of exercise, the smaller the meal should be.
Individuals may benefit from consuming CHO such as fresh fruit or
fru[illegible]
ja[illegible]
dr[illegible]
ho[illegible]
gl[illegible]
ce[illegible]
ci[illegible]
im[illegible]
sm[illegible]
may be a good approach to aid with glucose delivery to both muscle and the brain, especially if the last meal was consumed more than 3 to 4 hours before exercise or if clients are hungry or tired.

- **Quanto mais próximo do treino, menor deverá ser a refeição;**
- **Se sentir fome ou cansaço, uma pequena refeição de fácil digestão com HC é uma opção.**



Programa Nacional para a Promoção da Alimentação Saudável
Nutrição no Desporto, 2016

Antes

1–4h antes do exercício
1–4g hidratos de carbono/kg peso corporal

Adaptado de Jeukendrup 2014

| "Timing" Treino | "Timing" Específico | Características Nutricionais | Notas Importantes |
|---|---|---|---|
| Antes do treino | 3 a 4 horas antes | 1-2 g de HC/kg de Peso Corporal<br>+<br>0,15-0,25 g de Proteína/kg de Peso Corporal<br>+<br>≈ 5–7 mL de água/kg de peso corporal | - Refeição com alimentos e/ou bebidas ricos em HC, com baixo teor de gordura e de fibra, e com conteúdo moderado em proteína de forma a evitar problemas gastrointestinais.<br>- O conteúdo destas refeições deve ser adaptado a cada situação (p.e. intensidade e duração do treino) e melhorado consoante experiências feitas.<br>- Em relação a água, é recomendada a ingestão de aproximadamente 5–7 mL/kg de peso corporal pelo menos 4h antes do exercício e, se o individuo não produz urina ou esta é escura ou muito concentrada, deverão ser ingeridos aproximadamente 3–5 mL/kg adicionais cerca de 2h antes. |
| | 1 a 2 horas antes | 1-2 g de HC/kg de Peso Corporal<br>+<br>≈ 3–5 mL de água/kg de peso corporal | - Quanto mais próximo se está da hora de treino, maior cuidado se deve ter em relação ao conteúdo das refeições, passando a ser, essencialmente, à base de alimentos e/ou bebidas ricos em HC.<br>- A refeição antes do exercício poderá ser perto do início (<10-15 minutos) ou durante o aquecimento. |

Castro M. & Jorge R. Nutrição e Suplementação *in* Manual do Técnico de Exercício. 2022
*Adaptado de Kerksick et al, 2008, Thomas et al, 2016, Graça et al, 2016, Sawka et al, 2007, Rodiguez et al, 2009)*



## FUELING DURING EXERCISE

CHO intake during exercise has been shown to maintain energy levels and improve exercise capacity and performance of endurance and intermittent type sports (for reviews, see Karelis *et al.* (11), Phillips *et al.* (18), and Temesi *et al.* (24)). CHO supplementation during prolonged exercise serves to reduce mental fatigue and maintains CHO oxidation rates (*e.g.*, the ability of the muscle to burn CHO), especially late during exercise. These two issues are critical to prevent the famous "bonking" or "hitting the wall," and therefore, CHO supplementation helps to maintain blood glucose concentration and exercise intensity and, thus, delays the onset of fatigue. Therefore, CHO supplementation during exercise may make the overall physical task more enjoyable and do so with less strain to both body and mind. However, CHO supplementation during exercise may not be suitable for everyone. In fact, there is little benefit to using CHO for a low intensity, 45- to 60-minute exercise bout, such as a cardio session in the gym, especially if incorporated for weight management. For activities exceeding 1 hour, CHO supplementation may be recommended.

## FUELING DURING EXERCISE

CHO intake during exercise has been shown to maintain energy levels and improve exercise capacity and performance of endurance and intermittent type sports (for reviews, see Karelis *et al.* (11), ...n

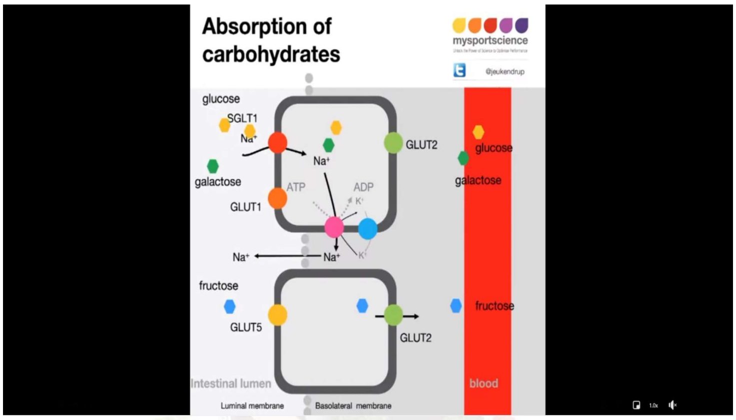
**•O aporte de HC durante o exercício ajuda a manter os níveis de energia e melhora a performance (em treinos/provas de maior duração: + de 60 min);**

**•Evita a chegada a um ponto de fadiga total e torna mais agradável a prática da atividade.**

...to 60-minute exercise bout, such as a cardio session in the gym, especially if incorporated for weight management. For activities exceeding 1 hour, CHO supplementation may be recommended.



| Duration of exercise | Amount of carbohydrate needed | Recommended type of carbohydrate | Additional recommendation |
|---|---|---|---|
| 30–75 minutes | Small amounts or mouth rinse | Single or multiple transportable carbohydrates | Nutritional training recommended |
| 1–2 hours | 30 g/hour | Single or multiple transportable carbohydrates | Nutritional training recommended |
| 2–3 hours | 60 g/hour | Single or multiple transportable carbohydrates | Nutritional training highly recommended |
| > 2.5 hours | 90 g/hour | **ONLY multiple transportable** carbohydrates | Nutritional training essential |




- Os cotransportadores de glucose dependentes do sódio (SGLT1) **saturam** com um **aporte superior a 60 g de glucose por hora**.
- Usando também **frutose** é possível **aumentar entre 50% a 75%** a chegada de hidratos de carbono ao sangue (num rácio de 2:1).

**E porque não usar a galactose?**



## Via de Leloir

Após entrada no <u>enterócito</u>:

-Transportada para o sangue através dos **GLUT2**

No <u>fígado</u>:

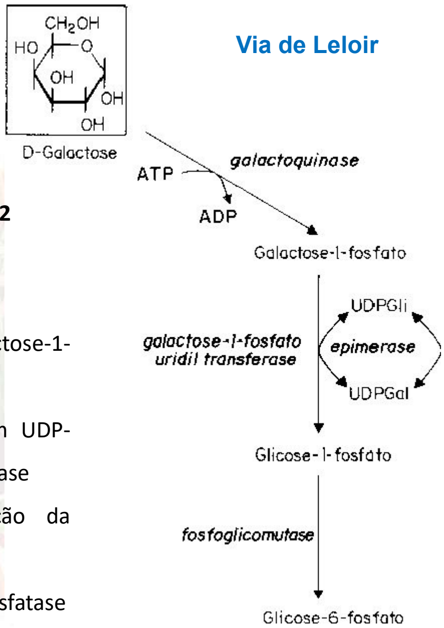
-Fosforilada no carbono 1 pela galactoquinase;

-Forma-se a UDP-galactose pela ação da galactose-1-fosfato uridil transferase;

-Dá-se a isomerização da UDP-galactose em UDP-glicose catalisada pela UDPgalactose-4-epimerase

-Formação de glucose-6 fosfato pela ação da fosfoglicomutase

-Formação de **glucose** por ação da glicose-6-fosfatase



Entre 6 a 8% de hidratos de carbono numa bebida desportiva parece ser a concentração que mais favorece a performance física!

O'Connell SM, Woodman RJ, Brown IL, Vincent DJ, Binder HJ, Ramakrishna BS, Young GP. Comparison of a sports-hydration drink containing high amylose starch with usual hydration practice in Australian rules footballers during intense summer training. J Int Soc Sports Nutr. 2018 Sep 21;15(1):46. doi: 10.1186/s12970-018-0253-8

Orrù S, Imperlini E, Nigro E, Alfieri A, Cevenini A, Polito R, Daniele A, Buono P, Mancini A. Role of Functional Beverages on Sport Performance and Recovery. Nutrients. 2018 Oct 10;10(10):1470. doi: 10.3390/nu10101470

Murray R, Bartoli W, Stofan J, Horn M, Eddy D. A comparison of the gastric emptying characteristics of selected sports drinks. Int J Sport Nutr. 1999 Sep;9(3):263-74. doi: 10.1123/ijsn.9.3.263



É fundamental que as reservas de HC sejam restabelecidas diariamente, pois os HC são um fator limitante para a atividade física!

Burke, L.M., et al., *Carbohydrates for training and competition. Journal of Sports Sciences, 2011.* ***29(SUPPL. 1): p. S17-S27.***

## FUELING AFTER EXERCISE

### *Carbohydrate*

The window for optimal recovery of muscle energy (glycogen) stores ranges from 30 minutes to 4 hours after exercise. The earlier CHO is ingested within this window, the faster glycogen (energy) stores are replenished. To fully replenish glycogen stores (*e.g.*, after a marathon, soccer match, or heavy 2-hour lifting protocol), 24 hours are needed generally (3). Thus, immediate CHO intake is important especially for those exercising multiple times per day or engaging in high-intensity or prolonged exercise. These individuals should aim at ingesting approximately 1 to 1.2 g CHO/kg/h (~0.4 to 0.5 g/lb/h; see Table 1 for CHO content). This means that recovery occurs over a period of several hours, starting with initial recovery within the first 30 minutes after exercise and repeatedly for up to 4 hours (3,26). For most recreational exercisers, the timing and amount of CHO intake is not as critical, as long as a meal is consumed within a reasonable time frame after exercise.



## FUELING AFTER EXERCISE

### *Carbohydrate*

**•A ressíntese de glicogénio muscular aparenta ser mais eficiente entre 30 a 240 min após o exercício.**

**•Para a maioria das pessoas que faz atividade física recreativamente não é essencial a reposição de HC logo após o treino. Devemos avaliar caso a caso (ex. perda de peso).**

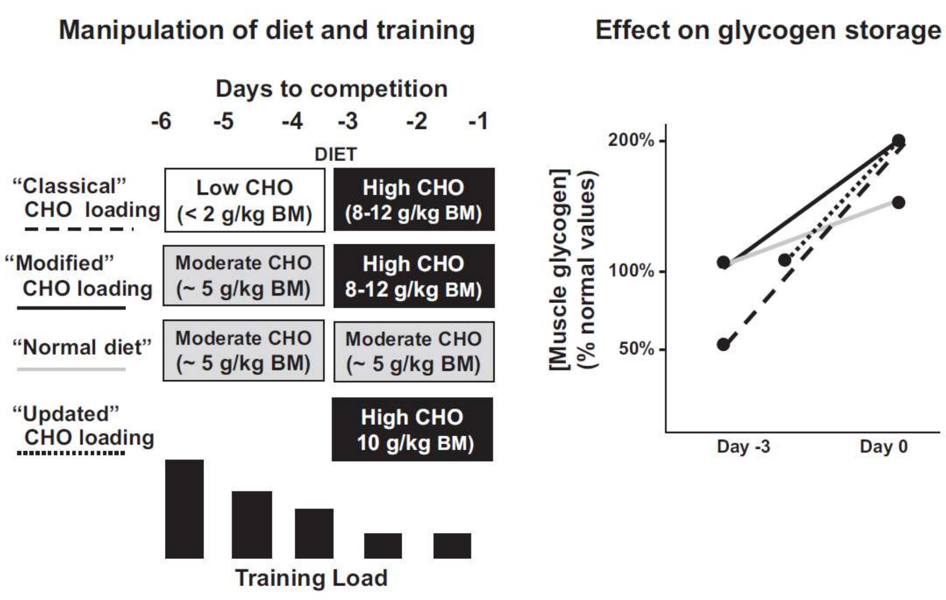
ing with initial recovery within the first 30 minutes after exercise and repeatedly for up to 4 hours (3,26). For most recreational exercisers, the timing and amount of CHO intake is not as critical, as long as a meal is consumed within a reasonable time frame after exercise.

| "Timing" Treino | "Timing" Específico | Características Nutricionais | Notas Importantes |
|---|---|---|---|
| Depois do treino | Iniciar refeições pós-treino até 30 minutos depois e repetir ao longo de 4h depois | 1,2 g de HC/kg de Peso Corporal/h OU 0,8 g de HC/kg de Peso Corporal/h + 0,24 g de Proteína/kg de Peso Corporal/h | - A ingestão combinada de proteínas e HC permite aumentar a eficiência do armazenamento do glicogénio muscular quando a quantidade de HC ingerida é abaixo do limiar mínimo para maximizar a recuperação de glicogénio (1,2g/kg/hora).<br>- Quando o intervalo entre sessões de treino é curto (inferior a 8h), o praticante de exercício deve maximizar o tempo de recuperação iniciando a ingestão de HC o mais rapidamente possível, prolongando-se por 4h, divididos por pequenas refeições de hora a hora.<br>- Quando os períodos de recuperação entre treinos são maiores, a principal preocupação deve ser atingir a quantidade total diária em HC. |

Castro M. & Jorge R. Nutrição e Suplementação *in* Manual do Técnico de Exercício. 2022

*Adaptado de Kerksick et al, 2008, Thomas et al, 2016, Graça et al, 2016, Sawka et al, 2007, Rodiguez et al, 2009)*








*J Appl Physiol* 122: 1055–1067, 2017

## Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance

March 2016 Volume 116 Number 3 JOURNAL OF THE ACADEMY OF NUTRITION AND DIETETICS

**Acute fueling strategies** — These guidelines promote high carbohydrate availability to promote optimal performance during competition or key training sessions

| | | | |
|---|---|---|---|
| General fueling up | • Preparation for events <90 min exercise | 7-12 g/kg/24 h as for daily fuel needs | • Athletes may choose carbohydrate-rich sources that are low in fiber/residue and easily consumed to ensure that fuel targets are met, and to meet goals for gut comfort or lighter "racing weight" |
| Carbohydrate loading | • Preparation for events >90 min of sustained/ intermittent exercise | 36-48 h of 10-12 g/kg body weight/24 h | |
| Speedy refueling | • <8 h recovery between 2 fuel-demanding sessions | 1-1.2 g/kg/h for first 4 h then resume daily fuel needs | • There may be benefits in consuming small, regular snacks<br>• Carbohydrate-rich foods and drink may help to ensure that fuel targets are met |
| Pre-event fueling | • Before exercise >60 min | 1-4 g/kg consumed 1-4 h before exercise | • Timing, amount, and type of carbohydrate foods and drinks should be chosen to suit the practical needs of the event and individual preferences/experiences<br>• Choices high in fat/protein/fiber may need to be avoided to reduce risk of gastrointestinal issues during the event<br>• Low glycemic index choices may provide a more sustained source of fuel for situations where carbohydrate cannot be consumed during exercise |

## "Sleep Low" Strategy

1) promoting the nutritional environment (i.e., high carbohydrate [CHO] availability) before and during prolonged/high-intensity exercise to optimize performance via optimal fuel availability 2) creating an intracellular environment in skeletal muscle in which training responses and adaptations are enhanced via the restriction of CHO, so-called training low.

The SL strategy consisted of a 3-wk training–diet intervention comprising three blocks of diet–exercise manipulations:

1) "train-high" interval training sessions in the evening with high-CHO availability,

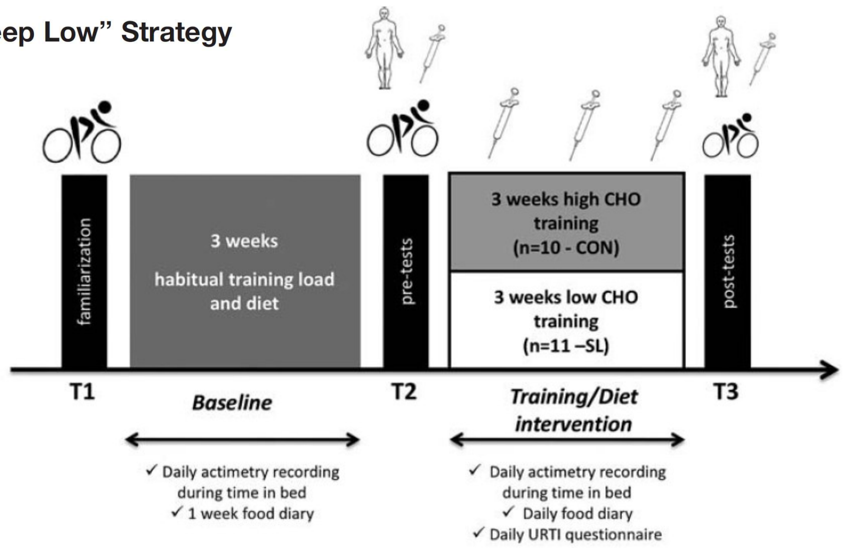
2) overnight CHO restriction ("sleeping-low"),

3) "train-low" sessions with low endogenous and exogenous CHO availability.



DOI: 10.1249/MSS.0000000000000823

## “Sleep Low” Strategy




**Conclusion**: Short-term periodization of dietary CHO availability around selected training sessions promoted significant improvements in submaximal cycling economy, as well as supramaximal cycling capacity and 10-km running time in trained endurance athletes.


DOI: 10.1249/MSS.0000000000000823

AMERICAN COLLEGE of SPORTS MEDICINE
www.acsm.org

## Pre-Event Meals

**Morning events:**
The night before, eat a high-carbohydrate meal. Early morning, eat a light breakfast or snack: cereal and non-fat milk, fresh fruit or juice, toast, bagel or English muffin, pancakes or waffles, non-fat or low-fat fruit yogurt, or a liquid pre-event meal

AMERICAN COLLEGE of SPORTS MEDICINE
www.acsm.org

## Pre-Event Meals

**Morning events:**
The night before, eat a high-carbohydrate meal. Early morning, eat a light breakfast or snack: cereal and non-fat milk, fresh fruit or juice, toast, bagel or English muffin, pancakes or waffles, non-fat or low-fat fruit yogurt, or a liquid pre-event meal

**Afternoon events:**
Eat a high-carbohydrate meal both the night before and for breakfast. Follow with a light lunch: salads with low-fat dressings, turkey sandwiches with small portions of turkey, fruits, juice, low-fat crackers, high-carbohydrate nutritional bars, pretzels, rice cakes



AMERICAN COLLEGE of SPORTS MEDICINE
www.acsm.org

## Pre-Event Meals

**Morning events:**
The night before, eat a high-carbohydrate meal. Early morning, eat a light breakfast or snack: cereal and non-fat milk, fresh fruit or juice, toast, bagel or English muffin, pancakes or waffles, non-fat or low-fat fruit yogurt, or a liquid pre-event meal

**Afternoon events:**
Eat a high-carbohydrate meal both the night before and for breakfast. Follow with a light lunch: salads with low-fat dressings, turkey sandwiches with small portions of turkey, fruits, juice, low-fat crackers, high-carbohydrate nutritional bars, pretzels, rice cakes

**Evening events:**
Eat a high-carbohydrate breakfast and lunch, followed by a light meal or snack: pasta with marinara sauce, rice with vegetables, light-cheese pizza with vegetable toppings, noodle or rice soups with crackers, baked potato, frozen yogurt

AMERICAN COLLEGE of SPORTS MEDICINE www.acsm.org

## Pre-Event Meals

**Morning events:**
The night before, eat a high-carbohydrate meal. Early morning, eat a light breakfast or snack: cereal and non-fat milk, fresh fruit or juice, toast, bagel or English muffin, pancakes or waffles, non-fat or low-fat fruit yogurt, or a liquid pre-event meal

**Afternoon events:**
Eat a high-carbohydrate meal both the night before and for breakfast. Follow with a light lunch: salads with low-fat dressings, turkey sandwiches with small portions of turkey, fruits, juice, low-fat crackers, high-carbohydrate nutritional bars, pretzels, rice cakes

**Evening events:**
Eat a high-carbohydrate breakfast and lunch, followed by a light meal or snack: pasta with marinara sauce, rice with vegetables, light-cheese pizza with vegetable toppings, noodle or rice soups with crackers, baked potato, frozen yogurt

No one food or group of foods works for everybody; the person may need to experiment to find which foods, and the amount of food, that works best. Food choices may vary based on the type of exercise, as well as the intensity and duration of the exercise. However, it is important to experiment with new foods during training rather than around competition.



## Algumas funções dos Lípidos

**Lipidos**

São constituintes essenciais das membranas das células

Percursores de hormonas e vitamina D

Indispensáveis para a absorção de vitaminas lipossolúveis

Funções estruturais dos fosfolipídos e do colesterol

Adaptado de Minderico C. Nutrição Treino e Competição. IPDJ, 2016

# Alguns valores de referência…

| Macronutriente | IOM[1] (2002) | EFSA[2] (2017) | WHO[3] (2003) | ATP[4] (2013) |
|---|---|---|---|---|
| Lípidos | 20 a 35%* | 20 a 35%* | 15 a 30%* | 25 a 35%* |

[1] Institute of Medicine
[2] European Food Safety Authority
[3] World Health Organization
[4] Adult Treatment Panel
*of the Estimated Energy Requirement



Todas as gorduras são iguais?

| Ácidos Gordos | Saturados | Polinsaturados n-3 | Polinsaturados n-6 | Monoinsaturados |
|---|---|---|---|---|
| **Gorduras (%VET)** | <10% | 1 a 2% | 5 a 8% | Restante VET proveniente das gorduras |
| World Health Organization, *Diet, Nutrition and the Prevention of Chronic Diseases: Report of a Joint WHO/FAO Expert Consultation. 2003: World Health Organization.* | | | | |

**Notas adicionais:**
-Ácidos Gordos *Trans* o mínimo possível, e nunca ≥ 1% do VET;
-Evitar alimentos que possuam ingredientes como **"gordura totalmente ou parcialmente hidrogenada"** ou **"óleos totalmente ou parcialmente hidrogenados".**



A gordura é importante para um atleta?

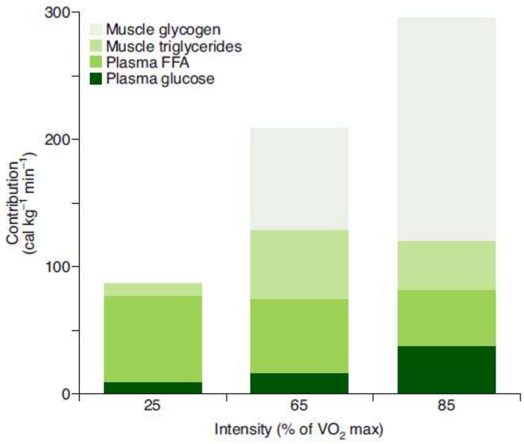



**Fig. 3 | Relative contributions of carbohydrate and fat fuel sources during exercise.** Trained cyclists exercised at increasing intensities, and the relative contributions of fuels for contracting skeletal muscle were measured with indirect calorimetry and tracer methods. An increasing contribution of carbohydrate fuels, notably muscle glycogen, is observed at higher exercise intensities. FFA, free fatty acids; cal, calorie. Adapted with permission from ref. [11], American Physiological Society.


NATURE METABOLISM | VOL 2 | SEPTEMBER 2020 | 817–828

**TABLE 2.1 Body Stores of Fuels and Associated Energy Availability**

| Location | g | kcal |
|---|---|---|
| **CARBOHYDRATES** | | |
| Liver glycogen | 110 | 451 |
| Muscle glycogen | 500 | 2,050 |
| Glucose in body fluids | 15 | 62 |
| **FAT** | | |
| Subcutaneous and visceral | 7,800 | 73,320 |
| Intramuscular | 161 | 1,513 |
| **Total** | **7,961** | **74,833** |

*Note.* These estimates are based on a body weight of 65 kg (143 lb) with 12% body fat.

Kenney, W.L., J. Wilmore, and D. Costill, *Physiology of Sport and Exercise*. 6th ed. 2015, United States of America: Human Kinetics Publishers.

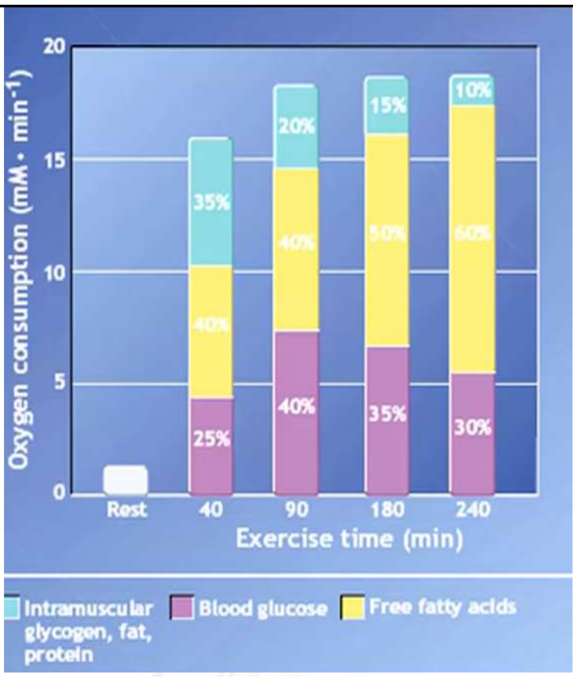
## Catabolismo lipídico

- **Triglicéridos presentes no tecido adiposo** – reserva "universal";
- **Triglicéridos intramusculares** - apenas utilizáveis pelo próprio músculo.



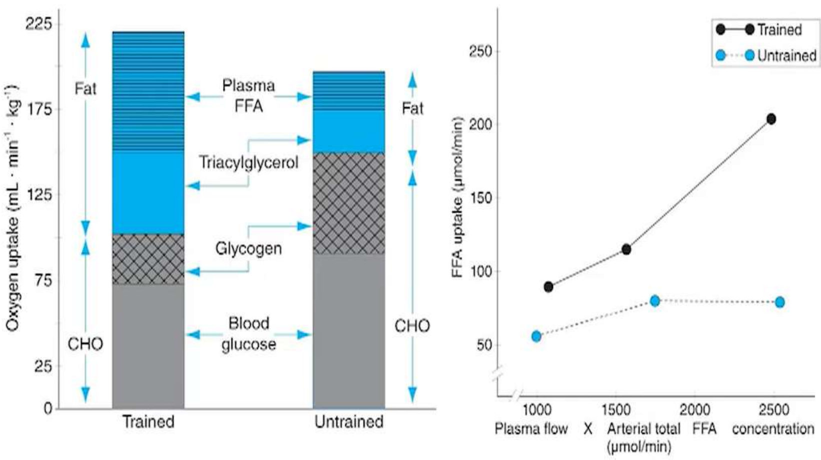
## Catabolismo lipídico

- **Triglicéridos presentes no tecido adiposo** – reserva "universal";
- **Triglicéridos intramusculares** - apenas utilizáveis pelo próprio músculo;
- Quanto mais tempo dura a sessão de exercício maior é a preponderância da utilização dos triglicéridos presentes no tecido adiposo, sob a forma de ácidos gordos plasmáticos (a fonte alimentar é pouco relevante devido às enormes reservas.




Nutrição e Suplementação no Exercício Físico

Prof.º Dr.º Rui Jorge

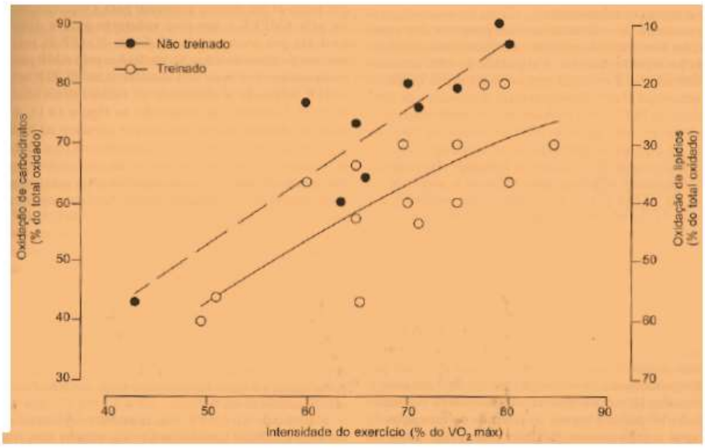



Nutrição e Suplementação no Exercício Físico

Prof.º Dr.º Rui Jorge

## O Treino na Optimização da Gestão dos Recursos Energéticos

Oxidação de HC (% do total oxidado)




Oxidação de lípidos (% do total oxidado)

Adaptado de McArdle W, et al, 1996, por Rogero MM, 2014. In Paschoal V, Naves A. Tratado de Nutrição Esportiva Funcional; Roca, 2014



## « CROSSOVER » CONCEPT

*Nutrients* 2022, *14*, 1605.

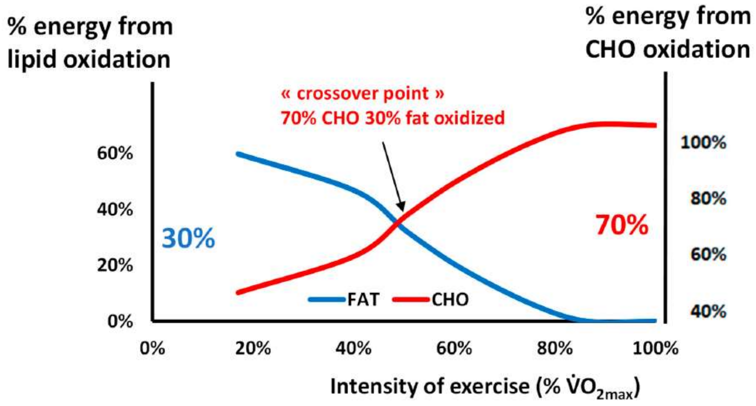
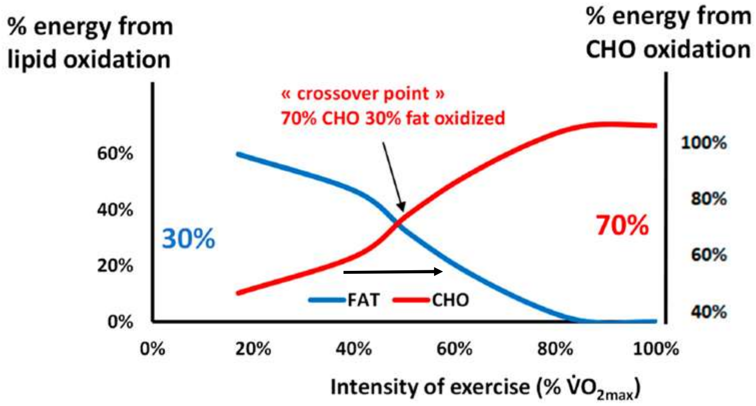



**Figure 1.** The classical picture of Brooks and Mercier's "Crossover concept" redrawn from our personal database of more than 5000 exercise calorimetries (see text). This hypothesis assumes that there is a major shift in the balance of substrates used for oxidation during exercise grossly around 50% of the maximal aerobic capacity, when carbohydrates represent more than 70% of the sources of energy for the exercising body. Oxidative use of fat culminates below this level, and close to it or slightly above it, blood lactate increases and the ventilatory threshold occurs. Note that the ordinates for % of fat oxidation and % of CHO oxidation are not symmetric, in order to better visualize the crossover. In a series of more than 5000 exercise calorimetries, we find that the crossover point is, on average, at 55.1% of $VO_{2max}$ but exhibits a wide variability among individuals.

# « CROSSOVER » CONCEPT

*Nutrients* 2022, *14*, 1605.






## Overfeeding Polyunsaturated and Saturated Fat Causes Distinct Effects on Liver and Visceral Fat Accumulation in Humans

Diabetes 2014;63:2356–2368 | DOI: 10.2337/db13-1622

(PUFAs). LIPOGAIN was a double-blind, parallel-group, randomized trial. Thirty-nine young and normal-weight individuals were overfed muffins high in SFAs (palm oil) or n-6 PUFAs (sunflower oil) for 7 weeks. Liver fat, visceral adipose tissue (VAT), abdominal subcutaneous adipose tissue (SAT), total adipose tissue, pancreatic fat, and lean tissue were assessed by magnetic resonance imaging.

### Dietary Intervention

Forty-one participants were randomized to eat muffins containing either sunflower oil (high in the major dietary PUFA linoleic acid, 18:2 n-6) or palm oil (high in the major SFA palmitic acid, 16:0). Both oils were refined.

**Table 2—Liver fat and body composition before and after 7 weeks of PUFA or SFA overeating**

| | PUFA (*n* = 18) baseline | Mean absolute change | SFA (*n* = 19) baseline | Mean absolute change | Mean difference in change (95% CI) | *P* value |
|---|---|---|---|---|---|---|
| Body weight, kg | 67.4 ± 8.2 | 1.6 ± 0.85 | 63.3 ± 6.8 | 1.6 ± 0.96 | −0.02 (−0.63 to 0.58) | 0.94 |

Diabetes 2014;63:2356–2368 | DOI: 10.2337/db13-1622

**Grupo SFA: 86% do peso ganho foi massa gorda**

**Grupo PUFA: 56% do peso ganho foi massa gorda**

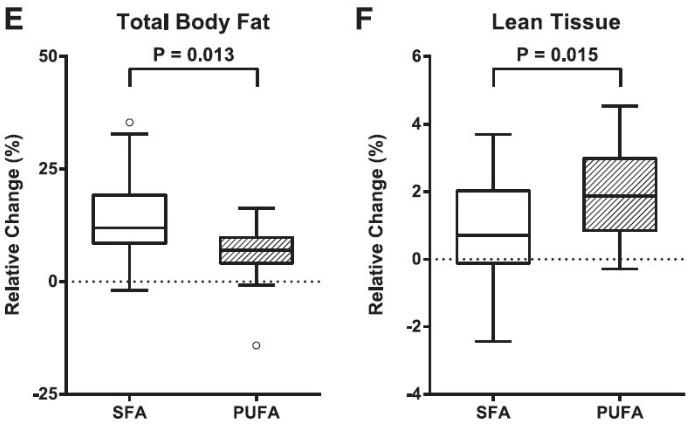



**Figure 2**—Relative changes in liver fat and body composition by MRI during 7 weeks of overeating SFAs or PUFAs. *A–F*: Relative changes are calculated for each individual as change during the intervention/baseline measurement. Boxes represent medians and IQRs, whiskers represent the most extreme value besides outliers, and circles represent outliers (>1.5 IQRs outside IQR). *P* values represent between-group *t* test or Mann-Whitney *U* test. *A*: Change in liver fat is in percentage. *B*, *C*, *E*, and *F*: Changes are in liters. *D*: VAT/SAT ratio is calculated as VAT/(TAT − VAT).



Diabetes 2014;63:2356–2368 | DOI: 10.2337/db13-1622

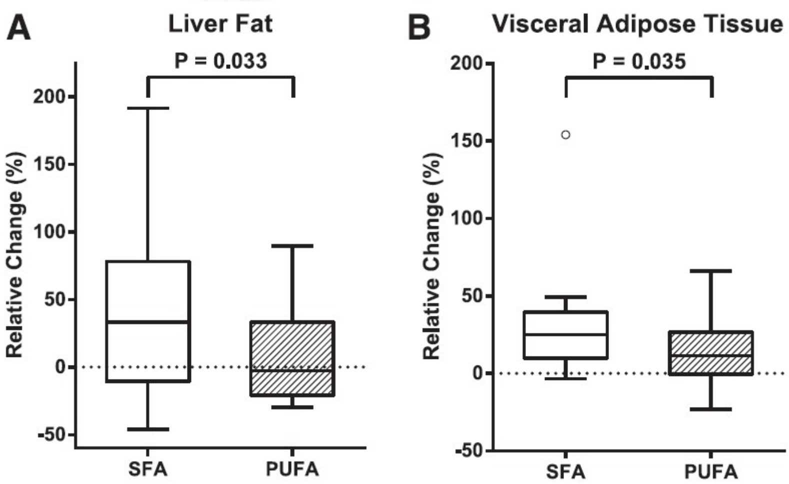
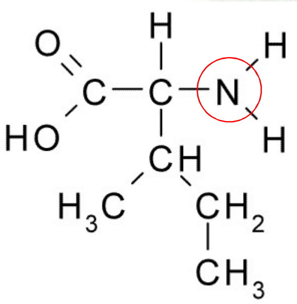
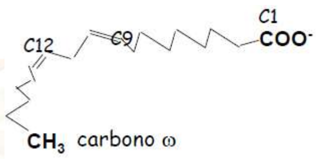


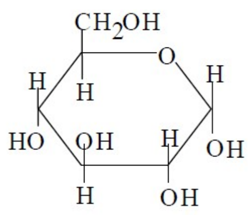

**Figure 2**—Relative changes in liver fat and body composition by MRI during 7 weeks of overeating SFAs or PUFAs. *A–F*: Relative changes are calculated for each individual as change during the intervention/baseline measurement. Boxes represent medians and IQRs, whiskers represent the most extreme value besides outliers, and circles represent outliers (>1.5 IQRs outside IQR). *P* values represent between-group *t* test or Mann-Whitney *U* test. *A*: Change in liver fat is in percentage. *B*, *C*, *E*, and *F*: Changes are in liters. *D*: VAT/SAT ratio is calculated as VAT/(TAT − VAT).

# Proteína







# Algumas recomendações gerais...

| Macronutrient | IOM[1] (2002) | WHO[2] (2003) | ATP[3] (2013) |
|---|---|---|---|
| **Protein** | 10 a 35%* | 10 a 15%* | ≈ 15%* |

[1] Institute of Medicine
[2] World Health Organization
[3] Adult Treatment Panel
*of the Estimated Energy Requirement

RDA (IOM) 0,8 g/kg
PRI (EFSA) 0,83 g/kg



## Protein "requirements" beyond the RDA: implications for optimizing health[1]

Stuart M. Phillips, Stéphanie Chevalier, and Heather J. Leidy

Because of anabolic resistance, sedentary lifestyles, and common illnesses, older adults need higher protein intakes (≥1.2 g/(kg·day)) to help prevent age-related sarcopenia.

The consumption of higher protein diets (~1.2–1.6 g/(kg·day)), including ~30 g protein per eating occasion, improves appetite control, satiety, and weight management.

Appl. Physiol. Nutr. Metab. 41: 565–572 (2016) dx.doi.org/10.1139/apnm-2015-0550

# Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance

March 2016 Volume 116 Number 3 JOURNAL OF THE ACADEMY OF NUTRITION AND DIETETICS

***Protein needs.*** Current data suggest that dietary protein intake necessary to support metabolic adaptation, repair, remodeling, and for protein turnover generally ranges from 1.2 to 2.0 g/kg/



As necessidades proteicas são distintas para atletas de diferentes modalidades desportivas e até no mesmo atleta em função de vários aspetos.

## Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance

March 2016 Volume 116 Number 3
JOURNAL OF THE ACADEMY OF NUTRITION AND DIETETICS

"Higher intakes may be indicated for short periods during **intensified training** or **energy deficit**";

"Although general daily ranges are provided, individuals **should no longer be solely categorized as strength or endurance athletes and provided with static daily protein intake targets**"

**"Guia"**, mas não **"dogma"**:

-Endurance athletes **1.2 to 1.4** g/kg body weight per day;

-Resistance and strength-trained athletes **1.6 to 1.7** g/kg body weight per day.



## Alguns conceitos importantes...

# Aminoácidos (aa)

- **Essenciais:**
  - Leucina; isoleucina; valina; fenilalanina; triptofano; histidina; treonina; metionina e lisina.
- Não-essenciais:
  - Alanina; asparagina; ácido aspártico; ácido glutâmico; serina; arginina; cisteína; glicina; glutamina; prolina e tirosina.



Dietary **protein quality** is assessed based on the essential amino acid composition of a protein as it relates to human needs and the ability of the protein to be digested, absorbed, and retained by the body.

Moore, D.R.; Soeters, P.B. The Biological Value of Protein. *Nestle Nutr. Inst. Workshop Ser.* **2015**, 82, 39–51.

# Aminoácido limitante

**limiting amino acid** an amino acid in short supply as a precursor for protein synthesis; lack of a specific limiting amino acid restricts the level of protein synthesis in the body



# Valor biológico

- **Proporção da proteína (aa) absorvida que é retida pelo organismo (que passa a constituir proteínas do organismo).**

Moore, D.R.; Soeters, P.B. The Biological Value of Protein. *Nestle Nutr. Inst. Workshop Ser.* **2015**, *82*, 39–51.

# Digestibilidade das proteínas

$$\text{True protein (N) digestibility (\%)} = \frac{I - (F - F_k) \times 100}{I}$$

where $I$ = nitrogen intake
$F$ = faecal nitrogen output on the test diet
$F_k$ = faecal nitrogen output on a non-protein diet.

Disponível em: www.fao.org/docrep/003/aa040e/AA040E08.htm#ch7.3



Values for the digestibility of protein in man

| Protein source | True digestibility (mean ± SD) |
|---|---|
| Egg | 97±3 |
| Milk, cheese | 95±3  95 |
| Meat, fish | 94±3 |
| Maize | 85±6 |
| Rice, polished | 88±4 |
| Wheat, whole | 86±5 |
| Wheat, refined | 96±4 |
| Oatmeal | 86±7 |
| Millet | 79 |
| Peas, mature | 88 |
| Peanut butter | 95 |
| Soyflour | 86±7 |
| Beans | 78 |
| Maize + beans | 78 |
| Maize + beans + milk | 84 |
| Indian rice diet | 77 |
| Indian rice diet + milk | 87 |
| Chinese mixed diet | 96 |
| Brazilian mixed diet | 78 |
| Filipino mixed diet | 88[d] |
| American mixed diet | 96[d] |
| Indian rice + beans diet | 78[d] |

# Digestibilidade das proteínas

- **Vai depender de fatores como:**
  - Conformação da proteína;
  - Fixação de metais, lípidos, ácidos nucleicos e hidratos de carbono;
  - Presença de inibidores de proteases;
  - Tamanho e área superficial das proteínas;
  - Temperatura e pH.



# Digestibilidade das proteínas

- **Vai depender de fatores como:**
  - Conformação da proteína;
  - Fixação de metais, lípidos, ácidos nucleicos e hidratos de carbono;
  - Presença de inibidores de proteases;
  - <u>Tamanho e área superficial das proteínas;</u>
  - Temperatura e pH.

## Conformação

- **Proteínas "mais enroladas" são mais dificilmente digeríveis, daí a necessidade de serem desnaturadas.**


## Ligação a outros compostos

- Quanto mais e **mais fortes forem as ligações das proteínas** a outras moléculas **menor será a sua digestibilidade**. **Ex: Reações de Maillard.**

# Presença de inibidores de proteases

- Alguns alimentos como por exemplo as **leguminosas** possuem **inibidores enzimáticos** que **dificultam a digestão da proteína**. Ex: Inibidores da tripsina na soja.

# Temperatura

- **Uma questão de temperatura…**
  - Após o **aquecimento moderado**, as proteínas são **mais facilmente digeridas**, graças à sua desnaturação, permitindo que as proteases atuem mais facilmente.
  - Temperaturas >100°C podem dificultar a digestão da proteína por **destruição de alguns aa** sendo a temperaturas **>180°C** que mais se denota essa situação.

## Protein Digestibility Corrected Amino Acid Score (PDCAAS)

"Composite indicator of protein quality used to assess the ability of dietary protein to meet the body's amino acid requirements."

| |
|---|
| PDCAAS % = (mg of limiting aa in 1 g of test protein / mg of same aa in 1 g of reference protein) x fecal true digestibility percentage |

FAO/WHO. *Protein Quality Evaluation: Report of the Joint FAO/WHO Expert Consultation 1989*; FAO Food and Nutrition Paper 51; FAO: Rome, Italy, 1991.

- Considera os aa essenciais e a digestibilidade fecal.
- Se o valor de PDCAAS for inferior a 100% significa que essa proteína não consegue garantir na totalidade as necessidades de aa essenciais.



## Digestible Indispensable Amino Acid Score (DIAAS)

"Takes into account the digestible amino acid content compared to a reference protein and its ileal digestibility."

| |
|---|
| DIAAS % = 100 × [(mg of digestible indispensable aa in 1 g of dietary protein)/(mg of the same indispensable aa in 1 g of reference protein)] |

FAO. *Dietary Protein Evaluation in Human Nutrition: Report of an FAO Expert Consultation 2011*; FAO Food and Nutrition Paper 92; FAO: Rome, Italy, 2013.

- Considera que a **digestibilidade ileal** reflete melhor (não sobrestima) a absorção de aa, comparativamente à digestibilidade fecal, pois a ileal considera a metabolização da microbiota colónica.

Table 1. Protein quality assessment based on protein sources.

| Protein Type | Protein Digestibility (%) | PDCAAS | DIAAS |
|---|---|---|---|
| Red meat [1] | | 92 | |
| Casein [1,3,6] | 99 | 100 | |
| Whey [1] | | 100 | |
| Milk [1,4,6] | 96 | 100 | 114 |
| Egg [1,4,6] | 98 | 100 | 113 |
| Black bean [1,6,8] | 70 | 75 | |
| Cooked black bean [7,8] | 83 | 65 | 59 |
| Soy flour [5,8] | 80 | 93 | 89(SAA) |
| Soy protein isolate[1,6] | 98 | 100 | |
| Green lentil [3,4] | 84 | 63 | 65 |
| Yellow split pea [4,6] | 88 | 64 | 73 |
| Cooked pea [7] | 89 | 60 | 58 |
| Pea protein concentrate [7] | 99 | 89 | 82 |
| Chickpea [3,4] | 89 | 74 | 83 |
| Peanuts [1] | | 52 | |
| Roasted peanuts [7] | 98 | 51 | 43 |
| Peanut butter [3,4] | 98 | 45 | 46 |
| Whole grains [2] | | 45 | |
| Wheat [3,5,6] | 91 | 51 | 45(Lys) |
| Wheat gluten [1] | | 25 | |
| White bread [4,6] | 93 | 28 | 29 |
| White rice [4,6] | 93 | 56 | 57 |
| Cooked rice [7] | 87 | 62 | 60 |

[1] Hoffman and Falvo [52]; [2] van Vliet et al. [53]; [3] Sarwar et al. [54]; [4] Marinangeli and House [55]; [5] Mathai et al. [56]; [6] ANSES [57]; [7] Rutherfurd et al. [58]; [8] Sarwar [59]. Abbreviations: PDCAAS: protein digestibility-corrected amino acid score; DIAAS: digestible indispensable amino acid score; Lys: lysine; SAA: sulfur amino acids.



*Nutrients* 2019, *11*, 1825; doi:10.3390/nu11081825

AMERICAN COLLEGE of SPORTS MEDICINE
www.acsm.org

**Guidelines ACSM, 2009:**

- Protein – 15-20%
  - 1.2 – 1.4 g/kg/bw/day for endurance athletes
  - 1.6 – 1.7 g/kg/bw/day for strength athletes
  - RDA 0.8 - 1.0 g/kg/bw/day
- Carbohydrate 50-60%
  - 6-10 g/kg/bw/day
- Fat <30% total kcal/day
  - Less than 10% from saturated fat

AMERICAN COLLEGE of SPORTS MEDICINE
www.acsm.org

**Guidelines ACSM, 2016:**

**Proteína - 1,2 a 2 g/kg** (aporte fracionado e regular ao longo do dia de 0,3 g/kg)

**Hidratos de Carbono - 3 a 10 g/kg** (aporte de até 12 g/kg em atividades de extrema duração)

**Lípidos – 20 a 35% do aporte energético total**

IEPAP Nutrição e Suplementação no Exercício Físico

DOI: 10.1249/MSS.0000000000000852

## Proteína e aumento de massa muscular (AMM)

AMM = SPM (Síntese proteica muscular) – DPM (Degradação proteica muscular)

IEPAP Nutrição e Suplementação no Exercício Físico Prof.º Dr.º Rui Jorge

## É necessário:

- Balanço azotado positivo.
- Balanço energético positivo, nulo ou “ligeiramente” negativo.



## O que é o balanço azotado?

# Balanço Azotado

**= g de N ingerido - g de N eliminado**

**> 0 (balanço positivo) é necessário em fases específicas da vida como o crescimento, gravidez e quando presentes objetivos de aumento de massa muscular.**

**< 0 (balanço negativo) promovido por situações como jejuns prolongados, dietas restritivas ou estados de doença.**



- Após o treino de força, o **balanço proteico continua negativo** até haver aporte proteico;

Moore, D.R., et al., *Ingested protein dose response of muscle and albumin protein synthesis after resistance exercise in young men. American Journal of Clinical Nutrition, 2009.* ***89(1): p. 161-168.***

- O efeito do aporte proteico e do treino de força são independentes e aditivos, principalmente devido à **estimulação da síntese proteica muscular**.

Phillips, S.M., *A Brief Review of Critical Processes in Exercise-Induced Muscular Hypertrophy. Sports Medicine, 2014.* ***44(1): p. 71-77.***

Sports Medicine
https://doi.org/10.1007/s40279-019-01053-5

REVIEW ARTICLE

# The Muscle Protein Synthetic Response to Meal Ingestion Following Resistance-Type Exercise

Jorn Trommelen[1] · Milan W. Betz[1] · Luc J. C. van Loon[1]

## Key Points

Ingestion of 20 g of isolated, quickly digestible protein results in a near-maximal muscle protein synthetic response at rest and post-exercise, with a 10–20% further increase when the ingested amount is doubled to 40 g.

The ingestion of ≥ 40 g of slow digestible protein is recommended to maximize muscle protein synthesis rates when there is a prolonged period until the next feeding opportunity (≥ 6 h, e.g., overnight sleep).

Nutritional recommendations to optimize the muscle protein synthetic response to feeding should be personalized to the individual athlete (i.e., age, sex, and body composition, and type, intensity, and duration of exercise).

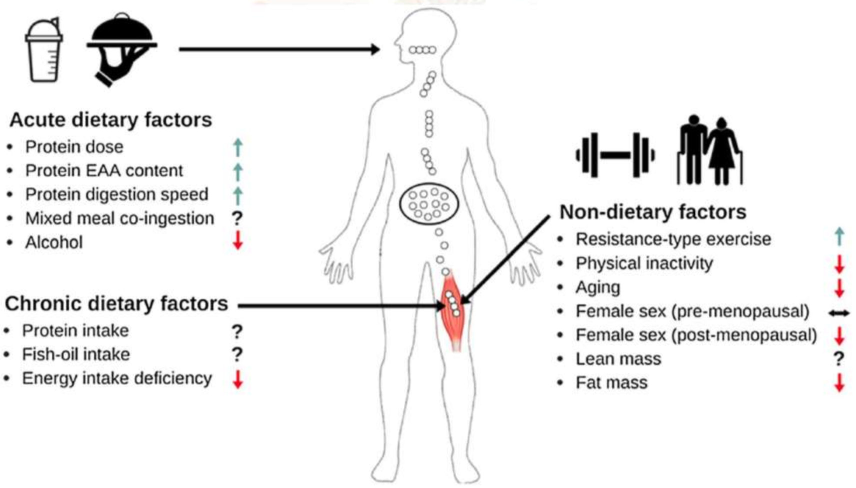


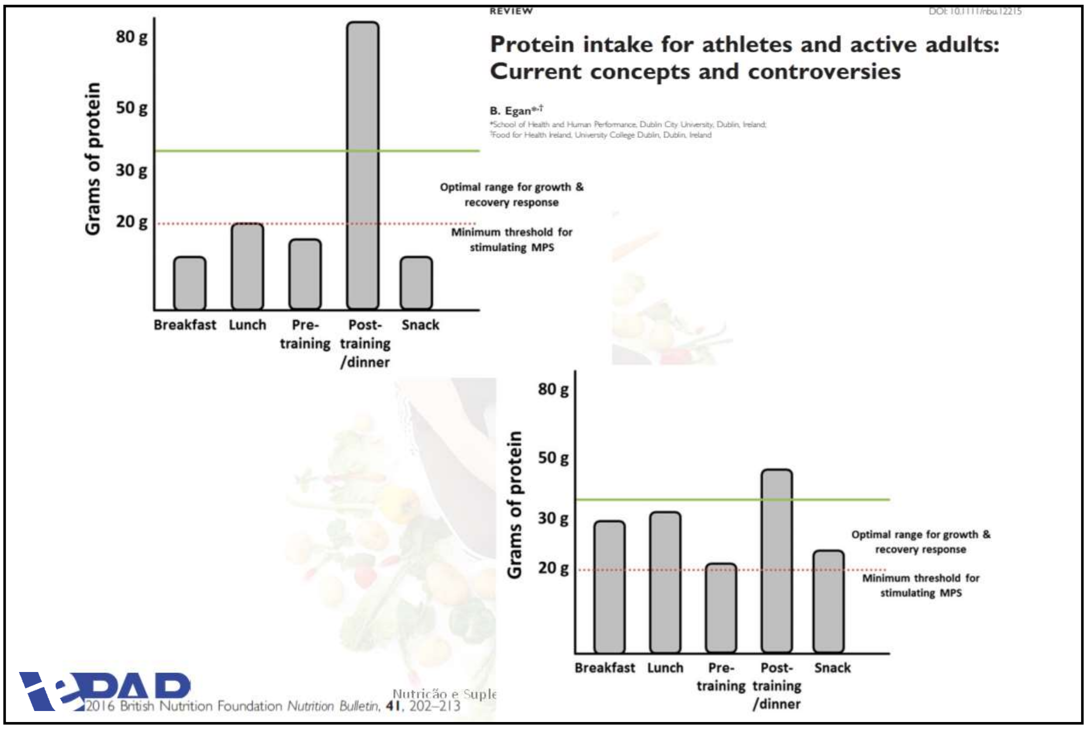
Sports Medicine
https://doi.org/10.1007/s40279-019-01053-5

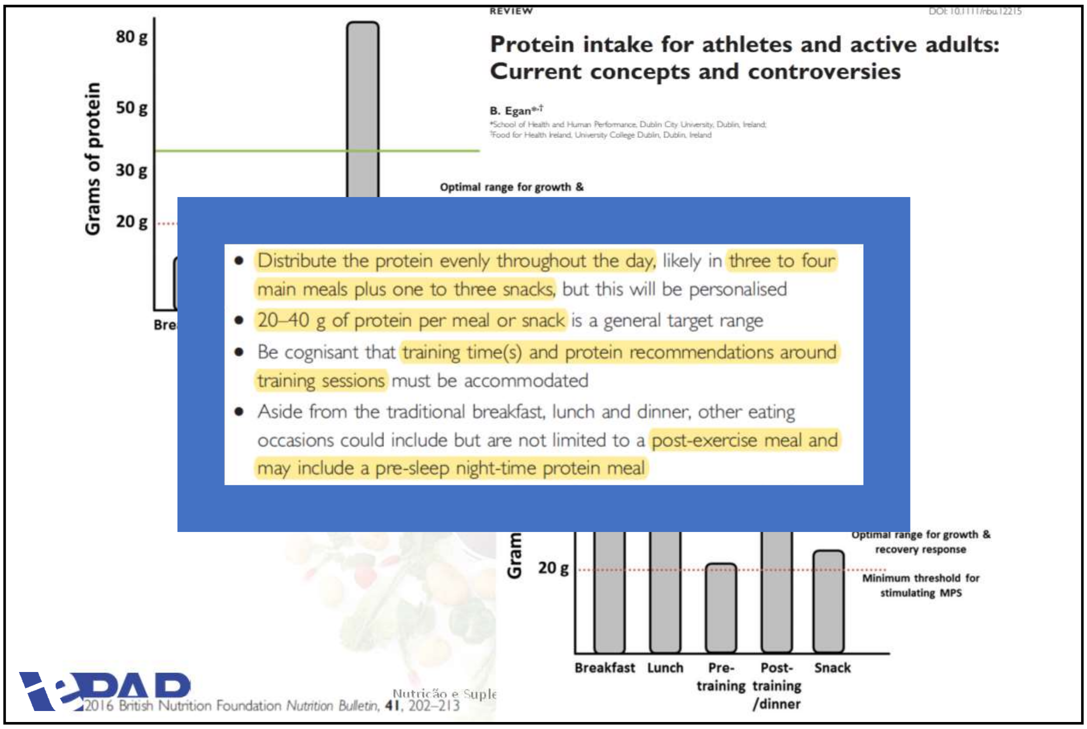
REVIEW ARTICLE

The Muscle Protein Synthetic Response to Meal Ingestion Following Resistance-Type Exercise

Jorn Trommelen[1] · Milan W. Betz[1] · Luc J. C. van Loon[1]




REVIEW
DOI: 10.1111/nbu.12215
Protein intake for athletes and active adults: Current concepts and controversies
B. Egan
Grams of protein
80 g
50 g
30 g
20 g
Optimal range for growth & recovery response
Minimum threshold for stimulating MPS
Breakfast
Lunch
Pre-training
Post-training /dinner
Snack
© 2016 British Nutrition Foundation Nutrition Bulletin, 41, 202–213
Nutrição e Suple


REVIEW
DOI: 10.1111/nbu.12215
Protein intake for athletes and active adults: Current concepts and controversies
B. Egan
Grams of protein
80 g
50 g
30 g
20 g
Optimal range for growth & recovery response
Minimum threshold for stimulating MPS
Breakfast
Lunch
Pre-training
Post-training /dinner
Snack
• Distribute the protein evenly throughout the day, likely in three to four main meals plus one to three snacks, but this will be personalised
• 20–40 g of protein per meal or snack is a general target range
• Be cognisant that training time(s) and protein recommendations around training sessions must be accommodated
• Aside from the traditional breakfast, lunch and dinner, other eating occasions could include but are not limited to a post-exercise meal and may include a pre-sleep night-time protein meal
© 2016 British Nutrition Foundation Nutrition Bulletin, 41, 202–213
Nutrição e Suple

JAMA Internal Medicine | Original Investigation

# Effects of Time-Restricted Eating on Weight Loss and Other Metabolic Parameters in Women and Men With Overweight and Obesity

The TREAT Randomized Clinical Trial

Dylan A. Lowe, PhD; Nancy Wu, MS; Linnea Rohdin-Bibby, BA; A. Holliston Moore, PhD; Nisa Kelly, MS;

**OBJECTIVE** To determine the effect of 16:8-hour time-restricted eating on weight loss and metabolic risk markers.

**DESIGN, SETTING, AND PARTICIPANTS** This 12-week randomized clinical trial including men and women aged 18 to 64 years with a body mass index (BMI, calculated as weight in kilograms

## Conclusions

In this RCT, a prescription of TRE did not result in weight loss when compared with a control prescription of 3 meals per day. Time-restricted eating did not change any relevant metabolic markers. Finally, there was a decrease in ALM in the TRE group

*JAMA Intern Med*. doi:10.1001/jamainternmed.2020.4153
Published online September 28, 2020.

ALM - Appendicular Lean Mass

# Eight-hour time-restricted eating does not lower daily myofibrillar protein synthesis rates: A randomized control trial

Evelyn B. Parr[1] | Imre W. K. Kouw[1] | Michael J. Wheeler[1] |

**Results:** There were no differences in daily integrated MyoPS rates (TRE: 1.28% ± 0.18% per day, CON: 1.26% ± 0.22% per day; $p = 0.82$) between groups. From continuous glucose monitoring, 24-hour total area under the curve was reduced following TRE (−578 ± 271 vs. CON: 12 ± 272 mmol/L × 24 hours; $p = 0.001$). Total body mass declined (TRE: −1.6 ± 0.9 and CON: −1.1 ± 0.7 kg; $p < 0.001$) with no differences between groups ($p = 0.22$). Lean mass loss was greater following TRE compared with CON (−1.0 ± 0.7 vs. −0.2 ± 0.5 kg, respectively; $p = 0.01$).

**Conclusion:** Consuming food within an 8-hour time-restricted period does not lower daily MyoPS rates when compared with an isoenergetic diet consumed over 12 hours. Future research should investigate whether these results translate to free-living TRE.

*Obesity (Silver Spring)*. 2023;31(Suppl. 1):116–126.

## Recomendações aparentemente mais consensuais

- 1,2 a 2,2 g até 2,3 a 3,1 g de proteína por kg de peso corporal, em balanço energético nulo a positivo e **negativo**, respetivamente;

e

- 20 a 40g de proteína ou 0,24 a 0,55 g de proteína por kg de peso corporal por refeição.

Moore, D.R., et al., Ingested protein dose response of muscle and albumin protein synthesis after resistance exercise in young men. *American Journal of Clinical Nutrition, 2009.* ***89(1): p. 161-168.***

Stokes T., et al., Recent Perspectives Regarding the Role of Dietary Protein for the Promotion of Muscle Hypertrophy with Resistance Exercise Training. *Nutrients,* 2018. **10(1): p. 180-192.**

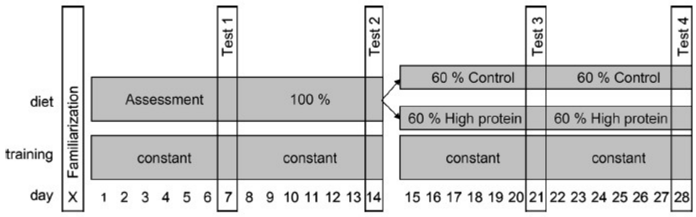
Schoenfeld, B.J., Aragon, A.A. How much protein can the body use in a single meal for muscle-building? Implications for daily protein distribution. *Journal of the International Society of Sports Nutrition* **15,** 10 (2018). https://doi.org/10.1186/s12970-018-0215-1



# Increased Protein Intake Reduces Lean Body Mass Loss during Weight Loss in Athletes

SAMUEL METTLER[1,2], NIGEL MITCHELL[3], and KEVIN D. TIPTON[1]

body mass loss and performance during short-term hypoenergetic weight loss in athletes. **Methods**: In a parallel design, 20 young healthy resistance-trained athletes were examined for energy expenditure for 1 wk and fed a mixed diet (15% protein, 100% energy) in the second week followed by a hypoenergetic diet (60% of the habitual energy intake), containing either 15% (~1.0 g·kg$^{-1}$) protein (control group, $n$ = 10; CP) or 35% (~2.3 g·kg$^{-1}$) protein (high-protein group, $n$ = 10; HP) for 2 wk. Subjects continued their habitual



# Increased Protein Intake Reduces Lean Body Mass Loss during Weight Loss in Athletes

SAMUEL METTLER[1,2], NIGEL MITCHELL[3], and KEVIN D. TIPTON[1]

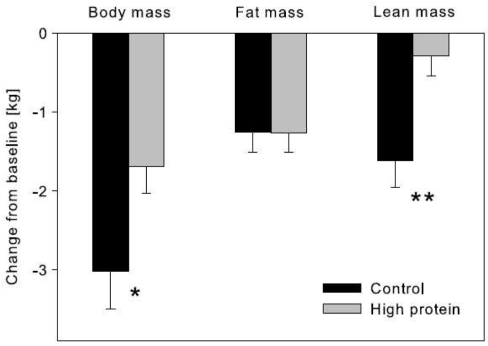



FIGURE 2—Change of body mass, fat, and lean mass from baseline (average of the two measurements before the weight loss) to the end of the 2-wk weight loss for the control ($n$ = 10) and the high-protein ($n$ = 10) groups. Values are mean ± SE. *Significant difference between the two groups ($P$ = 0.036). **Significant difference between the two groups ($P$ = 0.006).

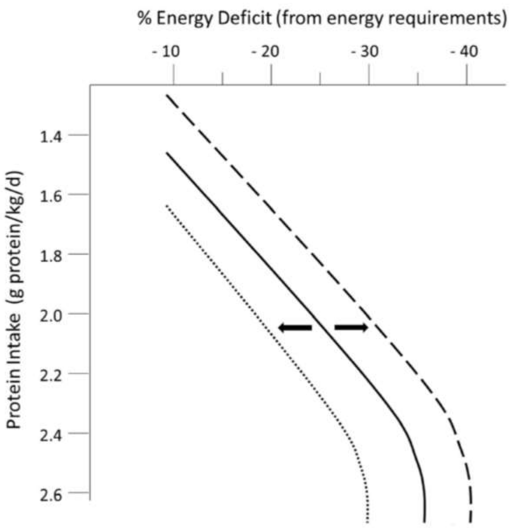
In conclusion, we found a significantly reduced loss of lean body mass with increased protein (~2.3 g·kg$^{-1}$·d$^{-1}$) compared with a normal protein diet (~1.0 g·kg$^{-1}$·d$^{-1}$) during short-term weight loss in healthy lean athletes. On



International Journal of Sport Nutrition and Exercise Metabolism, 2018, 28, 170-177

# Protein Recommendations for Weight Loss in Elite Athletes: A Focus on Body Composition and Performance

Amy J. Hector and Stuart M. Phillips



Sports Medicine
https://doi.org/10.1007/s40279-019-01111-y


# Should Competitive Bodybuilders Ingest More Protein than Current Evidence-Based Recommendations?

Alex S. Ribeiro[1] · João Pedro Nunes[2] · Brad J. Schoenfeld[3]

## Key Points

Bodybuilders may benefit from ingesting more daily protein than the current evidence-based recommendations.



Sports Medicine
https://doi.org/10.1007/s40279-019-01111-y
© Springer Nature Switzerland AG 2019

Should Competitive Bodybuilders Ingest More Protein than Current Evidence-Based Recommendations?

Alex S. Ribeiro[1] · João Pedro Nunes[2] · Brad J. Schoenfeld[3]

Key Points

Bodybuilders may benefit from ingesting more daily protein than the current evidence-based recommendations.

There is some evidence indicating that a higher ingestion of protein ($\geq 3.0$ g/kg/day) enhances improvements in body composition.

Sports Medicine
https://doi.org/10.1007/s40279-019-01111-y



# Should Competitive Bodybuilders Ingest More Protein than Current Evidence-Based Recommendations?

Alex S. Ribeiro[1] · João Pedro Nunes[2] · Brad J. Schoenfeld[3]

**Key Points**

Bodybuilders may benefit from ingesting more daily protein than the current evidence-based recommendations.

There is some evidence indicating that a higher ingestion of protein (≥ 3.0 g/kg/day) enhances improvements in body composition.

There is a lack of direct data regarding protein ingestion in competitive bodybuilders, making specific recommendations speculative.



Sports Medicine
https://doi.org/10.1007/s40279-019-01111-y



ficult to draw strong conclusions on the topic. Given the unique needs of competitive BBs, the optimal PRO intake for this population remains to be determined. In regard to maximizing muscle hypertrophy, it would seem prudent for BBs to consume at least 2.2 g/kg/day, as per the upper

It remains possible that a higher PRO intake may be beneficial during periods of very high-volume RT, although this hypothesis remains untested. Higher protein intakes during the pre-contest period appear warranted to help maintain muscle mass while losing body fat. Helms et al. [37] suggested an intake of 2.3–3.1 g/kg/day of lean body mass in lean, resistance-trained individuals in a caloric deficit; this recommendation needs confirmation in competitive BBs, but the upper range of these values may be considered a good target intake when energy restriction is implemented during the pre-contest phase. Finally, these

Lindsay Macnaughton
17.47 · Doctor of Philosophy

**sportscotland Institute of Sport**
Department
Technical Operations
Position
Performance Nutritionist

Kevin D Tipton
40.59 · PhD

**University of Stirling**
Location
Stirling, United Kingdom
Department
Physiology, Exercise and Nutrition Research Group

IEPAP Nutrição e Suplementação no Exercício Físico Prof.º Dr.º Rui Jorge

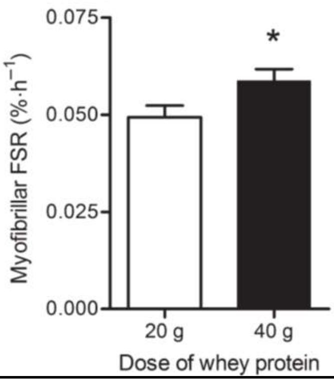
ORIGINAL RESEARCH

## The response of muscle protein synthesis following whole-body resistance exercise is greater following 40 g than 20 g of ingested whey protein

Lindsay S. Macnaughton[1], Sophie L. Wardle[1], Oliver C. Witard[1], Chris McGlory[2], D. Lee Hamilton[1], Stewart Jeromson[1], Clare E. Lawrence[3], Gareth A. Wallis[4] & Kevin D. Tipton[1]

Our data indicate that ingestion of 40 g whey protein following whole-body resistance exercise stimulates a greater MPS response than 20 g in young resistance-trained men.

Provavelmente o que se treina também interessa…




doi: 10.14814/phy2.12893

IEPAP Nutrição e Suplementação no Exe

*European Journal of Sport Science*, 2015

**Strategies to maintain skeletal muscle mass in the injured athlete: Nutritional considerations and exercise mimetics**

BENJAMIN T. WALL[1], JAMES P. MORTON[2], & LUC J. C. VAN LOON[1]

- Muscle loss during disuse is primarily attributed to a decline in basal muscle protein synthesis rate and the development of anabolic resistance to dietary protein intake.
- Due to the reduced levels of energy expenditure during recovery from injury, it can be challenging to achieve optimal macronutrient intakes that serve to maintain skeletal muscle mass but prevent any gains in fat mass.



*European Journal of Sport Science*, 2015

**Strategies to maintain skeletal muscle mass in the injured athlete: Nutritional considerations and exercise mimetics**

BENJAMIN T. WALL[1], JAMES P. MORTON[2], & LUC J. C. VAN LOON[1]

Daily protein intake 1.6–2.5 g $kg^{-1}$ bm may be required to support muscle mass maintenance during disuse. This should be achieved by the regular (4–6 times daily) consumption of adequate amounts (20–35 g) of rapidly digested protein sources with a high leucine content (2.5–3 g) and spaced evenly across the day (every ~3–4 h). Dietary protein ingestion with breakfast and prior to sleep may be of specific relevance here.

## Higher compared with lower dietary protein during an energy deficit combined with intense exercise promotes greater lean mass gain and fat mass loss: a randomized trial[1,2]

*Thomas M Longland, Sara Y Oikawa, Cameron J Mitchell, Michaela C Devries, and Stuart M Phillips**

*The American Journal of Clinical Nutrition*

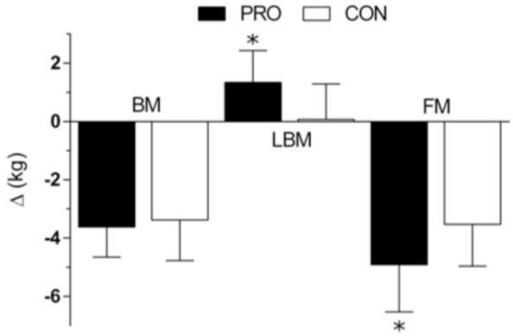



**FIGURE 2** Four-compartment model-derived changes in BM, LBM, and FM during the intervention in both PRO and CON groups; data were analyzed with the use of an unpaired *t* test. Values are means ± SDs; *n* = 40 (20/group). *Significantly different from CON ($P < 0.05$). BM, body mass; CON, lower-protein (1.2 g · $kg^{-1}$ · $d^{-1}$) control diet; FM, fat mass; LBM, lean body mass; PRO, higher-protein (2.4 g · $kg^{-1}$ · $d^{-1}$) diet.

Nutrição e Suplementação no Exercício Físico

*Am J Clin Nutr* 2016;103:738–46.

## A Systematic Review of Dietary Protein During Caloric Restriction in Resistance Trained Lean Athletes: A Case for Higher Intakes

Helms et al.

*International Journal of Sport Nutrition and Exercise Metabolism*, 2014, 24, 127-138

| Study | Group | Mean Difference [90% CI] |
|---|---|---|
| **Body Fat (%)** | | |
| Walberg et al., 1988 | LP; M | -2.10 [-3.38, -0.82] |
| | HP; M | -2.00 [-3.28, -0.72] |
| Umeda et., 2004 | LL; M | -0.50 [-1.65, 0.65] |
| | HL; M | -0.70 [-1.66, 0.26] |
| Maestu et al., 2010 | ER; M | -3.10 [-4.64, -1.56] |
| Mero et al., 2010 | SL; F | -1.90 [-3.91, 0.11] |
| | FL; F | -4.20 [-4.87, -3.53] |
| Mettler et al., 2010 | LP; M | -1.00 [-2.01, 0.01] |
| | HP; M | -1.20 [-2.21, -0.19] |
| Garthe et al., 2011 | FL; F | -2.03 [-2.85, -1.21] |
| | FL; M | -2.70 [-4.37, -1.03] |
| | SL; F | -6.61 [-8.62, -4.60] |
| | SL; M | -5.10 [-6.82, -3.38] |
| **Fat Free Mass (kg)** | | |
| Walberg et al., 1988 | LP; M | -2.70 [-3.87, -1.53] |
| | HP; M | -1.40 [-2.57, -0.23] |
| Umeda et., 2004 | LL; M | -1.70 [-2.00, -1.40] |
| | HL; M | -2.20 [-3.07, -1.33] |
| Maestu et al., 2010 | ER; M | -0.40 [-0.80, -0.00] |
| Mero et al., 2010 | SL; F | -0.30 [-0.89, 0.29] |
| | FL; F | 0.00 [-0.35, 0.35] |
| Mettler et al., 2010 | LP; M | -1.60 [-2.52, -0.68] |
| | HP; M | -0.30 [-1.22, 0.62] |
| Garthe et al., 2011 | FL; F | 0.55 [0.12, 0.98] |
| | FL; M | -1.40 [-2.91, 0.11] |
| | SL; F | 1.06 [0.47, 1.65] |
| | SL; M | 1.00 [0.55, 1.45] |

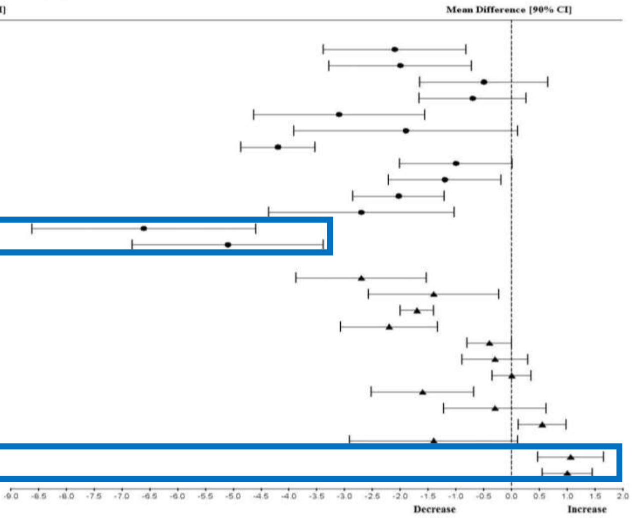



**Figure 2** — Forest plot summarizing the anthropometric changes within each group presented as pre versus post (mean difference [90% CI]). M, male; F, female; ER, energy restricted group; HP, high protein group; LP, low protein group; HL, high weight loss group; FL, fast weight loss group; LL, low weight loss group; SL, slow weight loss group; CI, confidence interval.

# A Systematic Review of Dietary Protein During Caloric Restriction in Resistance Trained Lean Athletes: A Case for Higher Intakes

Helms et al.

International Journal of Sport Nutrition and Exercise Metabolism, 2014, 24, 127-138

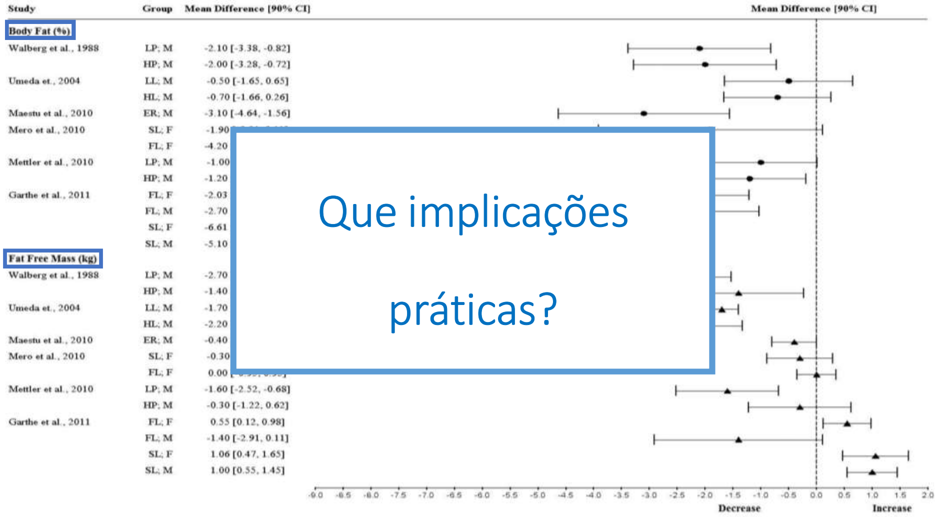



**Figure 2** — Forest plot summarizing the anthropometric changes within each group presented as pre versus post (mean difference [90% CI]). M, male; F, female; ER, energy restricted group; HP, high protein group; LP, low protein group; HL, high weight loss group; FL, fast weight loss group; LL, low weight loss group; SL, slow weight loss group; CI, confidence interval.

Que implicações práticas?

Hidratação

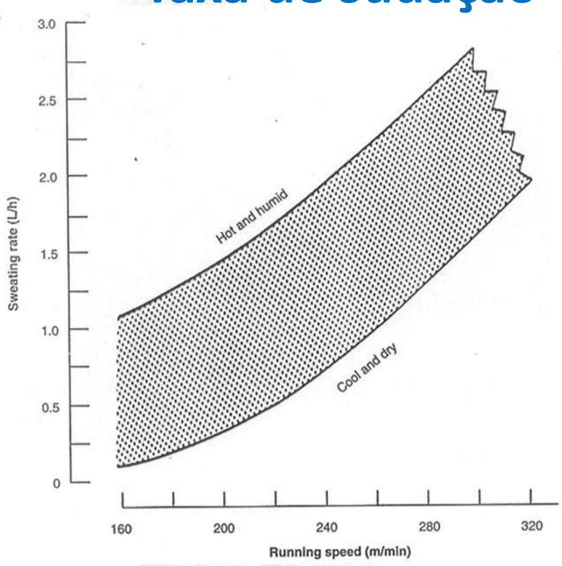
## Requirements

The body has no provision for water storage; therefore the amount of water lost every 24 hours must be replaced to maintain health and body efficiency.
In most cases a suitable daily allowance for water from all sources, including foods in adults, is approximately 3.7 L (125 oz) for males and 2.7 L (91 oz) for females, depending on body size.

*Mahan et al. (2013)*



# Taxa de sudação



# Fatores que influenciam a transpiração

- Maior **temperatura** = maior transpiração
- Maior **humidade** = maior transpiração, sem equivalente regulação (descida) de temperatura
- **Roupa** com pouca "respiração" ou demasiada roupa = maior transpiração sem descida equivalente de temperatura
- Pessoas **mais treinadas** = maior transpiração
- Melhor **estado de hidratação** = maior transpiração!

**(mais suor ... maior necessidade de hidratar)**



O défice de hidratação não só conduz a uma **diminuição do rendimento** desportivo, como pode **predispor o atleta para a lesão desportiva**."

*Mahan et al. (2013)*

## Dehydration

The process of losing body water is known as *dehydration*. During exercise, body water is most often lost through sweating. Water loss through urine (eg, diuretic use), respiration, feces (especially with diarrhea), or vomiting can also dehydrate the body.

*Journal of Athletic Training* 2017;52(9):877–895
doi: 10.4085/1062-6050-52.9.02



## Hypohydration

*Hypohydration* is a deficit of body water that is caused by acute or chronic dehydration. Hypohydration represents a continuum from both a clinical perspective (mild = 1% to 5%, moderate = 5% to 10%, and severe = >10% body mass deficit) and an athletic perspective (mild to moderate = 2% to 5% and severe = >5% body mass deficit) where mass = volume.

*Journal of Athletic Training* 2017;52(9):877–895
doi: 10.4085/1062-6050-52.9.02

TABLE 2. Observations of sweat rates, voluntary fluid intake and levels of dehydration in various sports. Values are mean, plus (range) or [95% reference range].

| | | Sweat rate ($L \cdot h^{-1}$) | | Voluntary fluid intake ($L \cdot h^{-1}$) | | Dehydration (% BM) (= change in BM) | |
|---|---|---|---|---|---|---|---|
| Sport | Condition | Mean | Range | Mean | Range | Mean | Range |
| Waterpolo [41] | Training (males) | 0.29 | [0.23–0.35] | 0.14 | [0.09–0.20] | 0.26 | [0.19–0.34] |
| | Competition (males) | 0.79 | [0.69–0.88] | 0.38 | [0.30–0.47] | 0.35 | [0.23–0.46] |
| Netball [16] | Summer training (females) | 0.72 | [0.45–0.99] | 0.44 | [0.25–0.63] | 0.7 | [+0.3–1.7] |
| | Summer competition (females) | 0.98 | [0.45–1.49] | 0.52 | [0.33–0.71] | 0.9 | [0.1–1.9] |
| Swimming [41] | Training (males & females) | 0.37 | | 0.38 | | 0 | (+1.0–1.4 kg) |
| Rowing [22] | Summer training (males) | 1.98 | (0.99–2.92) | 0.96 | (0.41–1.49) | 1.7 | (0.5–3.2) |
| | Summer training (females) | 1.39 | (0.74–2.34) | 0.78 | (0.29–1.39) | 1.2 | (0–1.8) |
| Basketball [16] | Summer training (males) | 1.37 | [0.9–1.84] | 0.80 | [0.35–1.25] | 1.0 | [0–2.0] |
| | Summer competition (males) | 1.6 | [1.23–1.97] | 1.08 | [0.46–1.70] | 0.9 | [0.2–1.6] |
| Soccer [130] | Summer training (males) | 1.46 | [0.99–1.93] | 0.65 | (0.16–1.15) | 1.59 | [0.4–2.8] |
| Soccer [89] | Winter training (males) | 1.13 | (0.71–1.77) | 0.28 | (0.03–0.63) | 1.62 | [0.87–2.55] |
| American football [62] | Summer training (males) | 2.14 | [1.1–3.18] | 1.42 | [0.57–2.54] | 1.7 kg (1.5%) | [0.1–3.5 kg] |
| Tennis [15] | Summer competition (males) | 1.6 | [0.62–2.58] | ~1.1 | | 1.3 | [+0.3–2.9] |
| | Summer competition (females) | | [0.56–1.34] | ~0.9 | | 0.7 | [+0.9–2.3] |
| Tennis [14] | Summer competition (cramp–prone males) | 2.60 | [1.79–3.41] | 1.6 | [0.80–2.40] | | |
| Squash [18] | Competition (males) | 2.37 | [1.49–3.25] | 0.98 | | 1.28 kg | [0.1–2.4 kg] |
| Half marathon running [21] | Winter competition (males) | 1.49 | [0.75–2.23] | 0.15 | [0.03–0.27] | 2.42 | [1.30–3.6] |
| Cross–country running [62] | Summer training (males) | 1.77 | [0.99–2.55] | 0.57 | [0–1.3] | ~1.8 | |
| Ironman triathlon [133] | Temperate competition (males & females] | | | | | | |
| | Swim leg | | | | | 1 kg | (+0.5–2.0 kg) |
| | Bike leg | 0.81 | (0.47–1.08) | 0.89 | (0.60–1.31) | +0.5 kg | (+3.0–1.0 kg) |
| | Run leg | 1.02 | (0.4–1.8) | 0.63 | (0.24–1.13) | 2 kg | (+1.5–3.5 kg) |
| | Total race | | | 0.71 | (0.42–0.97) | 3.5% | (+2.5–6.1 %) |

+ = gain in BM; ^not corrected for change in BM that occurs in very prolonged events due to factors other than fluid loss (e.g. metabolic fuel losses).

378 Official Journal of the American College of Sports Medicine http://www.acsm-msse.org

## Hyperhydration

*Hyperhydration* is the state of excessive total body water content with expanded intracellular and extracellular fluid volumes. The body normally excretes the excess fluids.

*Journal of Athletic Training* 2017;52(9):877–895
doi: 10.4085/1062-6050-52.9.02

AMERICAN COLLEGE of SPORTS MEDICINE®

POSITION STAND

# Exercise and Fluid Replacement

This pronouncement was written for the American College of Sports Medicine by Michael N. Sawka, FACSM (chair); Louise M. Burke, FACSM, E. Randy Eichner, FACSM, Ronald J. Maughan, FACSM, Scott J. Montain, FACSM, Nina S. Stachenfeld, FACSM.

**Evidence statement.** Symptomatic exercise-associated hyponatremia can occur in endurance events. *Evidence Category A*. Fluid consumption that exceeds sweating rate is the primary factor leading to exercise-associated hyponatremia. *Evidence Category A*. Large sweat sodium losses and small body mass (and total body water) can contribute to the exercise-associated hyponatremia. *Evidence Category B*.



## Exercise-Associated Hyponatremia

A potentially fatal condition, *EAH* is defined as a serum sodium concentration of less than 135 mmol·L$^{-1}$ during or within 24 hours of physical activity.[13,34–36] Exercise-associated hyponatremia is a potential medical emergency that is typically symptomatic at levels below 130 mmol·L$^{-1}$.

*Journal of Athletic Training* 2017;52(9):877–895
doi: 10.4085/1062-6050-52.9.02

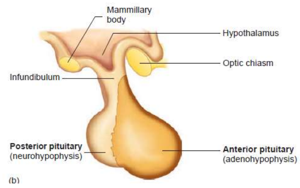



**Table 15.3 Hormones of the Pituitary Gland**

| Hormones | Structure | Target Tissue | Response |
|---|---|---|---|
| **Posterior Pituitary** | | | |
| Antidiuretic hormone (ADH) | Small peptide | Kidney | Increased water reabsorption (less water is lost in the form of urine) |
| Oxytocin | Small peptide | Uterus; mammary glands | Increased uterine contractions; increased milk expulsion from mammary glands; unclear function in males |
| **Anterior Pituitary** | | | |
| Growth hormone (GH), or somatotropin | Protein | Most tissues | Increased growth in tissues; increased amino acid uptake and protein synthesis; increased breakdown of lipids and release of fatty acids from cells; increased glycogen synthesis and increased blood glucose levels; increased somatomedin production |
| Thyroid-stimulating hormone (TSH) | Glycoprotein | Thyroid gland | Increased thyroid hormone secretion |
| Adrenocorticotropic hormone (ACTH) | Peptide | Adrenal cortex | Increased glucocorticoid hormone secretion |
| Melanocyte-stimulating hormone (MSH) | Peptide | Melanocytes in the skin | Increased melanin production in melanocytes to make the skin darker in color |
| Luteinizing hormone (LH) | Glycoprotein | Ovaries in females; testes in males | Ovulation and progesterone production in ovaries; testosterone synthesis and support for sperm cell production in testes |
| Follicle-stimulating hormone (FSH) | Glycoprotein | Follicles in ovaries in females; seminiferous tubes in males | Follicle maturation and estrogen secretion in ovaries; sperm cell production in testes |
| Prolactin | Protein | Ovaries and mammary glands in females | Milk production in lactating women; increased response of follicle to LH and FSH; unclear function in males |

**REVIEW ARTICLE**

Sports Med 2010; 40 (6): 459-479
0112-1642/10/0006-0459/$49.95/0



# Arginine Vasopressin, Fluid Balance and Exercise

## Is Exercise-Associated Hyponatraemia a Disorder of Arginine Vasopressin Secretion?

*Tamara Hew-Butler*

Exercise Science Program, Oakland University, Rochester, Michigan, USA

non-classical (oxytocin, interleukin-6) endocrine mediators. The review concludes with a hypothesis on how sustained fluid intakes beyond the capacity for fluid loss might possibly facilitate the development of hyponatraemia if exercise-induced non-osmotic stimuli override 'normal' osmotic suppression of AVP when hypo-osmolality exists.

REVIEW ARTICLE

Sports Med 2010; 40 (6): 459-479
0112-1642/10/0006-0459/$49.95/0



# Arginine Vasopressin, Fluid Balance and Exercise

## Is Exercise-Associated Hyponatraemia a Disorder of Arginine Vasopressin Secretion?

*Tamara Hew-Butler*

Exercise Science Program, Oakland University, Rochester, Michigan, USA

secretion. The hypothesis that EAH may develop when non-osmotic stimuli override 'regulatory' osmotic AVP stimulation during competitive endurance exercise, is thereby presented as a pathophysiological possibility if: (i) hypo-osmolality exists; and (ii) sustained fluid intake continues to exceed output over a significant (>4 hours) period of time.



TABLE 2. Observations of sweat rates, voluntary fluid intake and levels of dehydration in various sports. Values are mean, plus (range) or [95% reference range].

| | | Sweat rate ($L \cdot h^{-1}$) | | Voluntary fluid intake ($L \cdot h^{-1}$) | | Dehydration (% BM) (= change in BM) | |
|---|---|---|---|---|---|---|---|
| Sport | Condition | Mean | Range | Mean | Range | Mean | Range |
| Waterpolo [41] | Training (males) | 0.29 | [0.23–0.35] | 0.14 | [0.09–0.20] | 0.26 | [0.19–0.34] |
| | Competition (males) | 0.79 | [0.69–0.88] | 0.38 | [0.30–0.47] | 0.35 | [0.23–0.46] |
| Netball [16] | Summer training (females) | 0.72 | [0.45–0.99] | 0.44 | [0.25–0.63] | 0.7 | [+0.3–1.7] |
| | Summer competition (females) | 0.98 | [0.45–1.49] | 0.52 | [0.33–0.71] | 0.9 | [0.1–1.9] |
| Swimming [41] | Training (males & females) | 0.37 | | 0.38 | | 0 | (+1.0–1.4 kg) |
| Rowing [22] | Summer training (males) | 1.98 | (0.99–2.92) | 0.96 | (0.41–1.49) | 1.7 | (0.5–3.2) |
| | Summer training (females) | 1.39 | (0.74–2.34) | 0.78 | (0.29–1.39) | 1.2 | (0–1.8) |
| Basketball [16] | Summer training (males) | 1.37 | [0.9–1.84] | 0.80 | [0.35–1.25] | 1.0 | [0–2.0] |
| | Summer competition (males) | 1.6 | [1.23–1.97] | 1.08 | [0.46–1.70] | 0.9 | [0.2–1.6] |
| Soccer [130] | Summer training (males) | 1.46 | [0.99–1.93] | 0.65 | (0.16–1.15) | 1.59 | [0.4–2.8] |
| Soccer [89] | Winter training (males) | 1.13 | (0.71–1.77) | 0.28 | (0.03–0.63) | 1.62 | [0.87–2.55] |
| American football [62] | Summer training (males) | 2.14 | [1.1–3.18] | 1.42 | [0.57–2.54] | 1.7 kg (1.5%) | [0.1–3.5 kg] |
| Tennis [15] | Summer competition (males) | 1.6 | [0.62–2.58] | ~1.1 | | 1.3 | [+0.3–2.9] |
| | Summer competition (females) | | [0.56–1.34] | ~0.9 | | 0.7 | [+0.9–2.3] |
| Tennis [14] | Summer competition (cramp–prone males) | 2.60 | [1.79–3.41] | 1.6 | [0.80–2.40] | | |
| Squash [18] | Competition (males) | 2.37 | [1.49–3.25] | 0.98 | | 1.28 kg | [0.1–2.4 kg] |
| Half marathon running [21] | Winter competition (males) | 1.49 | [0.75–2.23] | 0.15 | [0.03–0.27] | 2.42 | [1.30–3.6] |
| Cross–country running [62] | Summer training (males) | 1.77 | [0.99–2.55] | 0.57 | [0–1.3] | ~1.8 | |
| Ironman triathlon [133] | Temperate competition (males & females) | | | | | | |
| | Swim leg | | | | | 1 kg | (+0.5–2.0 kg) |
| | Bike leg | 0.81 | (0.47–1.08) | 0.89 | (0.60–1.31) | +0.5 kg | (+3.0–1.0 kg) |
| | Run leg | 1.02 | (0.4–1.8) | 0.63 | (0.24–1.13) | 2 kg | (+1.5–3.5 kg) |
| | Total race | | | 0.71 | (0.42–0.97) | 3.5% | (+2.5–6.1 %) |

+ = gain in BM; ^not corrected for change in BM that occurs in very prolonged events due to factors other than fluid loss (e.g. metabolic fuel losses).

Br J Sports Med 2007;41:531–536. doi: 10.1136/bjsm.2006.031351

# An integrated physiological and performance profile of professional tennis

Daniel J Hornery, Damian Farrow, Iñigo Mujika, Warren Young

**Design:** 14 male professional tennis players (mean (SD) age, 21.4 (2.6) years; height, 183.0 (6.9) cm; body mass, 79.2 (6.4) kg) were studied while contesting international tennis tournaments. Environmental conditions, match notation, physiological (core temperature, hydration status, heart rate, blood variables), and performance indices (serve kinematics, serve velocity, error rates) were recorded.



Br J Sports Med 2007;41:531–536. doi: 10.1136/bjsm.2006.031351

An integrated physiological and performance profile of professional tennis

Daniel J Hornery, Damian Farrow, Iñigo Mujika, Warren Young

**Design:** 14 male professional tennis players (mean (SD) age, 21.4 (2.6) years; height, 183.0 (6.9) cm; body mass, 79.2 (6.4) kg) were studied while contesting international tennis tournaments. Environmental conditions, match notation, physiological (core temperature, hydration status, heart rate, blood variables), and performance indices (serve kinematics, serve velocity, error rates) were recorded.

**Results:** Hard and clay court tournaments elicited similar peak core temperature (38.9 (0.3) *v* 38.5 (0.6) ℃) and average heart rate (152 (15) *v* 146 (19) beats/min) but different body mass deficit (1.05 (0.49) *v* 0.32 (0.56)%, $p<0.05$). Average pre-match urine specific gravity was 1.022 (0.004). Time between points was longer during hard court matches (25.1 (4.3) *v* 17.2 (3.3) s, $p<0.05$). Qualitative analysis of first and second serves revealed inverse relations between the position of the tossing arm at ball release and the position of the ball toss and progressive match time (respectively, $r=-0.74$ and $r=-0.73$, $p<0.05$) and incurred body mass deficit ($r=0.73$ and $r=0.73$, $p<0.05$).

Br J Sports Med 2007;41:531–536. doi: 10.1136/bjsm.2006.031351

## An integrated physiological and performance profile of professional tennis

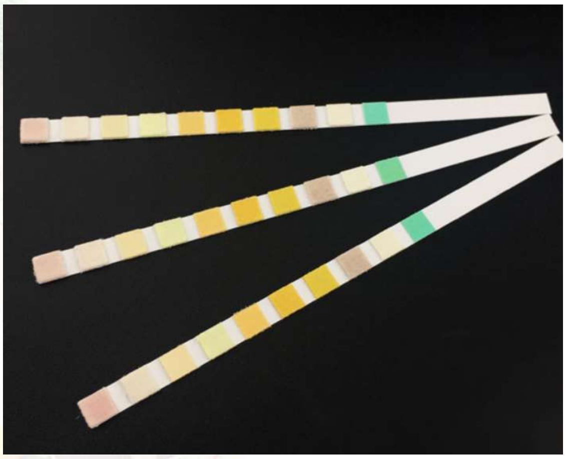
Daniel J Hornery, Damian Farrow, Iñigo Mujika, Warren Young

**Design:** 14 male professional tennis players (mean (SD) age, 21.4 (2.6) years; height, 183.0 (6.9) cm; body mass, 79.2 (6.4) kg) were studied while contesting international tennis tournaments. Environmental conditions, match notation, physiological (core temperature, hydration status, heart rate, blood variables), and performance indices (serve kinematics, serve velocity, error rates) were recorded.
**Results:** Hard and clay court tournaments elicited similar peak core temperature (38.9 (0.3) v 38.5 (0.6) ℃) and average heart rate (152 (15) v 146 (19) beats/min) but different body mass deficit (1.05 (0.49) v 0.32 (0.56)%, $p<0.05$). Average pre-match urine specific gravity was 1.022 (0.004). Time between points was longer during hard court matches (25.1 (4.3) v 17.2 (3.3) s, $p<0.05$). Qualitative analysis of first and second serves revealed inverse relations between the position of the tossing arm at ball release and the position of the ball toss and progressive match time (respectively, $r=-0.74$ and $r=-0.73$, $p<0.05$) and incurred body mass deficit ($r=0.73$ and $r=0.73$, $p<0.05$).
**Conclusions:** Participants began matches in a poor state of hydration, and experienced moderate thermoregulatory strain and dehydration during competition. These adverse physiological conditions may compromise performance and influence notational analyses.

| | Hard court | | Clay court | |
|---|---|---|---|---|
| Pre-match | Mean (SD) | Min–max | Mean (SD) | Min–max |
| Urine specific gravity | 1.023 (0.004) | 1.015–1.025 | 1.021 (0.004) | 1.017–1.028 |



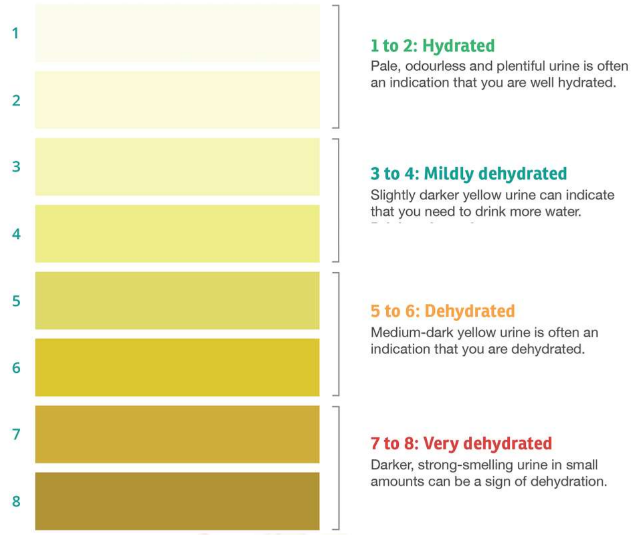
**-Tira de 10 testes rápidos à urina**



**-Escala do teste de densidade relativa da urina**

**Specific Gravity 45s**

## Forma rápida, simples, barata e viável de avaliar o nível de hidratação




www.healthdirect.gov.au



## FUELING FOR FITNESS: FOOD AND FLUID RECOMMENDATIONS FOR BEFORE, DURING, AND AFTER EXERCISE

by Nanna L. Meyer, Ph.D., R.D., CSSD; Melinda M. Manore, Ph.D., R.D., CSSD, FACSM; and Jacqueline Berning, Ph.D., R.D., CSSD

**Antes…**

### *Fluids*

Four hours before a workout, individuals are advised to drink 5 to 7 mL of water or sport drink/kg body mass (~1.5 to 2 cups) (21). This will optimize hydration and allow time for excretion of any excess fluid. To meet weight loss goals, individuals may prefer flavored water, diluted apple juice (a European tradition), or a low calorie sport drink over other beverages. A good way to monitor hydration status before exercise is to check one's urine color. It should be lightly yellow (*e.g.*, like lemonade), which indicates adequate hydration. Clients/fitness professionals should not begin exercise being thirsty. An additional 3 to 5 mL/kg body mass (~1 to 1.5 cups) of fluid should be consumed if urine is dark yellow (21).

VOL. 16/ NO. 3
ACSM's HEALTH & FITNESS JOURNAL®

## Mas, como em quase tudo, há exceções…



Front. Nutr. 7:549413. doi: 10.3389/fnut.2020.549413

## Sodium Ingestion Improves Groundstroke Performance in Nationally-Ranked Tennis Players: A Randomized, Placebo-Controlled Crossover Trial

*Edward H. Munson[1†], Samuel T. Orange[2†], James W. Bray[1], Shane Thurlow[3], Philip Marshall[1] and Rebecca V. Vince[1*]*

concentrations on markers of hydration and tennis skill. Twelve British nationally-ranked tennis players (age: 21.5 ± 3.1 years; $VO_{2peak}$: 45.5 ± 4.4 ml·kg·min$^{-1}$) completed

**Vs.**

**20min antes 250 mL + 1000 mL durante 1 hora, com 2,9 g/L de NaCl**

**20min antes 250 mL + 1000 mL durante 1 hora, "sem nada".**

sodium loss, serve or agility performance ($p$ > 0.05). In conclusion, consuming 50 mmol/L of sodium before and during a 1-h tennis training session reduced urine osmolality and improved groundstroke performance in nationally-ranked tennis players.

TABLE 2. Observations of sweat rates, voluntary fluid intake and levels of dehydration in various sports. Values are mean, plus (range) or [95% reference range].

| | | Sweat rate ($L \cdot h^{-1}$) | | Voluntary fluid intake ($L \cdot h^{-1}$) | | Dehydration (% BM) (= change in BM) | |
|---|---|---|---|---|---|---|---|
| Sport | Condition | Mean | Range | Mean | Range | Mean | Range |
| Waterpolo [41] | Training (males) | 0.29 | [0.23–0.35] | 0.14 | [0.09–0.20] | 0.26 | [0.19–0.34] |
| | Competition (males) | 0.79 | [0.69–0.88] | 0.38 | [0.30–0.47] | 0.35 | [0.23–0.46] |
| Netball [16] | Summer training (females) | 0.72 | [0.45–0.99] | 0.44 | [0.25–0.63] | 0.7 | [+0.3–1.7] |
| | Summer competition (females) | 0.98 | [0.45–1.49] | 0.52 | [0.33–0.71] | 0.9 | [0.1–1.9] |
| Swimming [41] | Training (males & females) | 0.37 | | 0.38 | | 0 | (+1.0–1.4 kg) |
| Rowing [22] | Summer training (males) | 1.98 | (0.99–2.92) | 0.96 | (0.41–1.49) | 1.7 | (0.5–3.2) |
| | Summer training (females) | 1.39 | (0.74–2.34) | 0.78 | (0.29–1.39) | 1.2 | (0–1.8) |
| Basketball [16] | Summer training (males) | 1.37 | [0.9–1.84] | 0.80 | [0.35–1.25] | 1.0 | [0–2.0] |
| | Summer competition (males) | 1.6 | [1.23–1.97] | 1.08 | [0.46–1.70] | 0.9 | [0.2–1.6] |
| Soccer [130] | Summer training (males) | 1.46 | [0.99–1.93] | 0.65 | (0.16–1.15) | 1.59 | [0.4–2.8] |
| Soccer [89] | Winter training (males) | 1.13 | (0.71–1.77) | 0.28 | (0.03–0.63) | 1.62 | [0.87–2.55] |
| American football [62] | Summer training (males) | 2.14 | [1.1–3.18] | 1.42 | [0.57–2.54] | 1.7 kg (1.5%) | [0.1–3.5 kg] |
| Tennis [15] | Summer competition (males) | 1.6 | [0.62–2.58] | ~1.1 | | 1.3 | [+0.3–2.9] |
| | Summer competition (females) | | [0.56–1.34] | ~0.9 | | 0.7 | [+0.9–2.3] |
| Tennis [14] | Summer competition (cramp–prone males) | 2.60 | [1.79–3.41] | 1.6 | [0.80–2.40] | | |
| Squash [18] | Competition (males) | 2.37 | [1.49–3.25] | 0.98 | | 1.28 kg | [0.1–2.4 kg] |
| Half marathon running [21] | Winter competition (males) | 1.49 | [0.75–2.23] | 0.15 | [0.03–0.27] | 2.42 | [1.30–3.6] |
| Cross–country running [62] | Summer training (males) | 1.77 | [0.99–2.55] | 0.57 | [0–1.3] | ~1.8 | |
| Ironman triathlon [133] | Temperate competition (males & females] | | | | | | |
| | Swim leg | | | | | 1 kg | (+0.5–2.0 kg) |
| | Bike leg | 0.81 | (0.47–1.08) | 0.89 | (0.60–1.31) | +0.5 kg | (+3.0–1.0 kg) |
| | Run leg | 1.02 | (0.4–1.8) | 0.63 | (0.24–1.13) | 2 kg | (+1.5–3.5 kg) |
| | Total race | | | 0.71 | (0.42–0.97) | 3.5% | (+2.5–6.1 %) |

+ = gain in BM; ^not corrected for change in BM that occurs in very prolonged events due to factors other than fluid loss (e.g. metabolic fuel losses).



## Voluntary Dehydration in Runners Despite Favorable Conditions for Fluid Intake

Dennis Passe, Mary Horn, John Stofan, Craig Horswill, and Robert Murray

- 18 maratonistas (15♂, 40,5 +/- 2,5 anos; 3♀, 42,0 +/- 2,3 anos)
- ≈ 12 provas anuais
- ≈ 8 horas de treinos semanais
- Todos usavam habitualmente **bebidas desportivas** nos treinos e provas
- O estudo incluiu uma prova de 16 km com **bebidas desportivas** disponíveis aos 3,2; 6,4; 9,6 e 12,8 km (em 4 pontos da prova)

Journal of Sport Nutrition and Exercise Metabolism, 2007, 17, 284-295

## Voluntary Dehydration in Runners Despite Favorable Conditions for Fluid Intake

Dennis Passe, Mary Horn, John Stofan, Craig Horswill, and Robert Murray

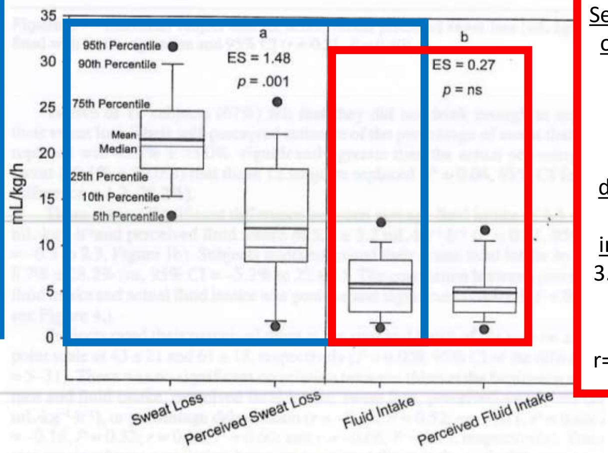
- **Objetivo:** Estudar a relação entre a perceção da necessidade de hidratação e a ingestão de líquidos em maratonistas, numa prova de 16 km com bebidas desportivas disponíveis aos 3,2; 6,4; 9,6 e 12,8 km (em 4 pontos da prova)



## Voluntary Dehydration in Runners Despite Favorable Conditions for Fluid Intake

Dennis Passe, Mary Horn, John Stofan, Craig Horswill, and Robert Murray

Subjects replaced only 30.5% +/- 18.1% of sweat loss and underestimated their sweat loss by 42.5% +/- 36.6%.




Self-estimations of fluid intake (5.2 +/- 3.2 mL·kg$^{-1}$·h$^{-1}$) were not significantly different from actual fluid intake (6.1 +/- 3.4 mL·kg$^{-1}$·h$^{-1}$) and were correlated r=0.63,P=0.005

**Figure 1** — (a) Actual versus perceived sweat loss and (b) actual versus perceived fluid intake (mL·kg$^{-1}$·h$^{-1}$). Box plots indicate mean (heavy line) and median (thin line), with 5th, 10th, 25th, 75th, 90th, and 95th percentiles. Effect sizes (ES) of mean differences and *p*-values are indicated for actual versus perceived sweat loss and fluid intake.

**Voluntary Dehydration in Runners Despite Favorable Conditions for Fluid Intake**

Dennis Passe, Mary Horn, John Stofan, Craig Horswill, and Robert Murray

- **Objetivo:** Estudar a relação entre a perceção da necessidade de hidratação e a ingestão de líquidos em maratonistas, numa prova de 16 km com bebidas desportivas disponíveis aos 3,2; 6,4; 9,6 e 12,8 km (em 4 pontos da prova)

0.005). The data indicate that even under favorable conditions, experienced runners voluntarily dehydrate ($P \leq 0.001$), possibly because they are unable to accurately estimate sweat loss and consequently cannot subjectively judge how much fluid to ingest to prevent dehydration. This conclusion suggests that runners should

In summary, the results indicate that judging by thirst is an ineffective way for many runners to protect their hydration status. Consequently, runners should either employ a predetermined fluid-replacement regimen based on body-weight change





# O que provocou esta perda de peso?

# Exercise and Fluid Replacement

AMERICAN COLLEGE of SPORTS MEDICINE®

POSITION STAND

This pronouncement was written for the American College of Sports Medicine by Michael N. Sawka, FACSM (chair); Louise M. Burke, FACSM, E. Randy Eichner, FACSM, Ronald J. Maughan, FACSM, Scott J. Montain, FACSM, Nina S. Stachenfeld, FACSM.

**Durante…**

**Recommendations.** Individuals should develop customized fluid replacement programs that prevent excessive (<2% body weight reductions from baseline body weight) dehydration. The routine measurement of pre- and postexercise body weights is useful for determining sweat rates and customized fluid replacement programs. Consumption of beverages containing electrolytes and carbohydrates can help sustain fluid-electrolyte balance and exercise performance.





In athletes, a deficit greater than 5% is consistently associated with impaired performance, extreme thirst, headache, and other symptoms; such a fluid deficit is difficult to replace, even with extended recovery time.

*Journal of Athletic Training* 2017;52(9):877–895
doi: 10.4085/1062-6050-52.9.02

AMERICAN COLLEGE of SPORTS MEDICINE®

POSITION STAND

# Exercise and Fluid Replacement

This pronouncement was written for the American College of Sports Medicine by Michael N. Sawka, FACSM (chair); Louise M. Burke, FACSM, E. Randy Eichner, FACSM, Ronald J. Maughan, FACSM, Scott J. Montain, FACSM, Nina S. Stachenfeld, FACSM.

**Evidence statement.** Body weight changes can reflect sweat losses during exercise and can be used to calculate individual fluid replacement needs for specific exercise and environmental conditions. *Evidence Category A.*

IEPAP

Nutrição e Suplementação no Exercício Físico

Prof.º Dr.º Rui Jorge

AMERICAN COLLEGE of SPORTS MEDICINE®

POSITION STAND

Exercise and Fluid Replacement

This pronouncement was written for the American College of Sports Medicine by Michael N. Sawka, FACSM (chair); Louise M. Burke, FACSM, E. Randy Eichner, FACSM, Ronald J. Maughan, FACSM, Scott J. Montain, FACSM, Nina S. Stachenfeld, FACSM.

**Evidence statement.** Body weight changes can reflect sweat losses during exercise and can be used to calculate individual fluid replacement needs for specific exercise and environmental conditions. *Evidence Category A.*

# Como fazer?

IEPAP

Nutrição e Suplementação no Exercício Físico

Prof.º Dr.º Rui Jorge

## Algumas considerações:

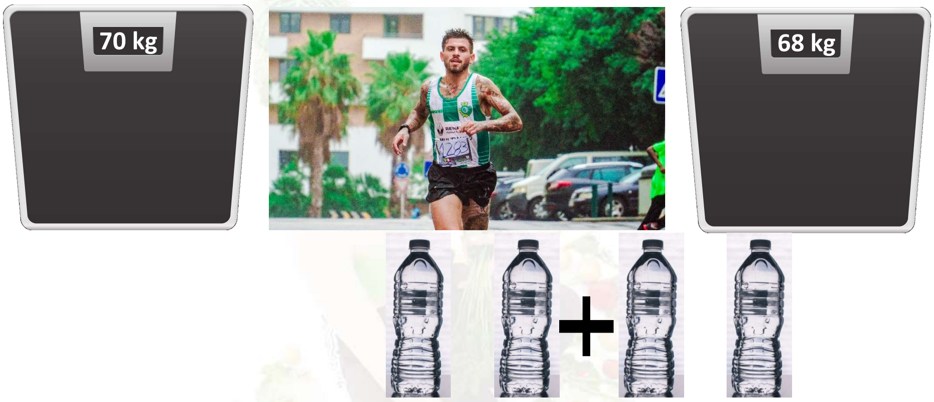
- Garantir que a pesagem inicial é feita sem roupa;
- Garantir que a pesagem final é feita sem roupa e **após secar bem o corpo** todo (incluindo o cabelo!);
- As condições de avaliação devem mimetizar as condições da competição quanto à ingestão de líquidos;
- Os valores irão **variar em função da temperatura e humidade**;
- O poder preditivo diminui à medida que aumenta a duração da prova e a depleção de glicogénio (considerar toda a ingestão).





**Perdas estimadas através do suor:** 70 – 67 ≈ **3 L**

**% de peso perdido:** 70 – 67 ≈ 3 L ; 3/70x100 ≈ **4,3%**




**Perdas estimadas através do suor:** 70 + 0,5 + 0,5 – 68 ≈ **3 L**

**% de peso perdido bebendo 1 L:** 70 – 68 ≈ 2 L ; 2/70x100 ≈ **2,9%**

**% de peso perdido bebendo 2 L:** 70 – 69 ≈ 1 L ; 1/70x100 ≈ **1,4%**

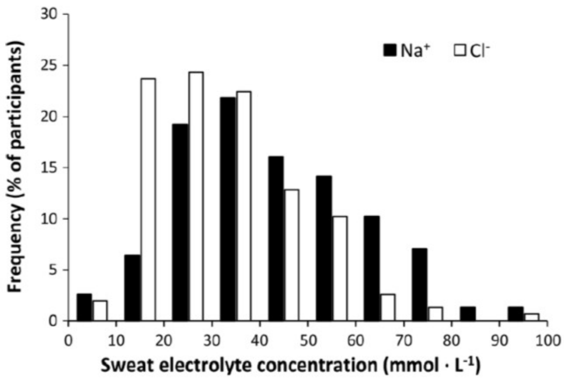


Lara et al. Journal of the International Society of Sports Nutrition (2016) 13:31

## Interindividual variability in sweat electrolyte concentration in marathoners

Beatriz Lara, César Gallo-Salazar, Carlos Puente, Francisco Areces, Juan José Salinero and Juan Del Coso*

**Methods:** A total of 157 experienced runners (141 men and 16 women) completed a marathon race (24.4 ± 3.6 °C and 27.7 ± 4.8 % of humidity). During the race, sweat samples were collected by using sweat patches placed on the




**Conclusions:** The inter-individual variability in sweat electrolyte concentration was not explained by any individual characteristics except for individual running pace and sex. An important portion (20 %) of marathoners might need special sodium intake recommendations due to their high sweat salt losses.

Lara *et al. Journal of the International Society of Sports Nutrition* (2016) 13:31

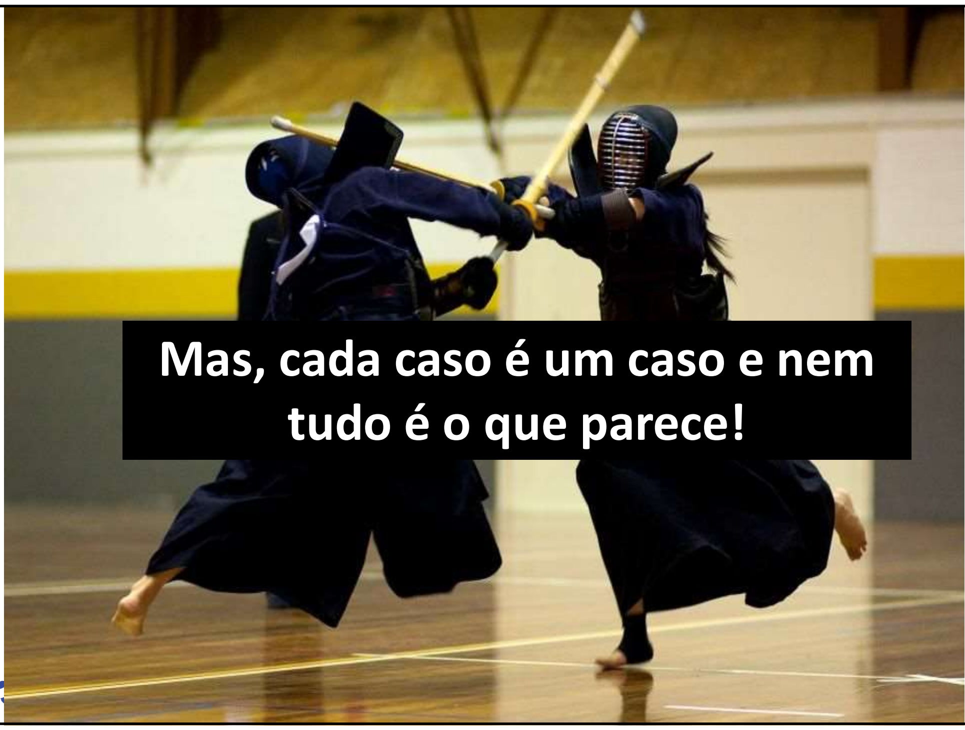
**Table 2** Sweat and performance variables according to sweat electrolyte concentration. Data is mean ± SD for each group

| Variable (units) | Low-salt sweat <30 mmol·L⁻¹ [sweat Na⁺] | Typical Sweat 30–60 mmol·L⁻¹ [sweat Na⁺] | Salty sweat >60 mmol·L⁻¹ [sweat Na⁺] | *P* value |
|---|---|---|---|---|
| Number/Frequency | 42/27 % | 84/54 % | 31/20 % | - |
| Men/women | 37/5 | 73/11 | 31/0 | 0.11 |
| Sweat $Na^+$ concentration ($mmol \cdot l^{-1}$) | 21.4 ± 6.4* | 43.2 ± 8.8 | 71.0 ± 9.0*† | <0.01 |
| | **≈1,25 g de NaCl/L** | **≈2,53 g de NaCl/L** | **≈4,16 g de NaCl/L** | |
| Sweat rate ($L \cdot h^{-1}$) | 0.9 ± 0.2 | 0.9 ± 0.3 | 1.0 ± 0.2 | 0.76 |
| Running pace ($m \cdot s^{-1}$) | 3.0 ± 0.4 | 3.1 ± 0.5 | 3.2 ± 0.5 | 0.18 |

**≈ 4 h a correr a Maratona**

**≈4,50 g de NaCl** **≈9,11 g de NaCl** **≈16,64 g de NaCl**





> J Sports Med Phys Fitness. 2011 Dec;51(4):603-8.

# Heat stress and dehydration in kendo

L Rossi [1], M Schaefer Cardoso, H Torres, V Ragasso Casalenovo

**Methods:** Participants were 12 male individuals. The studied variables were: age, weight, stature, body mass index, fat percentage, water loss percentage, tympanic temperature, and sweat rate. Measures were obtained in one day of 120 min practice (T: 24.1 ± 2.5 °C; RH: 73 ± 8.5%) using obligatory training equipment.

**Results:** The age of participants was on average 26 ± 6.2 years, stature 1.8 ± 0.03 m, weight 78 ± 13.7 kg, BMI 24.12 ± 4.03 kg/m$^2$ and fat percentage 15.7 ± 5.1%. Weight and temperature final values were significantly different from the initial ones (P<0.01). Estimated sweat rate was 0.35 L.h-1 (95% CI = [0.299; 0.400]) and estimated percentage of water loss was 0.946% (95% CI = [0.694; 1.174]).



**Position of the Academy of Nutrition and Dietetics, Dietitians of Canada, and the American College of Sports Medicine: Nutrition and Athletic Performance**

**Depois…**

After exercise, the athlete should restore fluid balance by drinking a volume of fluid that is equivalent to ~125% to 150% of the remaining fluid deficit (eg, 1.25 to 1.5 L fluid for every 1 kg BW lost).



JOURNAL OF THE ACADEMY OF NUTRITION AND DIETETICS

Suplementação



# Definição de suplementos alimentares

- **Géneros alimentícios** que se destinam a complementar e ou suplementar o regime alimentar normal e que constituem fontes concentradas de determinadas substâncias nutrientes ou outras com efeito nutricional ou fisiológico, **estremes ou combinadas**, comercializadas em **forma doseada**, tais como cápsulas, pastilhas, comprimidos, pílulas e outras formas semelhantes, saquetas de pó, ampolas de líquido, frascos com conta-gotas e outras formas similares de líquidos ou pós que se destinam a ser tomados em unidades medidas de **quantidade reduzida**;

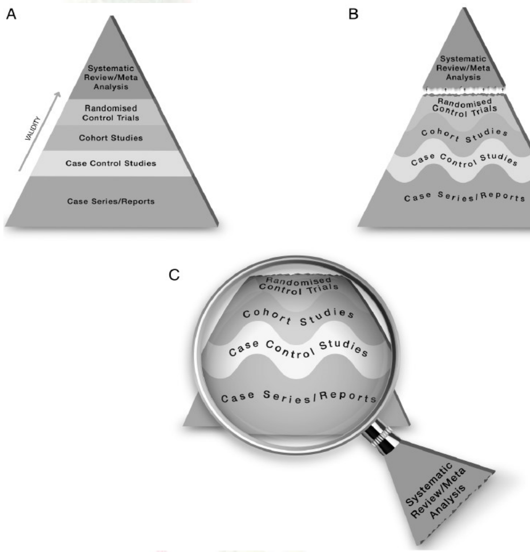
Decreto de Lei N.º 136/2003 de 28 de Junho

# Como perceber se um suplemento alimentar funciona ou não:
# Análise de eficácia



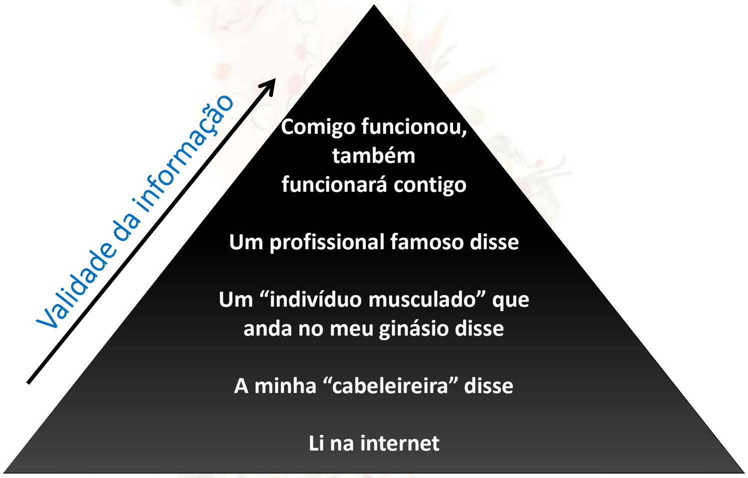
## New evidence pyramid

M Hassan Murad, Noor Asi, Mouaz Alsawas, Fares Alahdab




*Evid Based Med* August 2016 | volume 21 | number 4 |

# Pirâmide da evidência pela qual muitos dos nossos clientes se guiam




IPAP

Nutrição e Suplementação no Exercício Físico

Prof.º Dr.º Rui Jorge

---

Sports Med (2016) 46:103–123
DOI 10.1007/s40279-015-0387-7

CrossMark

SYSTEMATIC REVIEW

## Prevalence of Dietary Supplement Use by Athletes: Systematic Review and Meta-Analysis

Joseph J. Knapik[1,2,3] · Ryan A. Steelman[2] · Sally S. Hoedebecke[4] · Krista G. Austin[1,3] · Emily K. Farina[1,3] · Harris R. Lieberman[1]

**Key Points**

When dietary supplement use was compiled by sport, elite versus non-elite athletic status, and supplement type there was high variability in use prevalence among studies.

Elite athletes appeared to use dietary supplements much more than their non-elite counterparts.

For most dietary supplements, use prevalence appeared similar for men and women. Exceptions were that a larger proportion of women used iron and a larger proportion of men used vitamin E, protein, and creatine.

IPAP

Prof.º Dr.º Rui Jorge

## Porque razão os atletas utilizam suplementos?

*International Journal of Sport Nutrition and Exercise Metabolism*, 2018, 28, 126-138

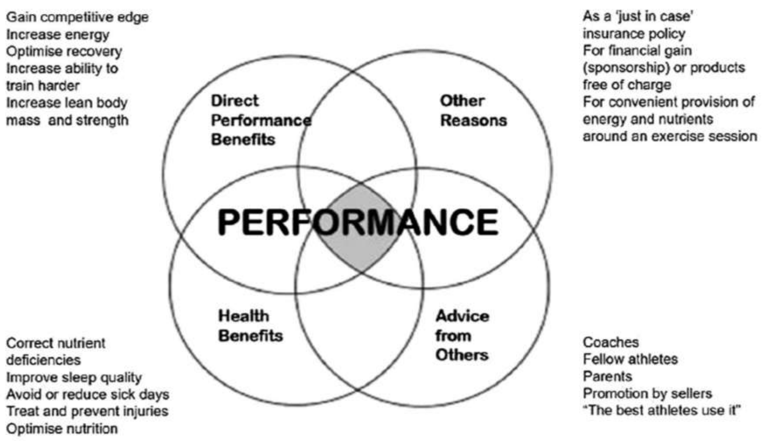
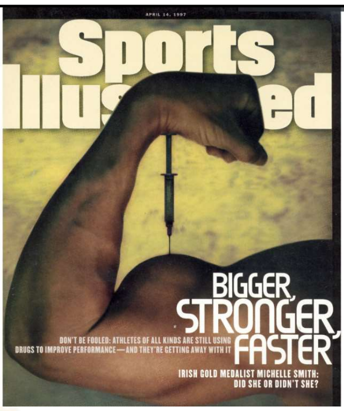



**Figure 4** — Common reasons given by athletes for the use of supplements.



## Ganhar a qualquer custo?


A SCENARIO, from a 1995 poll of 198 sprinters, swimmers, powerlifters and other assorted athletes, most of them U.S. Olympians or aspiring Olympians:

Tomaria uma substância proibida caso tivesse a garantia de que ganharia a prova e que não seria suspenso? **98% SIM**

E se essa substância elevasse as suas capacidades possibilitando **ganhar todas as competições** nos próximos 5 anos, mas depois resultasse em **morte**? **50% SIM**

1997

## Classificação da Eficácia e Segurança dos "Suplementos" Ergogénicos

| Categoria | Ergogénicos |
|---|---|
| Aparentemente eficazes e seguros | ß-alanina; **Bebidas desportivas;** Bicarbonato de Sódio; Cafeína; Creatina; Hidratos de Carbono. |
| Possivelmente eficazes | Aminoácidos de cadeia ramificada (BCAAs); Aminoácidos Essenciais; ß-Hidroxi-ß-Metilbutirato (HMB); Fosfato de Sódio; Glicerol; Proteína. |
| Aparentemente não eficazes e/ou perigosos | Glutamina; Inosina; Ribose; Triglicéridos de Cadeia Média (TCMs). |

Castro, M. & Jorge, R. Nutrição e Suplementação *in* Manual do Técnico de Exercício Físico, 2022



## Classificação da Eficácia e Segurança dos "Suplementos" Ergogénicos

| Categoria | Ergogénicos |
|---|---|
| Aparentemente eficazes e seguros | ß-alanina; **Bebidas desportivas;** Bicarbonato de Sódio; Cafeína; Creatina; Hidratos de Carbono. |
| Possivelmente eficazes | Aminoácidos de cadeia ramificada (BCAAs); Aminoácidos Essenciais; ß-Hidroxi-ß-Metilbutirato (HMB); Fosfato de Sódio; Glicerol; Proteína. |
| Aparentemente não eficazes e/ou perigosos | Glutamina; Inosina; Ribose; Triglicéridos de Cadeia Média (TCMs). |

Castro, M. & Jorge, R. Nutrição e Suplementação *in* Manual do Técnico de Exercício Físico, 2022

REVIEW **Open Access**

# International society of sports nutrition position stand: Beta-Alanine

Eric T. Trexler[1†], Abbie E. Smith-Ryan[1*†], Jeffrey R. Stout[2], Jay R. Hoffman[2], Colin D. Wilborn[3], Craig Sale[4], Richard B. Kreider[5], Ralf Jäger[6], Conrad P. Earnest[5,7], Laurent Bannock[8], Bill Campbell[9], Douglas Kalman[10], Tim N. Ziegenfuss[11] and Jose Antonio[12]

**Abstract**

**Position statement:** The International Society of Sports Nutrition (ISSN) provides an objective and critical review of the mechanisms and use of beta-alanine supplementation. Based on the current available literature, the conclusions of the ISSN are as follows: 1) Four weeks of beta-alanine supplementation (4–6 g daily) significantly augments muscle carnosine concentrations, thereby acting as an intracellular pH buffer; 2) Beta-alanine supplementation currently appears to be safe in healthy populations at recommended doses; 3) The only reported side effect is paraesthesia (tingling), but studies indicate this can be attenuated by using divided lower doses (1.6 g) or using a sustained-release formula; 4) Daily supplementation with 4 to 6 g of beta-alanine for at least 2 to 4 weeks has been shown to improve exercise performance, with more pronounced effects in open end-point tasks/time trials lasting 1 to 4 min in duration; 5) Beta-alanine attenuates neuromuscular fatigue, particularly in older subjects, and preliminary evidence indicates that beta-alanine may improve tactical performance; 6) Combining beta-alanine with other single or multi-ingredient supplements may be advantageous when supplementation of beta-alanine is high enough (4–6 g daily) and long enough (minimum 4 weeks); 7) More research is needed to determine the effects of beta-alanine on strength, endurance performance beyond 25 min in duration, and other health-related benefits associated with carnosine.



Trexler et al. Journal of the International Society of Sports Nutrition (2015) 12:30

doi: 10.23736/S0022-4707.20.11946-7.

The Journal of Sports Medicine and Physical Fitness 2020 Dec 11

DOI: 10.23736/S0022-4707.20.11946-7
Copyright © 2020 EDIZIONI MINERVA MEDICA
*language: English*

Online ahead of print.

**Beta-alanine fails to improve on 5,000 m running time despite increasing PAT1 expression in long-distance runners**

Gabriel S. FRANCO 1, 2, Natália Y. NORONHA 1, Bruno A. OLIVEIRA 1, Flávia C. FERREIRA 1, Ana Paula PINTO 3, Camila F. BRANDAO 4, 5, Marcelo PAPOTI 6, Carla B. NONINO 1

## RCT:

- 8 corredores com 4,8 g de Beta-alanina durante 4 semanas vs. 8 corredores a tomar placebo durante 4semanas;
- “Although beta-alanine supplementation increased PAT1 expression, **there was no statistically significant improvement in 5,000 m running performance.**”

A Beta-alanina tem mostrado aumentar a performance em atividades com duração compreendida ente **1 a 4 minutos**.

Kerksick *et al. Journal of the International Society of Sports Nutrition* (2018) 15:38
https://doi.org/10.1186/s12970-018-0242-y

# Cafeína

Caffeine contributes to endurance performance, apparently because of its ability to enhance mobilization of fatty acids and thus conserve glycogen stores. Caffeine may also directly affect muscle contractility, possibly by facilitating calcium transport. It could reduce fatigue as well by reducing plasma potassium accumulation, which contributes to fatigue.

The diuretic action of caffeine could have negative consequences for athletes with excessive water needs or for those participating in long-distance events who do not want to have to urinate during the event.

Mahan LK, Escott-Stump S. *Krause's Food and Nutrition Therapy*. Canada: 13th edition Elsevier (2013)



# Cafeína

**Será este aspeto relevante?**

The diuretic action of caffeine could have negative consequences for athletes with excessive water needs or for those participating in long-distance events who do not want to have to urinate during the event.

Mahan LK, Escott-Stump S. *Krause's Food and Nutrition Therapy*. Canada: 13th edition Elsevier (2013)

HHS Public Access
Author manuscript
*J Sci Med Sport*. Author manuscript; available in PMC 2016 January 25.

Published in final edited form as:
*J Sci Med Sport*. 2015 September ; 18(5): 569–574. doi:10.1016/j.jsams.2014.07.017.

## Caffeine and diuresis during rest and exercise: A meta-analysis

**Yang Zhang**[a], **Aitor Coca**[b], **Douglas J. Casa**[c], **Jose Antonio**[d], **James M. Green**[e], and **Phillip A. Bishop**[f]
Yang Zhang: dr.zhang.yang@qq.com

**Results—**The median caffeine dosage was 300 mg. The overall ES of 0.29 (95% confidence interval (CI) = 0.11-0.48, $p = 0.001$) corresponds to an increase in urine volume of 109 ± 195 mL or 16.0 ± 19.2% for caffeine ingestion vs. non-caffeine conditions. Subgroup meta-analysis confirmed exercise as a strong moderator: active ES = 0.10, 95% CI = −0.07 to 0.27, $p = 0.248$ vs. resting ES = 0.54, 95% CI = 0.22–0.85, $p = 0.001$ (Cochran's $Q$, $p = 0.019$). Females (ES = 0.75,95% CI = 0.38–1.13, $p < 0.001$) were more susceptible to diuretic effects than males (ES = 0.13,95% CI = −0.05 to 0.31, $p = 0.158$) (Cochran's $Q$, $p = 0.003$).

**Conclusions—**Caffeine exerted a minor diuretic effect which was negated by exercise. Concerns regarding unwanted fluid loss associated with caffeine consumption are unwarranted particularly when ingestion precedes exercise.




Kerksick *et al. Journal of the International Society of Sports Nutrition* (2018) 15:38
https://doi.org/10.1186/s12970-018-0242-y

*Toxicology Reports 5 (2018) 1140–1152*
doi: 10.1016/j.toxrep.2018.11.002

- Aumento do rendimento físico a partir de **2 mg/kg de peso corporal (PC);**
- Tomas entre **2 a 9mg/kg de PC** não têm necessariamente uma dose resposta proporcional (depende da modalidade e do indivíduo);
- **Toma única cerca de 30 a 90min antes** da prova ou em **pequenas doses durante** (provas prolongadas);
- Doses superiores a **9mg/kg de PC** aumentam o risco de efeitos adversos, sem benefícios acrescidos no rendimento físico;
- Consumo agudo de doses entre **5 g a 50 g** pode causar a morte (usualmente **10 g**).

# É fundamental a adequação à modalidade!

## Nutritional Ergogenic Aids in Racquet Sports: A Systematic Review

Néstor Vicente-Salar [1,2,*,†], Guillermo Santos-Sánchez [3,†,‡] and Enrique Roche [1,2,4]

21 RCTs (Ténis 15; Badminton 3; *Squash* 2; *Paddle* 1)

Melhor posologia:

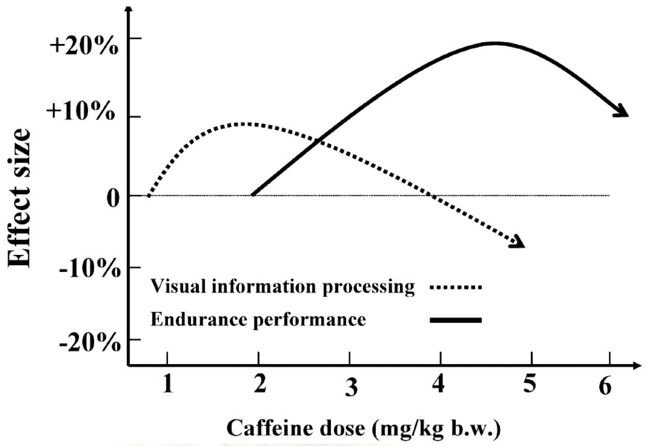
3–6 mg/kg 30–60 min before competition

- Improves specific racquet sports skills
- Improves sprints and jumps
- Improves mental performance and maybe accuracy



## Dietary supplements for football

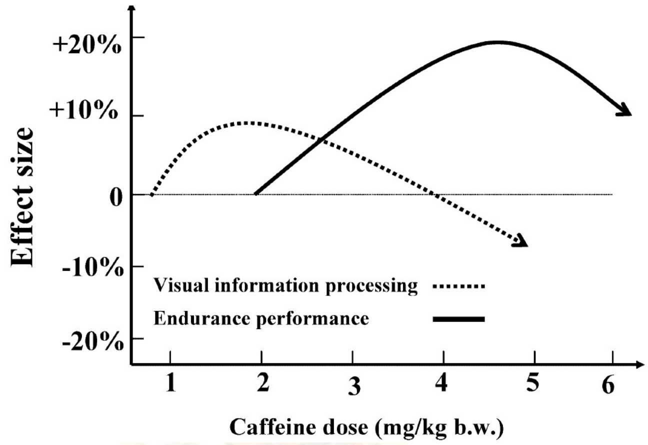
P. HESPEL[1], R. J. MAUGHAN[2], & P. L. GREENHAFF[3]




*Journal of Sports Sciences*, July 2006; 24(7): 749 – 761

# Dietary supplements for football

P. HESPEL[1], R. J. MAUGHAN[2], & P. L. GREENHAFF[3]




(3 – 6 mg · kg body mass$^{-1}$ during warming up)

goalkeeper (1 – 2 mg · kg body mass$^{-1}$)



Journal of Psychopharmacology
1–11 2016

# Mesmo pequenas doses podem ser benéficas em alguns contextos!

## Effects of a single, oral 60 mg caffeine dose on attention in healthy adult subjects

Micha MM Wilhelmus[1,3], Justin L Hay[1], Rob GJA Zuiker[1], Pieter Okkerse[1], Christelle Perdrieu[2], Julien Sauser[2], Maurice Beaumont[2], Jeroen Schmitt[2], Joop MA van Gerven[1] and Beata Y Silber[2]

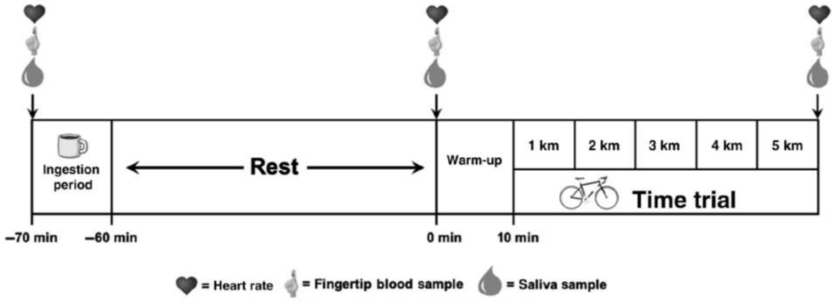
*Study design*

The current study was a single-centre acute cross-over, placebo-controlled, double-blind, randomised trial with two treatment conditions: caffeine (60 mg) and placebo (mannitol). Pure caf-

In conclusion, these results clearly highlight that caffeine doses as low as 60 mg improve sustained attention, alertness and mood in healthy adults.

# Será que causa tolerância?

(diminuição da resposta se usado repetidamente)




## Conclusions

Habitual caffeine consumption did not affect the ergogenic effect of coffee ingestion during 5-km cycling time trial. Furthermore, ingesting coffee providing 3 mg/kg of caffeine increased salivary caffeine levels and improved 5-km cycling time-trial performance.

Int J Sport Nutr Exerc Metab. 2020 Dec 1;1-8. doi: 10.1123/ijsnem.2020-0204. Online ahead of print.

IEPAP Nutrição e Suplementação no Exercício Físico Prof.º Dr.º Rui Jorge

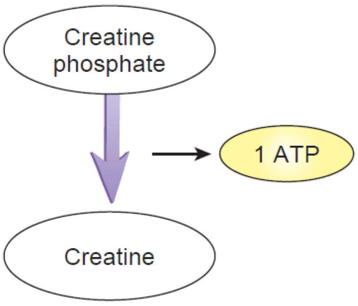
# Creatina

Em condições de repouso o ATP produzido através da respiração aeróbia é usado para sintetizar **fosfocreatina**.

A fosfocreatina **acumula-se nas fibras musculares armazenando energia, que poderá ser usada para sintetizar ATP**.

Quando os níveis de **ATP começam a diminuir o ADP reage com a fosfocreatina e produz ATP** e creatina.

IEPAP Nutrição e Suplementação no Exercício Físico Prof.º Dr.º Rui Jorge




(a) **Creatine phosphate**
Energy source: creatine phosphate
Oxygen required: no
ATP yield: 1 per creatine phosphate
Duration: up to 10 seconds

ADP + Creatine phosphate → Creatine + ATP

IPAP

Nutrição e Suplementação no Exercício Físico

Prof.º Dr.º Rui Jorge

**Position of the international society of sports nutrition (ISSN)**

1. Creatine monohydrate is the most effective ergogenic nutritional supplement currently available to athletes with the intent of increasing high-intensity exercise capacity and lean body mass during training.

Kreider *et al. Journal of the International Society of Sports Nutrition* (2017) 14:18
DOI 10.1186/s12970-017-0173-z

IPAP

Nutrição e Suplementação no Exercício Físico

Prof.º Dr.º Rui Jorge

## Position of the international society of sports nutrition (ISSN)

2. Creatine monohydrate supplementation is not only safe, but has been reported to have a number of therapeutic benefits in healthy and diseased populations ranging from infants to the elderly. There is no compelling scientific evidence that the short- or long-term use of creatine monohydrate (up to 30 g/day for 5 years) has any detrimental effects

Kreider *et al. Journal of the International Society of Sports Nutrition* (2017) 14:18
DOI 10.1186/s12970-017-0173-z



## Position of the international society of sports nutrition (ISSN)

5. At present, creatine monohydrate is the most extensively studied and clinically effective form of creatine for use in nutritional supplements in terms of muscle uptake and ability to increase high-intensity exercise capacity.

Kreider *et al. Journal of the International Society of Sports Nutrition* (2017) 14:18
DOI 10.1186/s12970-017-0173-z

**Position of the international society of sports nutrition (ISSN)**

Terá isto relevância prática?

6. The addition of carbohydrate or carbohydrate and protein to a creatine supplement appears to increase muscular uptake of creatine, although the effect on performance measures may not be greater than using creatine monohydrate alone.

Kreider *et al. Journal of the International Society of Sports Nutrition* (2017) 14:18
DOI 10.1186/s12970-017-0173-z



**Position of the international society of sports nutrition (ISSN)**

7. The quickest method of increasing muscle creatine stores may be to consume ~0.3 g/kg/day of creatine monohydrate for 5–7-days followed by 3–5 g/day

Kreider *et al. Journal of the International Society of Sports Nutrition* (2017) 14:18
DOI 10.1186/s12970-017-0173-z

Avaliação da adequação de um suplemento alimentar, numa situação específica.

Importância da avaliação da ingestão alimentar (e.g. leucina)



REVIEW **Open Access**

# Protein timing and its effects on muscular hypertrophy and strength in individuals engaged in weight-training

Matthew Stark[1], Judith Lukaszuk[1*], Aimee Prawitz[1] and Amanda Salacinski[2]

essential, nutrition-related, tenets need to be followed by weightlifters to maximize muscle hypertrophy: the consumption of 1.2-2.0 g protein.kg $^{-1}$ of body weight, and ≥44-50 kcal·kg$^{-1}$ of body weight. Researchers have tested the effects of timing of protein supplement ingestion on various physical changes in weightlifters. In general, protein supplementation pre- and post-workout increases physical performance, training session recovery, lean body mass, muscle hypertrophy, and strength. Specific gains, differ however based on protein type and amounts. Studies on timing of consumption of milk have indicated that fat-free milk post-workout was effective in promoting increases in lean body mass, strength, muscle hypertrophy and decreases in body fat. The leucine content of a protein source has an impact on protein synthesis, and affects muscle hypertrophy. Consumption of 3–4 g of leucine is needed to promote maximum protein synthesis. An ideal supplement following resistance exercise should contain whey protein that provides at least 3 g of leucine per serving. A combination of a fast-acting

REVIEW Open Access

# Protein timing and its effects on muscular hypertrophy and strength in individuals engaged in weight-training

Matthew Stark[1], Judith Lukaszuk[1*], Aimee Prawitz[1] and Amanda Salacinski[2]

essential, nutrition-related, tenets need to be followed by weightlifters to maximize muscle hypertrophy: the consumption of 1.2-2.0 g protein.kg $^{-1}$ of body weight, and ≥44-50 kcal·kg$^{-1}$ of body weight. Researchers have tested the effects of timing of protein supplement ingestion on various physical changes in weightlifters. In general, protein supplementation pre- and post-workout increases physical performance, training session recovery, lean body mass, muscle hypertrophy, and strength. Specific gains, differ however based on protein type and amounts. Studies on timing of consumption of milk have indicated that fat-free milk post-workout was effective in promoting increases in lean body mass, strength, muscle hypertrophy and decreases in body fat. The leucine content of a protein source has an impact on protein synthesis, and affects muscle hypertrophy. Consumption of 3–4 g of leucine is needed to promote maximum protein synthesis. An ideal supplement following resistance exercise should contain whey protein that provides at least 3 g of leucine per serving. A combination of a fast-acting

**3 g de leucina:**
5 ovos de galinha;
120g de carne de vaca;
1l de leite.

É prática comum em praticantes de musculação, tomar "whey" e "BCAAs", por exemplo no pós-treino. Será útil ou necessário?

| ESSENTIAL AMINO ACID | MILK PROTEIN ISOLATE | WHEY PROTEIN ISOLATE | WHEY PROTEIN HYDROL. | CASEIN | SOY PROTEIN ISOLATE | EGG PROTEIN |
|---|---|---|---|---|---|---|
| Isoleucine | 4.4 | 6.1 | 5.5 | 4.7 | 4.9 | 5.7 |
| Leucine | 10.3 | 12.2 | 14.2 | 8.9 | 8.2 | 8.4 |
| Lysine | 8.1 | 10.2 | 10.2 | 7.6 | 6.3 | 6.8 |
| Methionine | 3.3 | 3.3 | 2.4 | 3.0 | 1.3 | 3.4 |
| Phenylalanine | 5.0 | 3.0 | 3.8 | 5.1 | 5.2 | 5.8 |
| Threonine | 4.5 | 6.8 | 5.5 | 4.4 | 3.8 | 4.6 |
| Tryptophan | 1.4 | 1.8 | 2.3 | 1.2 | 1.3 | 1.2 |
| Valine | 5.7 | 5.9 | 5.9 | 5.9 | 5.0 | 6.4 |
| **Total BCAAs** | **20.4** | **24.2** | **25.6** | **19.5** | **18.1** | **20.4** |
| **Total EAAs** | **42.7** | **49.2** | **49.8** | **40.7** | **36.0** | **42.3** |

Approximate concentration of essential and branched chain amino acids (EAA and BCAA, respectively) present within various forms of commercially available protein (g/100 g).

U.S. Department of Health & Human Services | National Institutes of Health

NIH National Institutes of Health
*Office of Dietary Supplements*

Strengthening Knowledge and Understanding of Dietary Supplements

Font Size

Share:

Health Information | News & Events | For Researchers | About ODS | Search

Health Information

## EXERCISE AND ATHLETIC PERFORMANCE

https://ods.od.nih.gov/factsheets/list-all/ExerciseAndAthleticPerformance/



Sports Medicine (2021) 51 (Suppl 1):S59–S74
https://doi.org/10.1007/s40279-021-01540-8

REVIEW ARTICLE

### The Anabolic Response to Plant-Based Protein Ingestion

Philippe J. M. Pinckaers[1] · Jorn Trommelen[1] · Tim Snijders[1] · Luc J. C. van Loon[1]

Accepted: 6 August 2021 / Published online: 13 September 2021


Kerksick et al. Journal of the International Society of Sports Nutrition (2017) 14:33
DOI 10.1186/s12970-017-0189-4
Journal of the International Society of Sports Nutrition

REVIEW Open Access

### International society of sports nutrition position stand: nutrient timing

Chad M. Kerksick[1], Shawn Arent[2], Brad J. Schoenfeld[3], Jeffrey R. Stout[4], Bill Campbell[5], Colin D. Wilborn[6], Lem Taylor[6], Doug Kalman[7], Abbie E. Smith-Ryan[8], Richard B. Kreider[9], Darryn Willoughby[10], Paul J. Arciero[11], Trisha A. VanDusseldorp[12], Michael J. Ormsbee[13,14], Robert Wildman[15], Mike Greenwood[9], Tim N. Ziegenfuss[16], Alan A. Aragon[17]

Consensus statement

OPEN ACCESS

### IOC consensus statement: dietary supplements and the high-performance athlete

Ronald J Maughan,[1] Louise M Burke,[2,3] Jiri Dvorak,[4] D Enette Larson-Meyer,[5] Peter Peeling,[6,7] Stuart M Phillips,[8] Eric S Rawson,[9] Neil P Walsh,[10] Ina Garthe,[11] Hans Geyer,[12] Romain Meeusen,[13] Lucas J C van Loon,[3,14] Susan M Shirreffs,[1] Lawrence L Spriet,[15] Mark Stuart,[16] Alan Vernec,[17] Kevin Currell,[18] Vidya M Ali,[19] Richard GM Budgett,[20] Arne Ljungqvist,[21] Margo Mountjoy,[22,23] Yannis P Pitsiladis,[19] Torbjørn Soligard,[20] Uğur Erdener,[19] Lars Engebretsen[20]

FUEL THE PEDAL

Jäger et al. Journal of the International Society of Sports Nutrition (2017) 14:20
DOI 10.1186/s12970-017-0177-8
Journal of the International Society of Sports Nutrition

REVIEW Open Access

### International Society of Sports Nutrition Position Stand: protein and exercise

Ralf Jäger[1], Chad M. Kerksick[2], Bill I. Campbell[3], Paul J. Cribb[4], Shawn D. Wells[5], Tim M. Skwiat[5], Martin Purpura[1], Tim N. Ziegenfuss[6], Amy A. Ferrando[7], Shawn M. Arent[8], Abbie E. Smith-Ryan[9], Jeffrey R. Stout[10], Paul J. Arciero[11], Michael J. Ormsbee[12,13], Lem W. Taylor[14], Colin D. Wilborn[14], Doug S. Kalman[15], Richard B. Kreider[16], Darryn S. Willoughby[17], Jay R. Hoffman[10], Jamie L. Krzykowski[18] and Jose Antonio[19*]

*Review*

### Nutrient Timing: A Garage Door of Opportunity?

Shawn M. Arent [1,*], Harry P. Cintineo [1], Bridget A. McFadden [1], Alexa J. Chandler [1] and Michelle A. Arent [2]

1 Department of Exercise Science, University of South Carolina, Columbia, SC 29208, USA; cintineo@email.sc.edu (H.P.C.); bm39@mailbox.sc.edu (B.A.M.); alexajc@email.sc.edu (A.J.C.)
2 Department of Health Promotion, Education, and Behavior, University of South Carolina, Columbia, SC 29208, USA; mgalardi@mailbox.sc.edu
* Correspondence: sarent@mailbox.sc.edu; Tel.: +1-803-576-8394

Received: 15 June 2020; Accepted: 28 June 2020; Published: 30 June 2020

## Muito obrigado pela vossa atenção e interesse!

**+351 936 163 200**

**rjorge0077@onutricionistas.pt**

**ruijorgenutricionista.pt**

**www.facebook.com/ruijorgenutricionista**