JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

NUTRITION AND PERFORMANCE

- Spesific consideration on young female cross-country skiers

Oona Kettunen

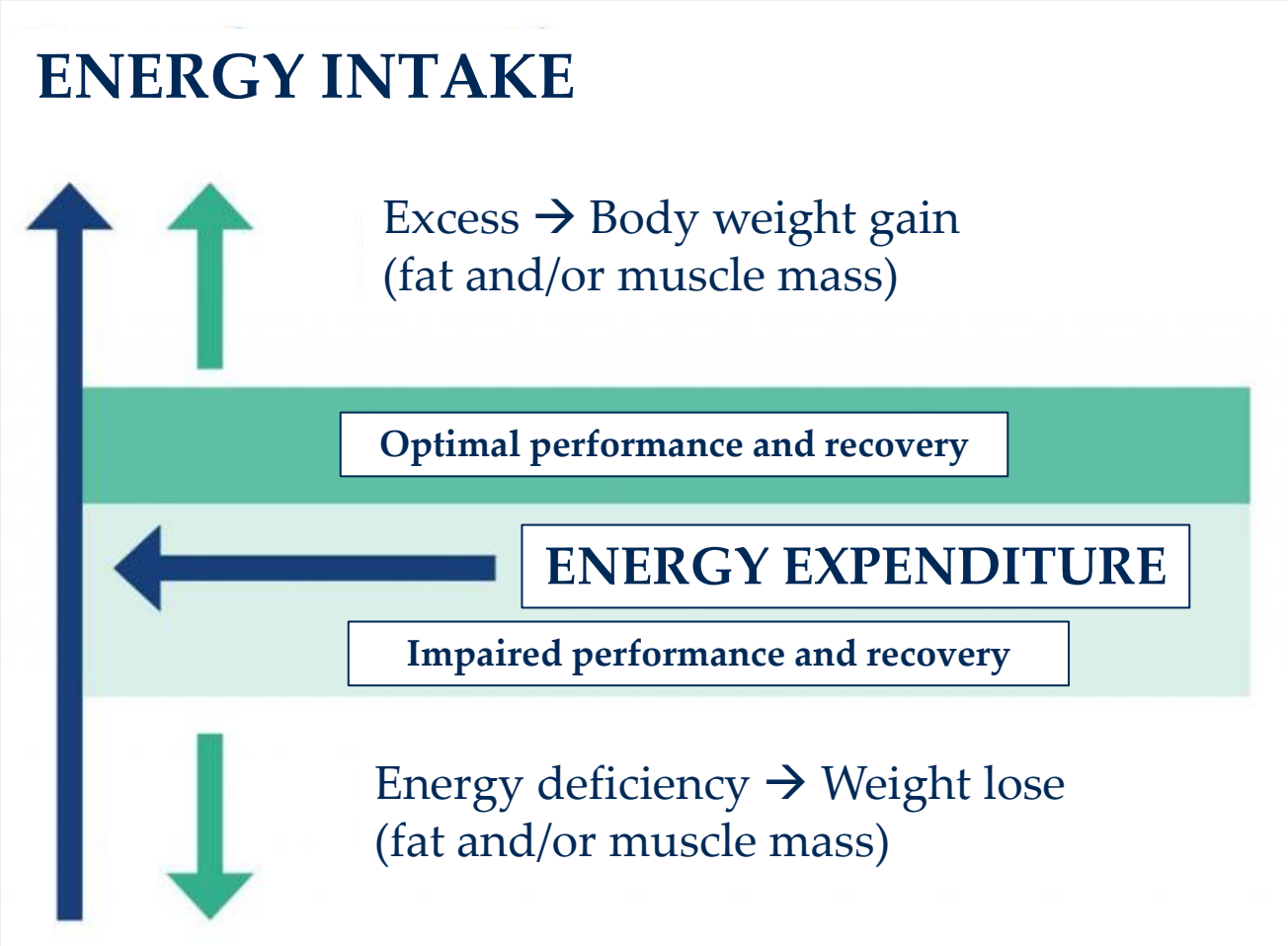
Doctoral researcher, Jyväskylän yliopisto

Oona Kettunen, MSc

- Master of Sport Sciences, Biology of Physical Activity, University of Jyväskylä, 2018
- Working at Vuokatti Sport sport testing lab 2018 →
- Doctoral researcher, Univesity of Jyväskylä 2020 →
  - PhD study: Associations between nutrition and performance in young female cross-country skiers
- Competing and coaching in cross-country skiing (and running)

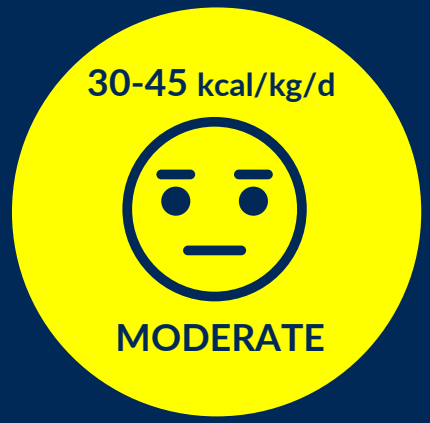
Introduction to the topic

- The most important nutritional goal is to get regularly enough energy
- Training performance, recovery, training adaptation and immune function are best supported when energy intake meets (or slightly exceed) energy needs
- In young atheletess, energy is needed for growing and maturation



Modified terveurheilija.fi

Energy availability (EA)



= (Energy intake – Exercise energy expenditure) / fat free body mass

- The amount of dietary energy remaining after exercise for all other metabolic processes
- Recommended unit to assess the adequacy of energy intake in relation to the energy needs in athletes

EXAMPLE: 50kg female athlete with 20% of body fat (= 80% fat free body mass) does 2h low intensity training with exercise energy expenditure of 1000 kcal. Daily energy intake is 2600 kcal.

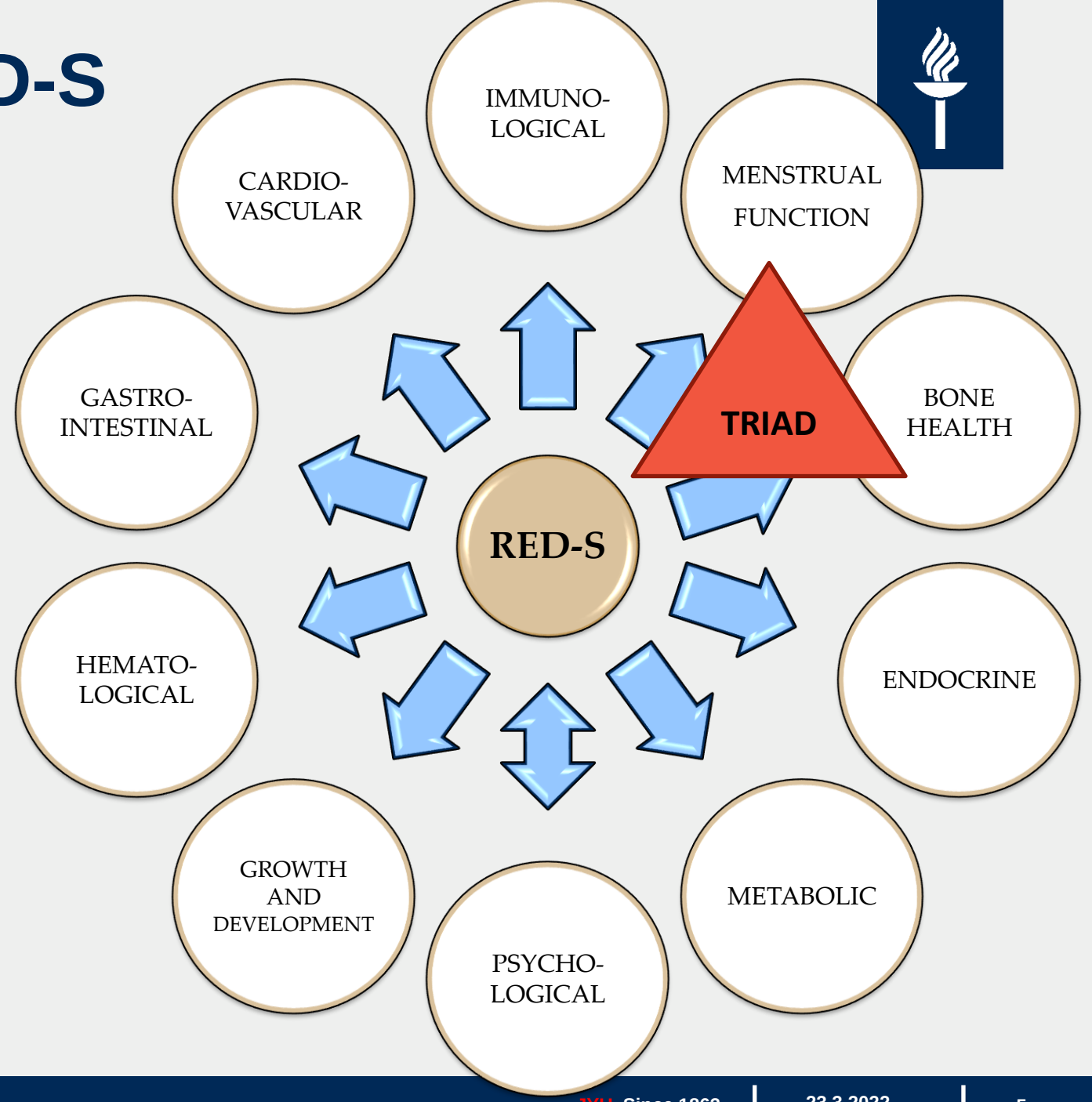
EA = (2600 kcal – 1000 kcal) / (50 kg x 0,8)
= 1600 kcal / 40 kg = 40 kcal/kg
→ Moderate EA

(Loucks et al. 2011))

Long term low EA → RED-S

= Relative energy defiency in sport

- Impaired physiological functioning caused by relative energy deficiency
- Negative health and performance consequences
- Note! Inadequate energy availability doesn´t automatically mean eating disorder!



(Mountjoy et al. 2018)

Body composition and athletic performance

- Body composition affects performance in certain sports
  - Moving body against gravity
  - Weight class
  - Aesthetic sports
- In (adults) elite level body composition may be modified by training and nutrition
  - The support of nutrition professional!
- In young athletes the body and mind are changing and sensitive for energy deficiency
  - To avoid long-term problem the nutritional concentration should be that food is fuel and fuel is needed for performance
  - In long-term, healthy body composition probably adapts to the needs of training and competition

Ackerman et al. 2020

In addition to energy availability…

- An athlete should ensure adequate intake of all macro- and micronutrients that have their spesific roles in the body
  - Macronutrients (include energy): carbohydrate, protein, fat
    - Recommendations are expressed as g / athletes body weight (kg)
  - Micronutrients (do not include energy): vitamins and minerals

- Hard training increases the need of almost every nutrient
  - Requirements are possible to meet by eating ”normal food” but an athlete must eat significantly more than inactive person

(Thomas et al. 2016))

Carbohydrates

- Main fuel during (hard) training and competition → Endurance athletes have significantly increased needs that may vary between training days and cycles:
  - 1-3 h/day 6-10 g/kg
  - 4-5 h/day (or getting ready to longer competition) 8-12 g/kg

- Body has limited capasity to store carbohydrates → important to replenish between harder sessions

- When an athlete is out of carbohydrates maintaining hard intensity is imposible
  - i.e. ”crash into wall in marathon”

(Thomas et al. 2016))

EXAMPLE: 60kg female XC skier, who is training 3 h/d → 8-10 g/kg carbohydrate → about 500-600 g/d to maintain optimal performance, recovery and immune function (high carbohydrate availability is not necessary during low intensity training but needed for optimal performance in high intensity training / competition)

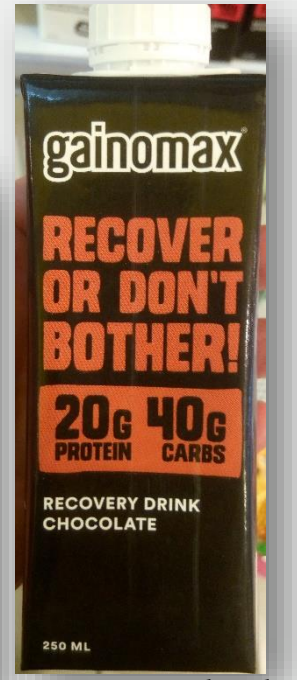
20g carbohydrate in each portion: 25 x 20 g = 500g
→ If you train hard, you should eat hard!

2 dl orange juice

3 slices

> 1 rkl honey

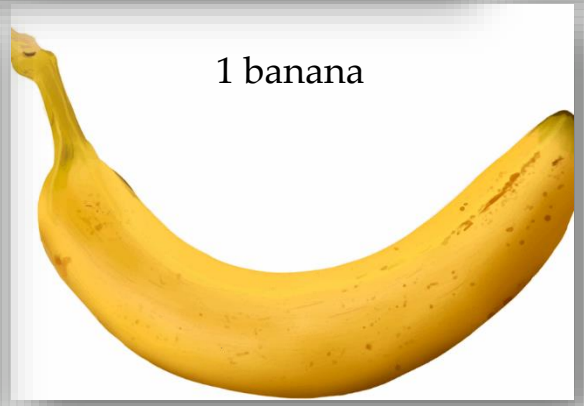
4 dl fat free milk



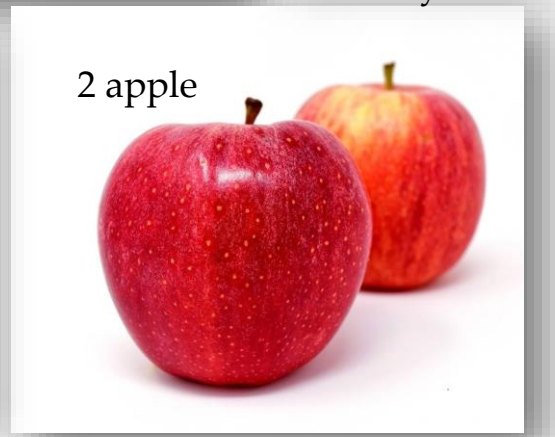
½ recovery drink

1 dl oats

2 dl pasta



1 banana



2 apple

Protein

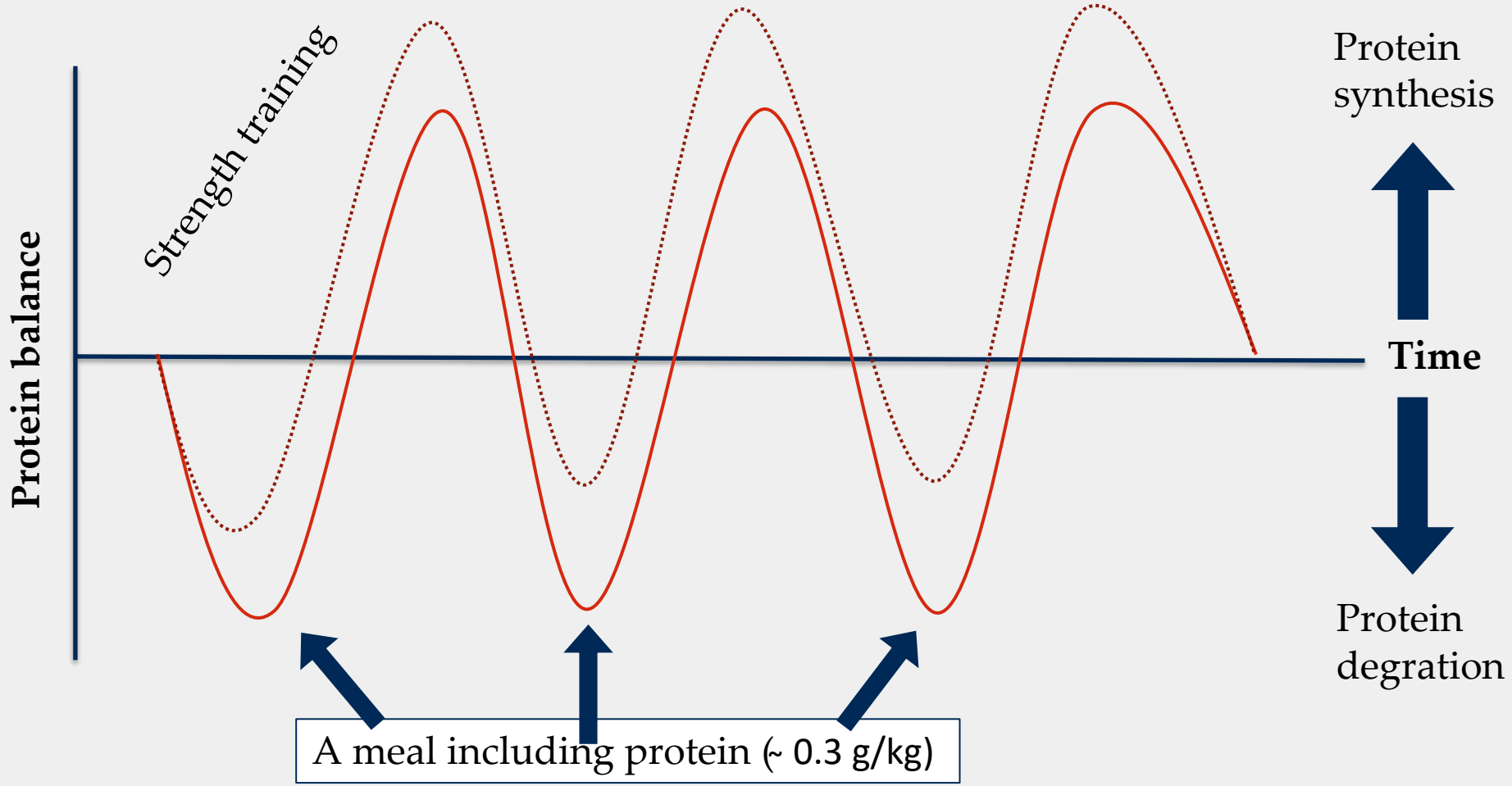
- Trigger and a substrate for the synthesis of protein synthesis and training adaptations

- Athletes have increased requirements, but the role of protein is ofter over emphasized
  - Protein is eaten more than required
  - Not dangerous but ”takes room” from carbohydates
  - Excess of protein is used as energy (not as efficient as carbohydrates in high intensities) or stored as fat

- Daily needs 1.2-2.0 g/kg but timing is important
  - Body has limited capasity to utilize protein
  - Intake should be divided regularly across day
  - → 0.2-0.4 g/kg 4-6 times per day in 2-4 h intervals

(Thomas et al. 2016))

Why timing is important?



(Ilander et al. 2014)

Fat

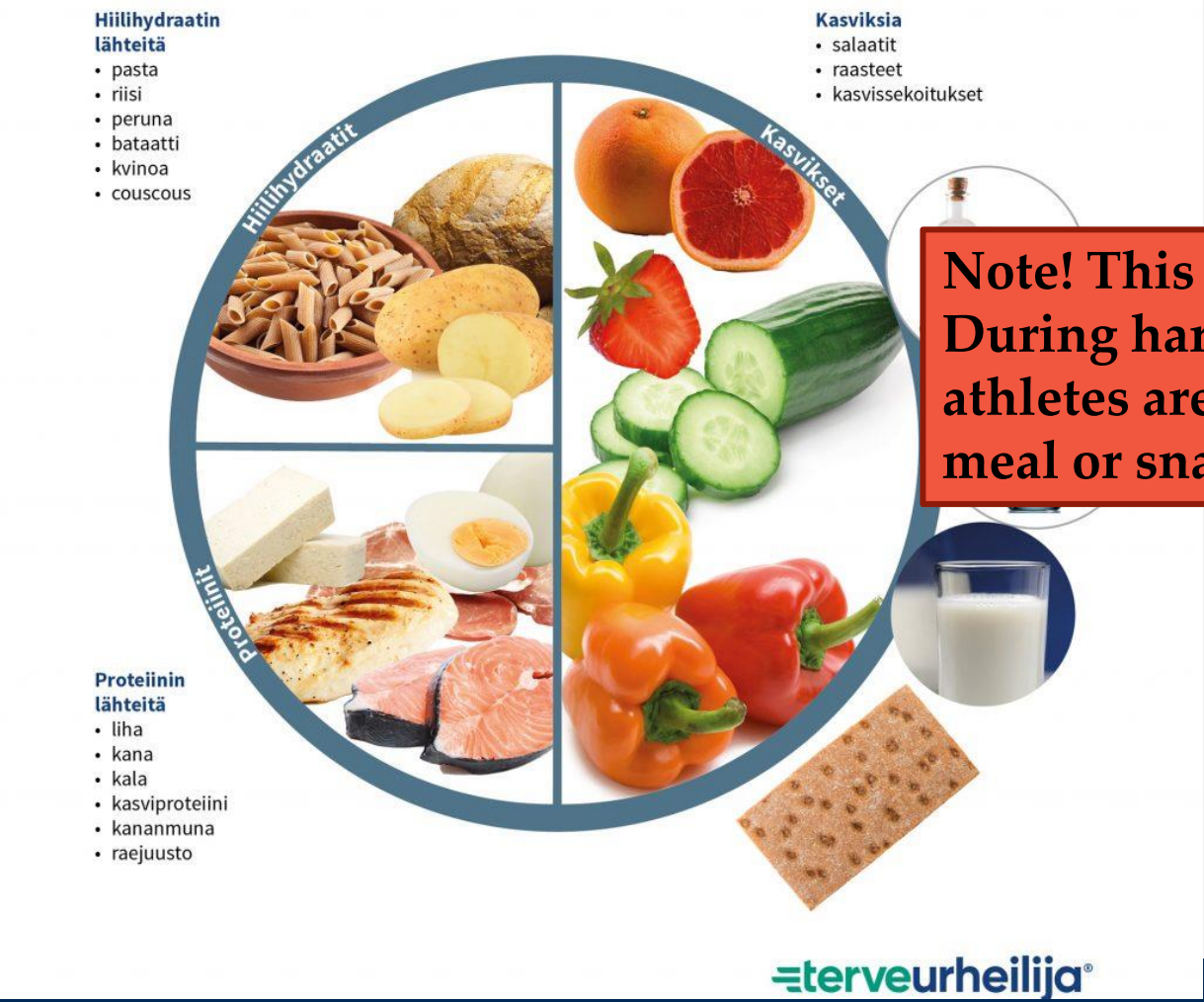
- A necessary component of a healthy diet
  - Provides energy
  - Essential elements of cell membranes
  - Facilitates the absorption of fat-soluble vitamins
  - Essential fat acids

- Recommended range 20-35% of total energy intake
  - Excess may increase body weight and / or take room from other nutrient that are important for performance, recovery and adaptation
  - Over restricting fat intake may lead inadequate intake of energy, fat soluble vitamins and essential fat acids

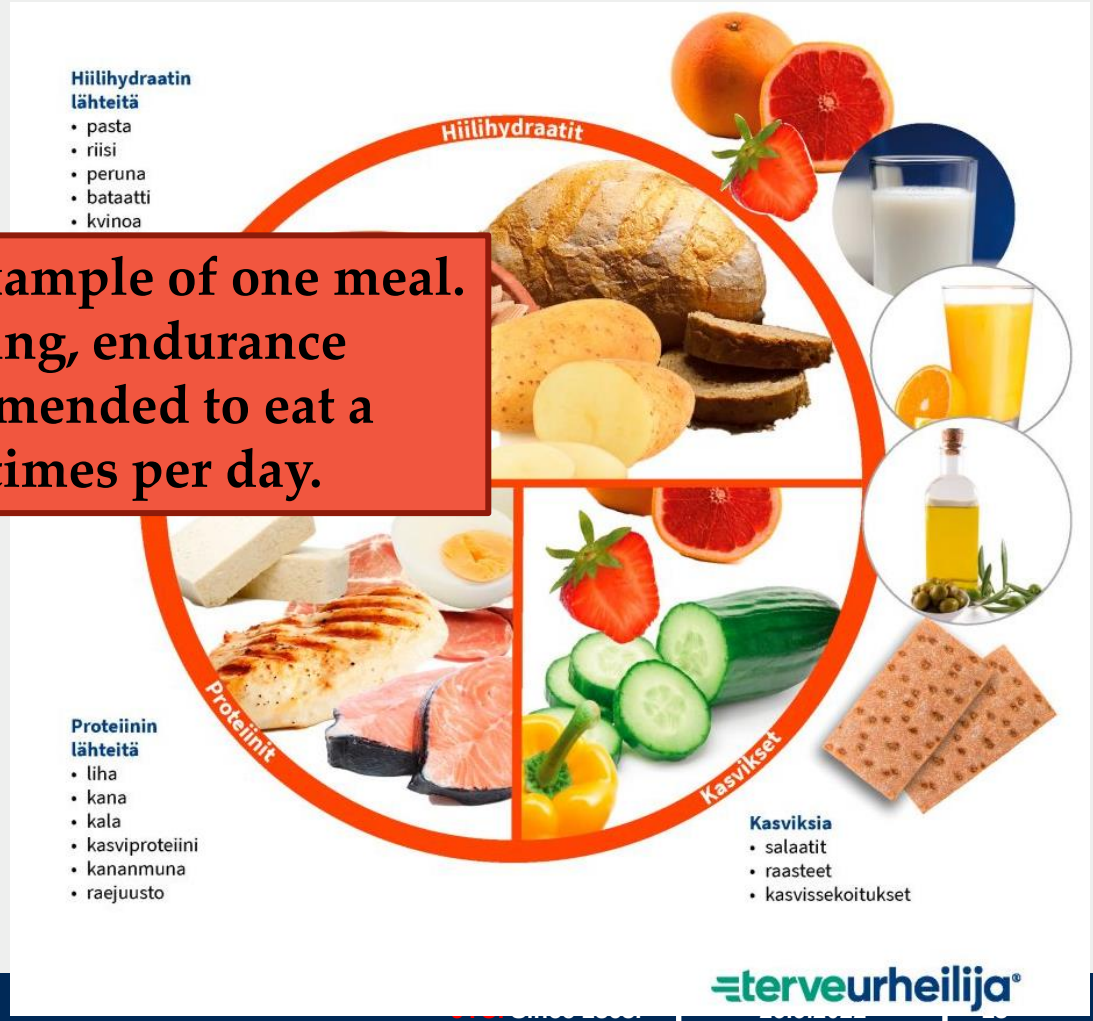
(Thomas et al. 2016)

How much is enough?

Easy day / rest day



Hard day (or normal day for endurance athletes)



Note! This is an example of one meal. During hard training, endurance athletes are recommended to eat a meal or snack 5-7 times per day.

PhD study: ”Nutrition and performance in young female cross-country skiers”

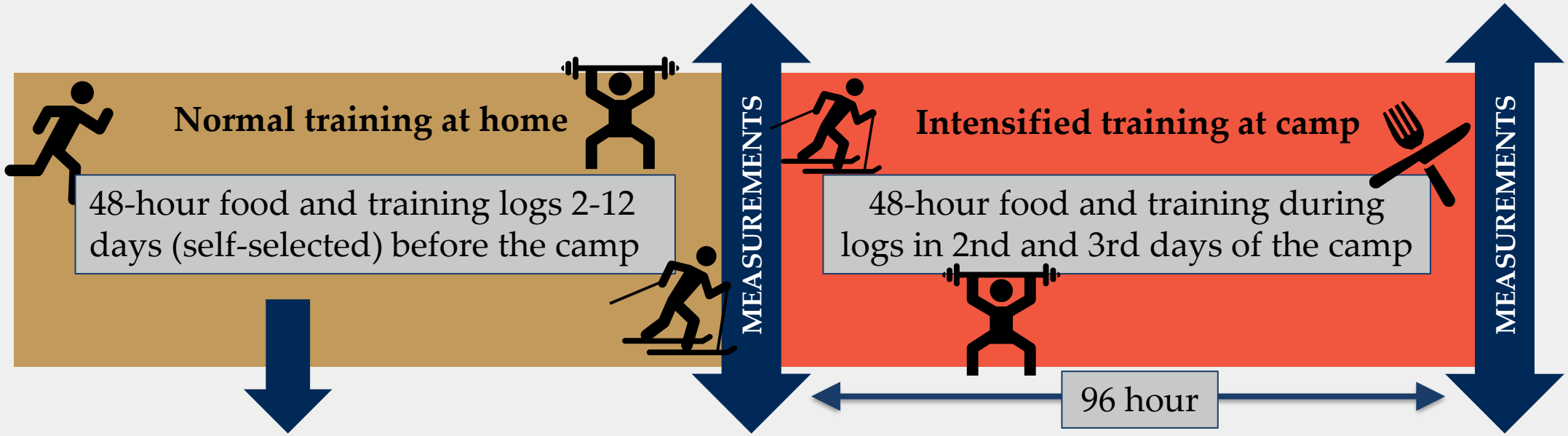
- Aims of the study:
  1) To evaluate, how well female XC skiers meet current nutritional recommendations at home training circumstances and during a training camp and how that affects on performance and recovery.
  2) To investigate, what is the prevalence of low EA and RED-S related conditions among Finnish female skiers.
  3) To monitor athletes’ nutritional intake, performance, hormonal function, body composition and bone density and see if energy and macronutrient availability affects other variables monitored.

- 2 parts
  1) Nutrition in home and training camp conditions (2 international open access articles published (see Kettunen et al. 2021a & 2021b in references))
  2) Nutrition during a training year and between the macrocycles (2 articles under writing)

Study 1 protocol

Participants
- 19 female XC skier from U18 national team
- National team camp (4 vrk) in October

Fasting measurements (6:30-8:00)
- Blood → Hemoglobin, leptin, T3, insulin, IGF-1, glucose
- Bioimpendance → body weight, fat free body mass



Questionnaires
- LEAF-Q: Risk of low energy availability (Melin ym. 2014)
- Nutrition knowledge (Heikkilä ym. 2018)

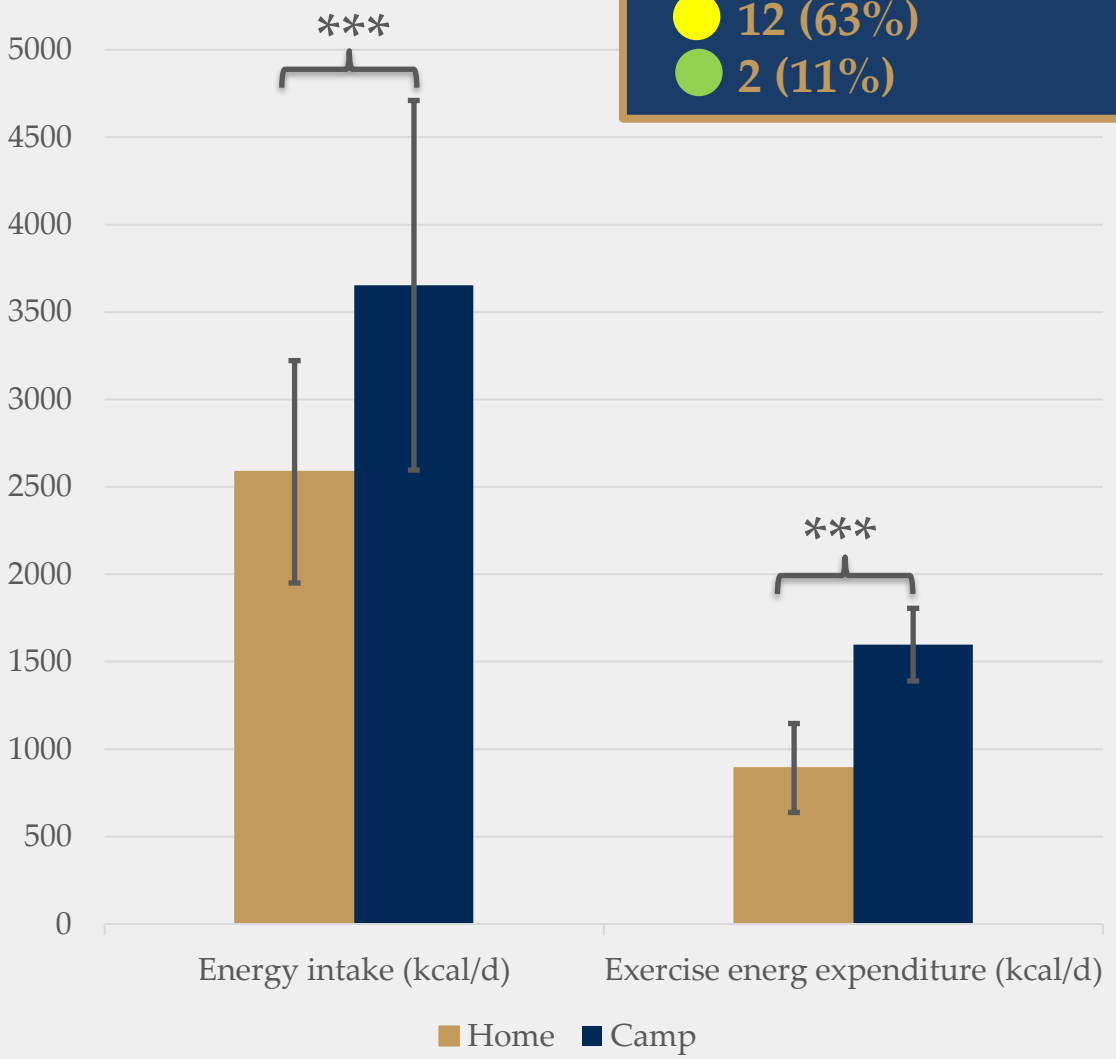
Performance (9:00-12:00)
- Counter movement jump → jump height
- Reactive jump → avg power
- Submaximal (4x4 min) treadmill running → heart rate, lactate, RPE from the end

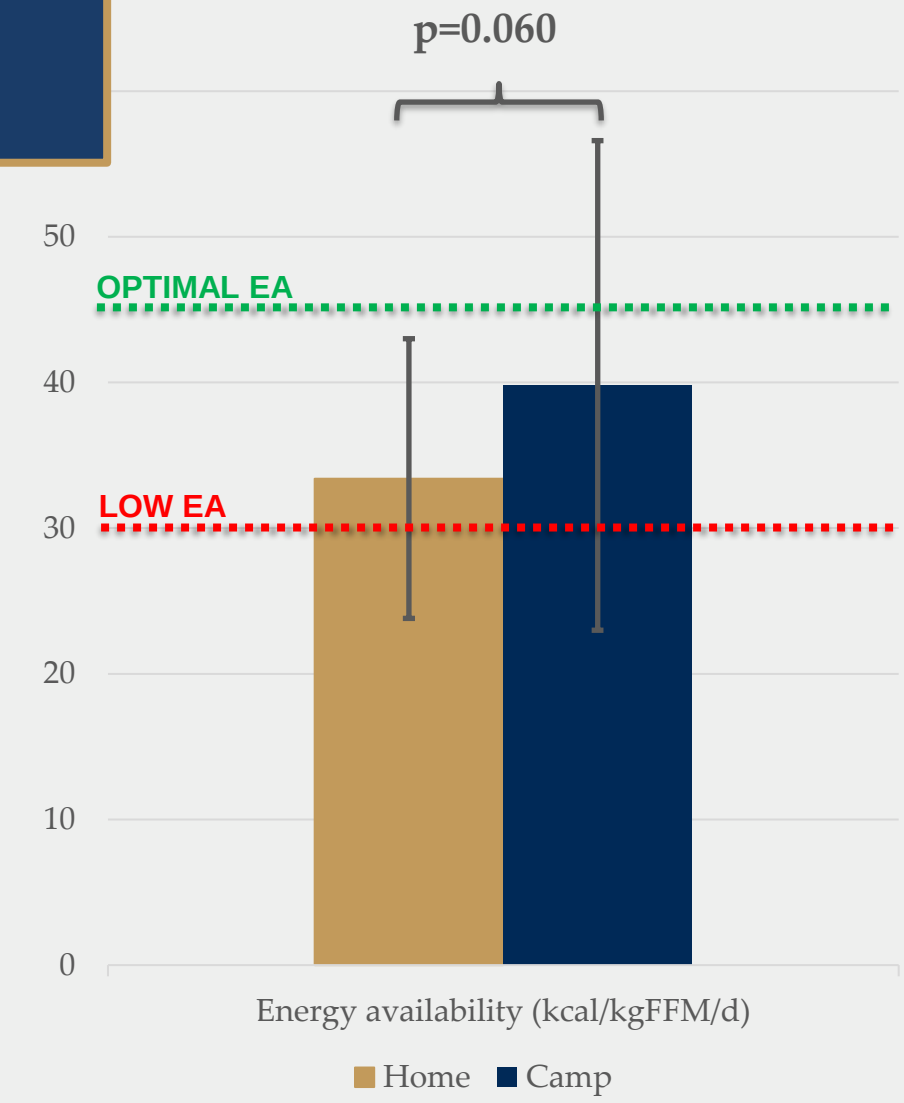
Based on questionnaires…

- 5 of the athletes (26 %) were categorized as being at risk for low EA
  - Concerning but mean score (6 points) less than in young runners (12 points) (Ihalainen et al. 2021)
- 3 of athletes (16 %) did not have menstrual bleeding
  - Concerning but less than in young runners (62%) (Ihalainen et al. 2021)
- Nutrition knowledge was similar or slightly better than earlier reported in young athletes (Heikkilä et al. 2019).
  - Individual differences!

INDIVIDUAL ENERGY AVAILABILITY

HOME	CAMP
5 (26%)	7 (37%)
12 (63%)	4 (21%)
2 (11%)	8 (42%)

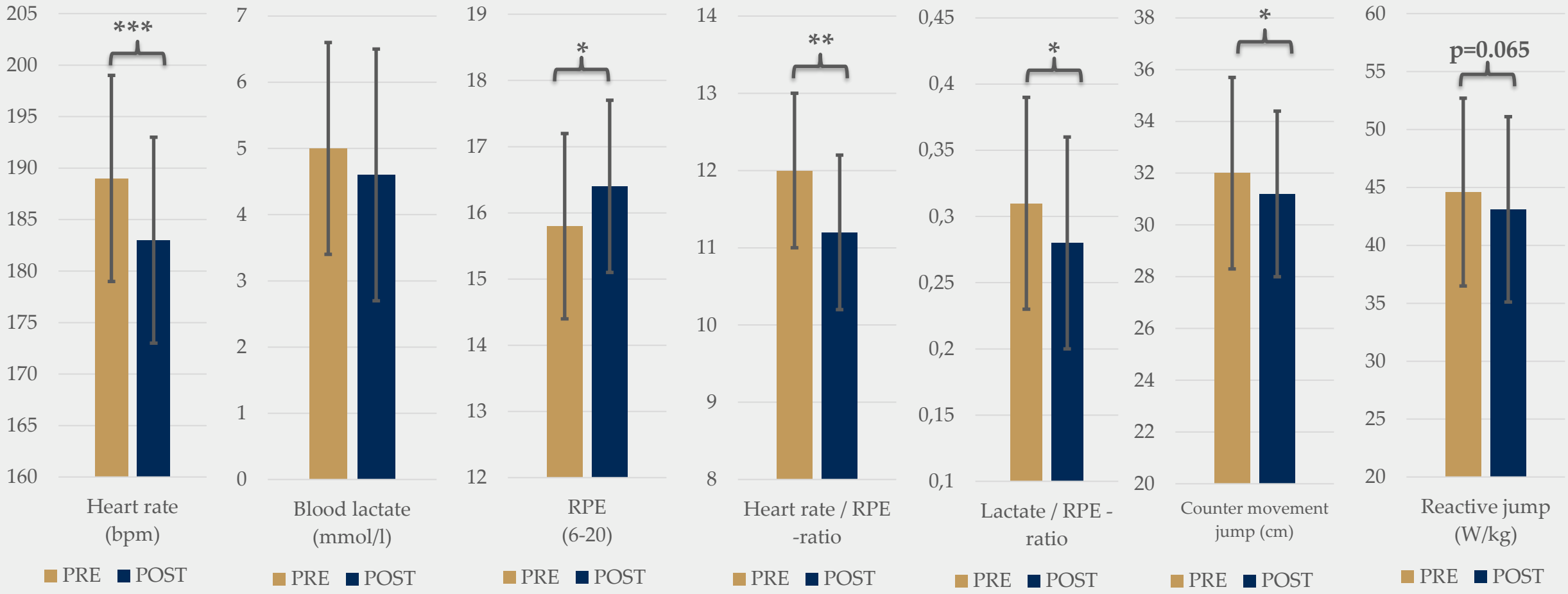




	HOME	%	CAMP	%	RECOMMENDATION
Training (min/d)	120 ± 26	-	214 ± 20***	-	-
Energy intake (kcal/kg/d)	43.1 ± 9.1	-	60.4 ± 13.1***	-	-
Exercise energy expenditure (kcal/kg/d)	14.9 ± 4.5	-	26.8 ± 4.3***	-	-
Energy availability (kcal/kg/d)	33.7 ± 9.6	11	40.3 ± 17.3	42	≥ 45
Protein intake (g/kg/d)	2.1 ± 0.3	100	2.5 ± 0.5**	100	1.2–2.0
Carbohydrate intake (g/kg/d)	5.0 ± 1.2	26	7.1 ± 1.6***	37	6–10 / 8–12
Fat intake (% of energy intake)	30 ± 6	95	32 ± 7	100	20–35

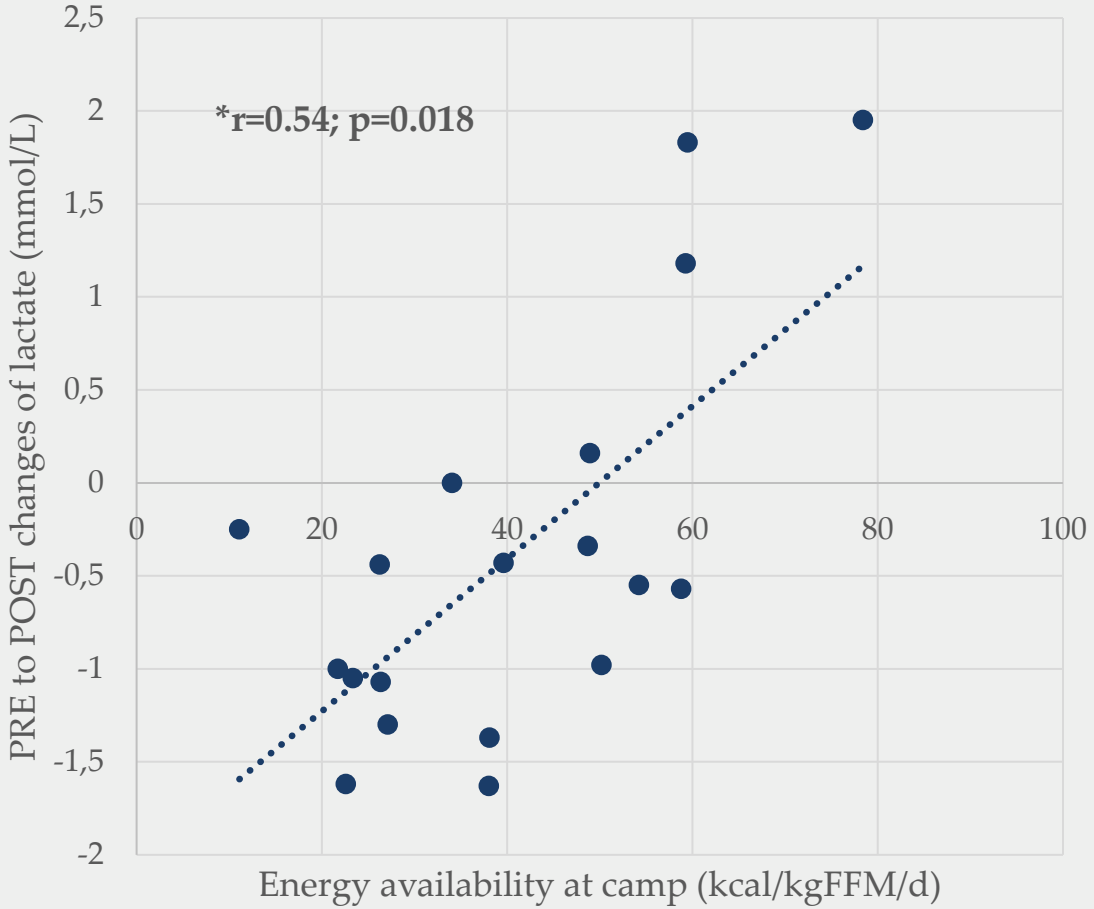
% = percentace of the athletes who met the recommendation for optimal EA and macronutrient intake (Thomas ym. 2016).

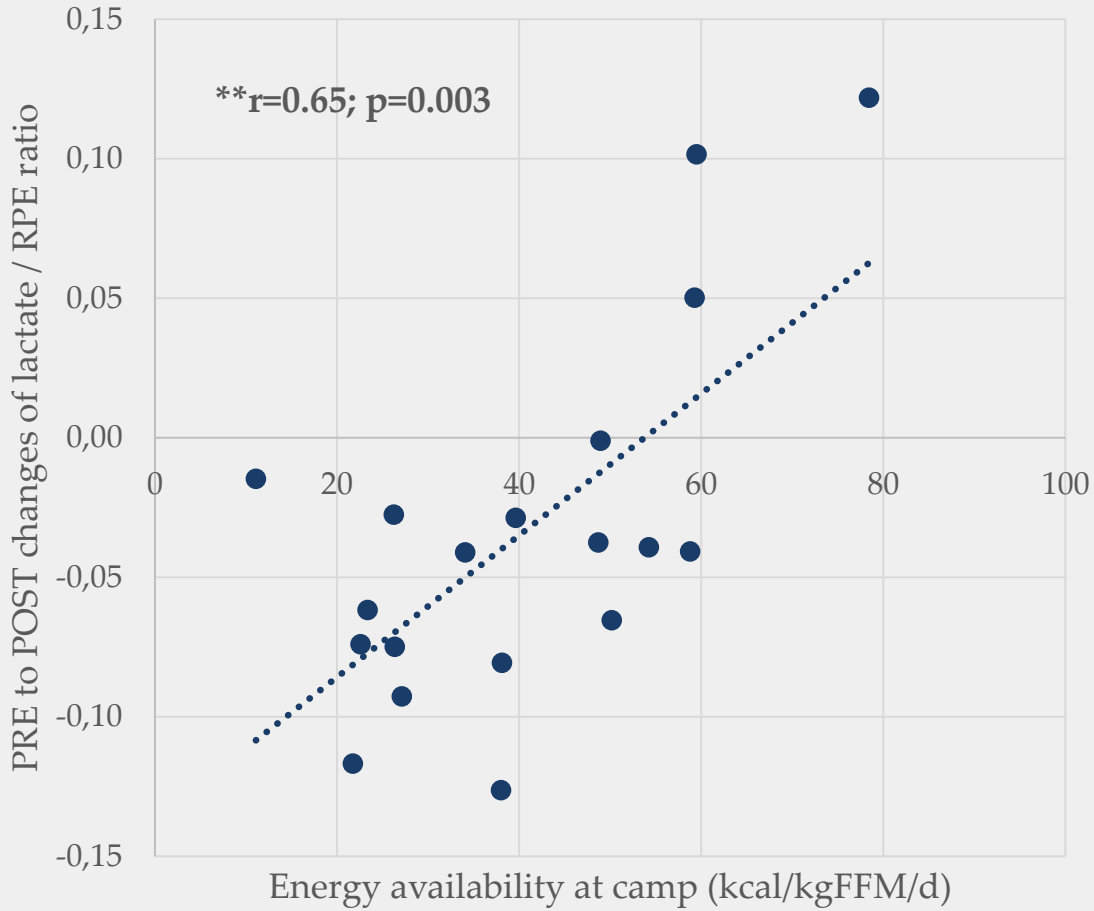
Performance variables before (PRE) and after (POST) the 96-hour intensified training period (camp)



HR, La, RPE from last stage of submaximal running test

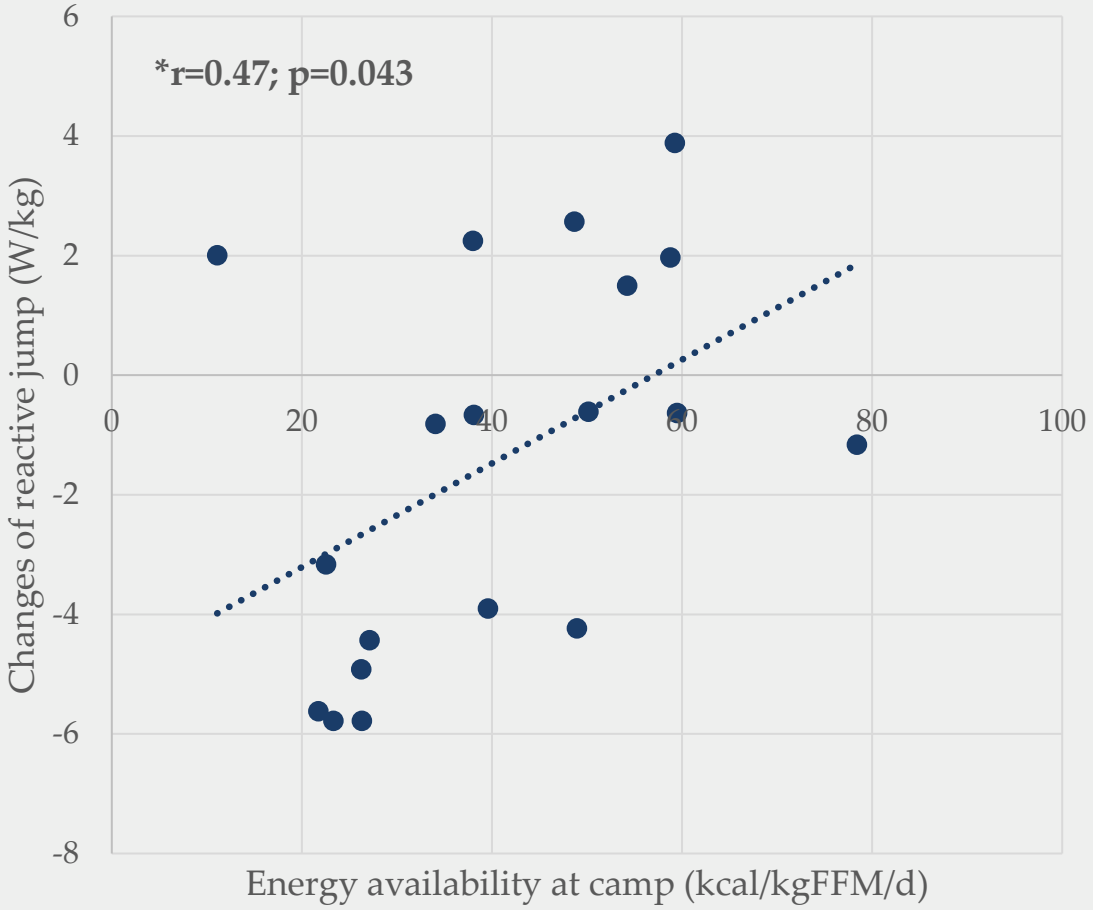
Higher energy availability was associated with smaller decrease of blood lactate concentrations as both absolute values and related to perceived exertion

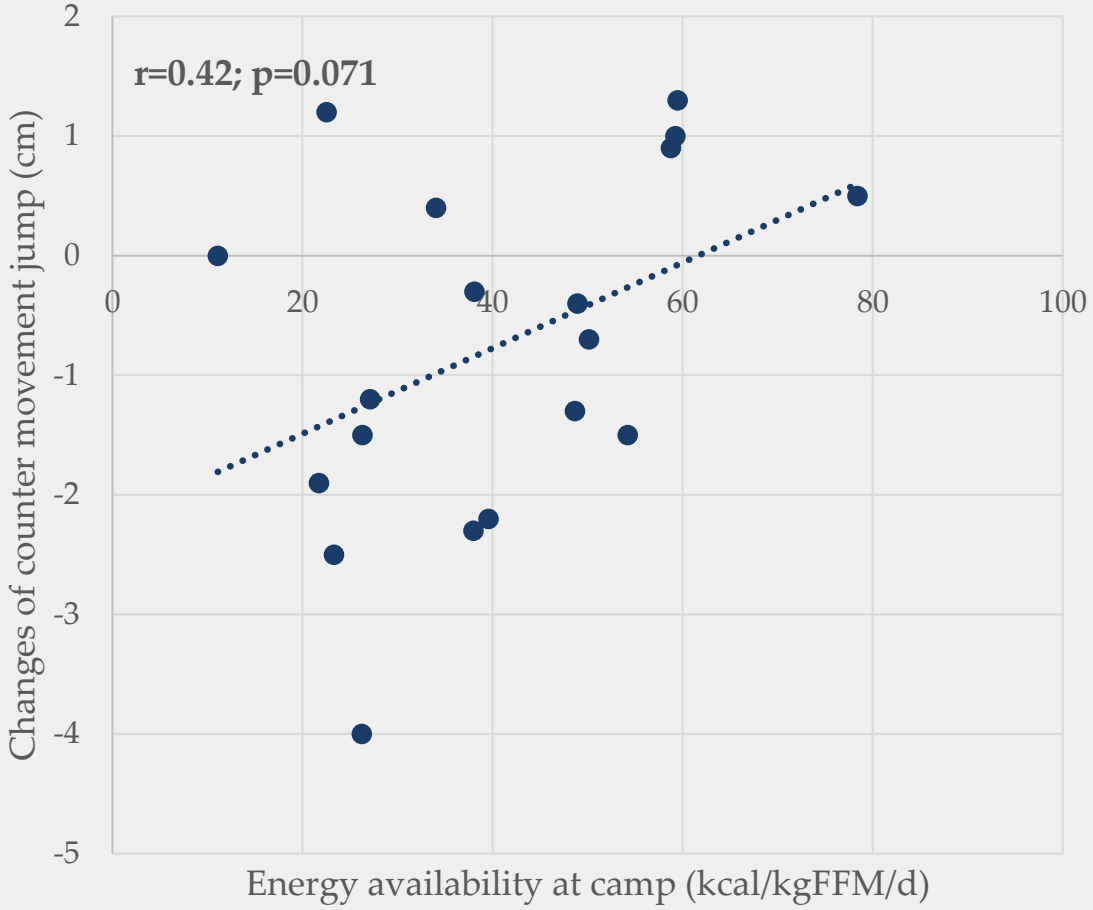




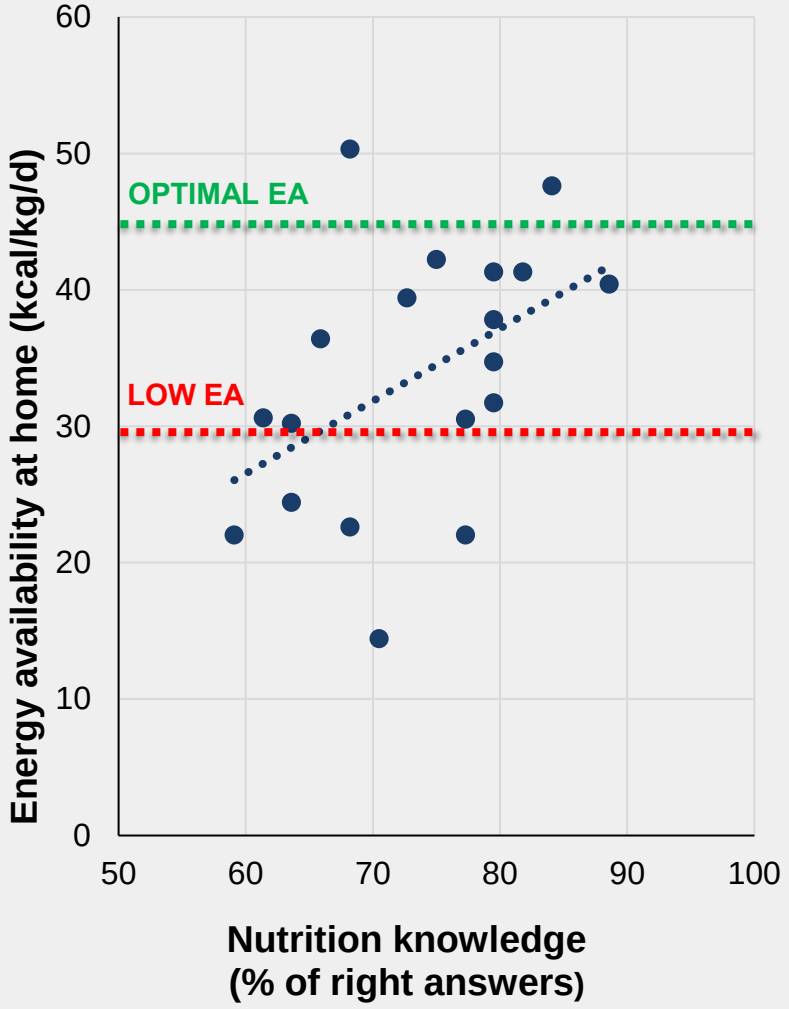
La, RPE from last stage of submaximal running test

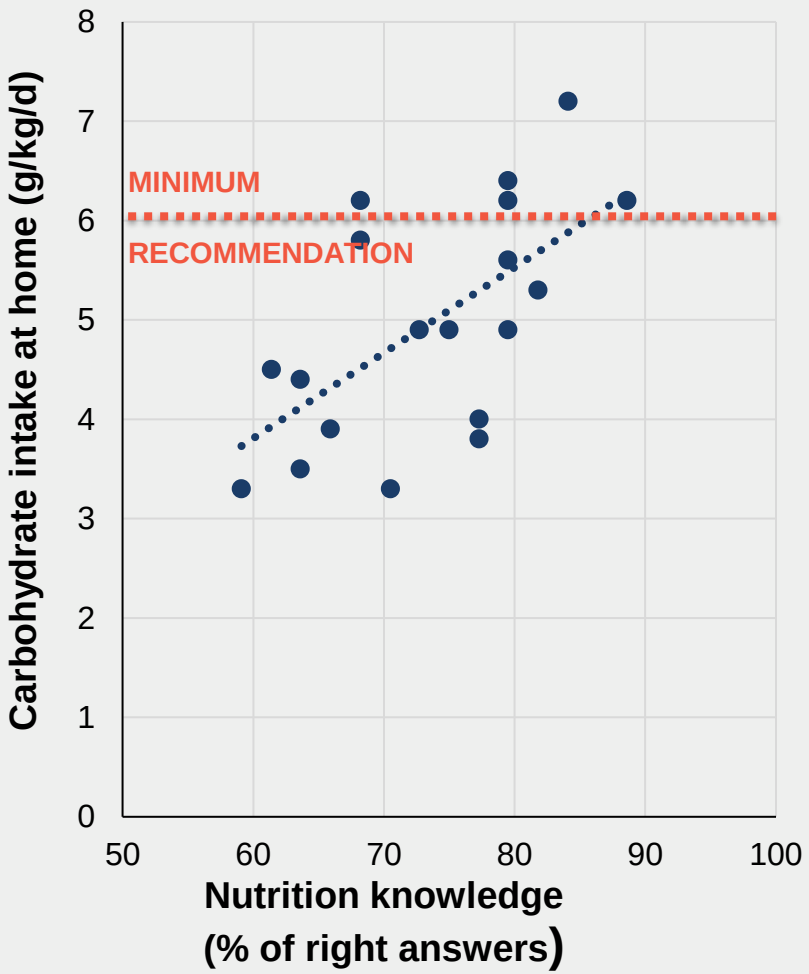
Higher energy availability during the camp may have helped to maintain / develop jump performance (power generation capasity)

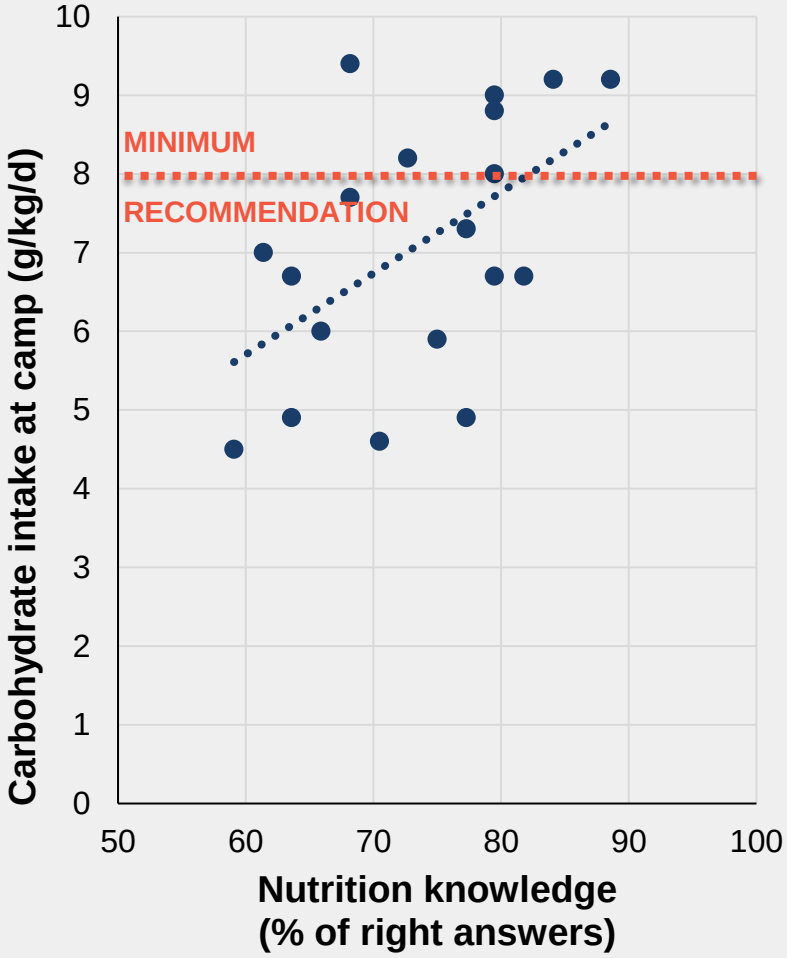




Nutrition knowledge and nutritional intake







CONCLUSIONS 1/2

- Mean energy availability is moderate but suboptimal
  - Only few individuals have optimal EA (”geen light”)
  - Some individuals have significant difficulties
  - Athletes have more optimal eating practices at camp where meals were served from buffet in prescheduled times
- Protein and fat intake are in line with the recommendations, but adequate carbohydrate intake is a major challenge

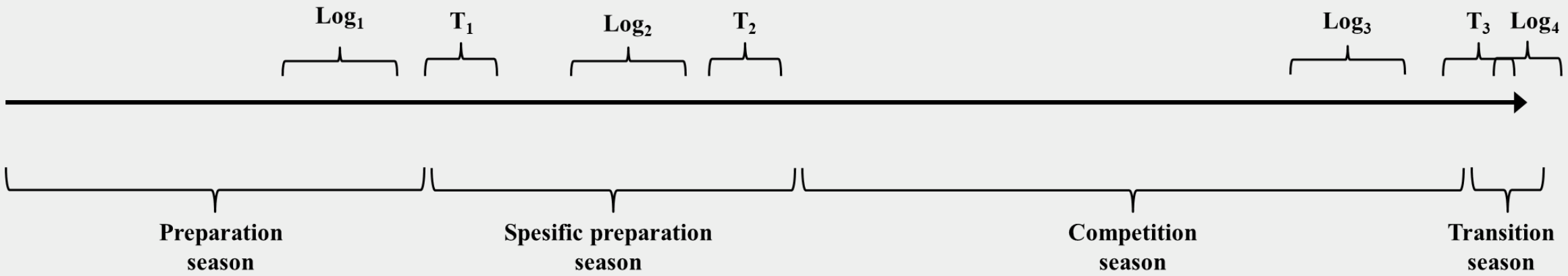
CONCLUSIONS 2/2

- Adequate energy and carbohydrate intake may help to maintain performance and avoid overreaching during hard training periods
  - Note! Low hearth rate and blood lactate are not automaticly a good sign → important to consider in relation to the feelings of an athlete
  - Maintaining adequate neuromuscular capasity during training camp is important as it is needed for high quality cross-coutry ski training

- Adequate nutrition knowledge and arrangements that reduce athletes´ own responsibility to plan, schedule and prepare the meals may help young athletes to meet recommended levels of energy availability and carbohydrate intake
  - Education!

Protocol study 2:

- During one year follow-up, 25 female skiers filled in four 3-day food and training logs and took three times part to the laboratory measurements (performance, anthropometrics)
  - Competition performance was determined by International Ski Federation (FIS) points gathered from youth national championships.

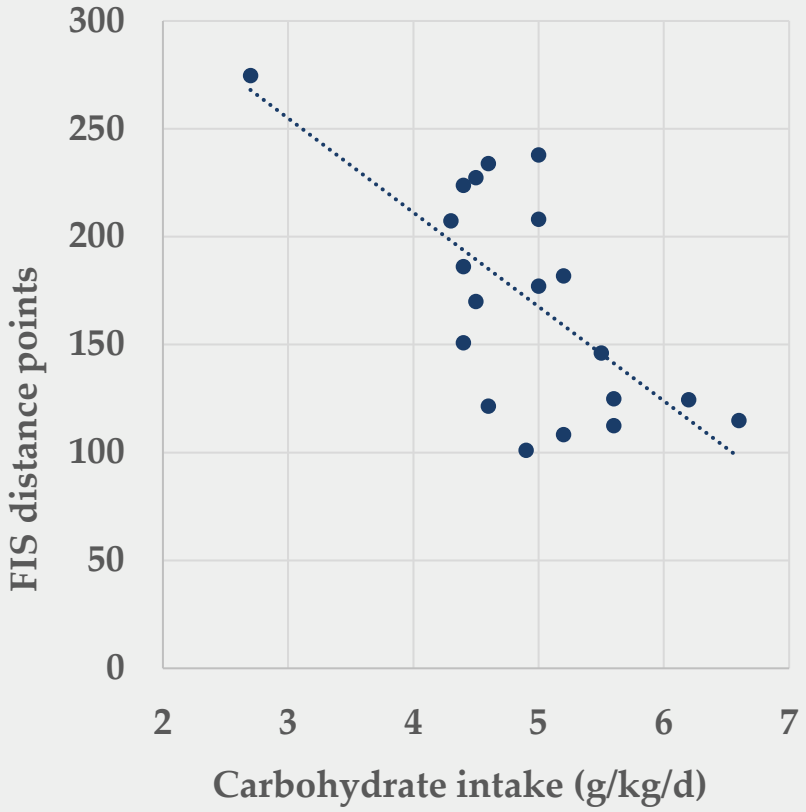


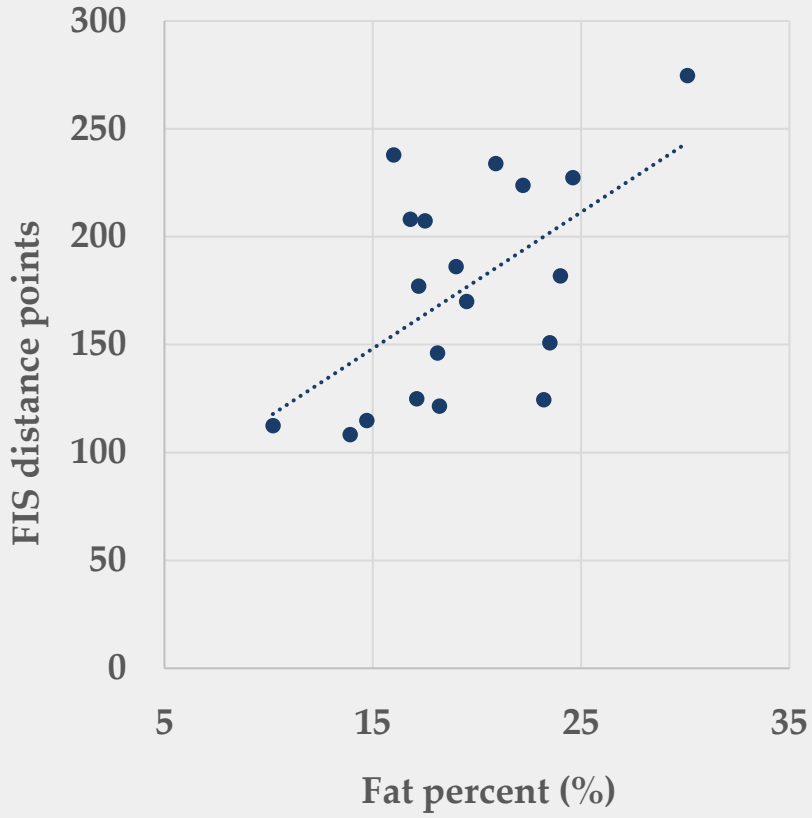
Results

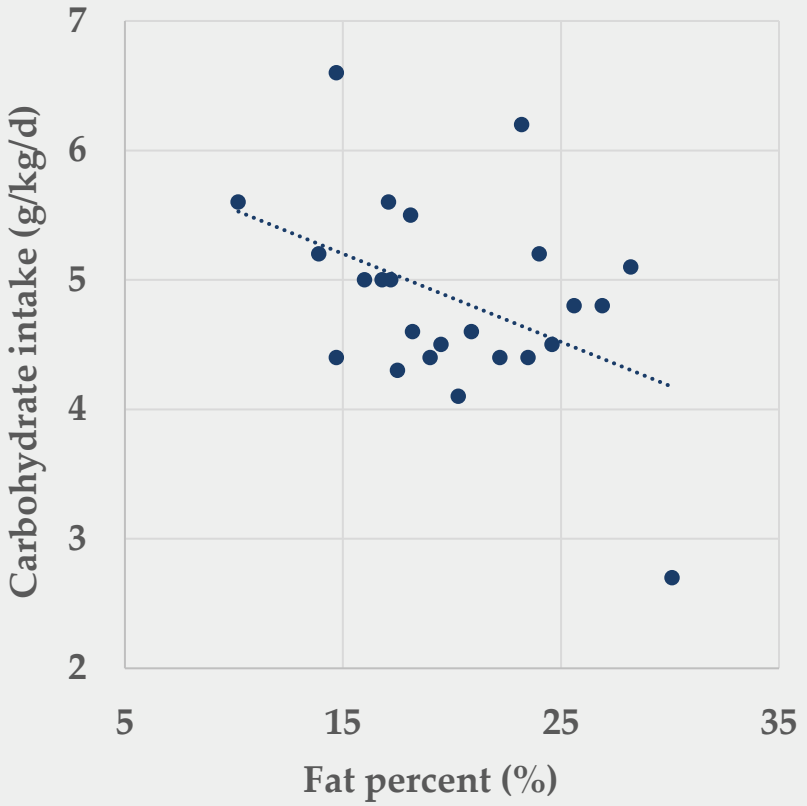
	Preparation season (Log_1)	Spesific preparation season (Log_2)	Competition season (Log_3)	Transition season (Log_4)
Energy intake ($kcal \cdot kgFFM^{-1} \cdot d^{-1}$)	50.8 ± 10.6	52.5 ± 9.3	53.3 ± 8.9	46.2 ± 10.7 $^{bb, cc}$
Exercise energy expenditure ($kcal \cdot kgFFM^{-1} \cdot d^{-1}$)	14.1 ± 5.5	14.2 ± 5.3	13.3 ± 5.7	7.7 ± 6.9 $^{aa, bbb, cc}$
Energy availability ($kcal \cdot kgFFM^{-1} \cdot d^{-1}$)	36.7 ± 11.0	37.8 ± 10.7	40.0 ± 9.6	38.5 ± 11.2
Carbohydrate intake ($g \cdot kg^{-1} \cdot d^{-1}$)	5.0 ± 1.0	5.0 ± 1.1	5.1 ± 1.0	4.4 ± 1.1
Protein intake ($g \cdot kg^{-1} \cdot d^{-1}$)	2.0 ± 0.5	2.1 ± 0.4	2.0 ± 0.4	1.6 ± 0.4 $^{aaa, bbb, ccc}$
Fat intake ($g \cdot kg^{-1} \cdot d^{-1}$)	1.5 ± 0.5	1.5 ± 0.4	1.5 ± 0.4	1.3 ± 0.5
Training (food diaries) ($h \cdot d^{-1}$)	2.1 ± 0.7	2.1 ± 0.7	1.9 ± 0.7	1.1 ± 0.7 $^{aaa, bb, cc}$
Training (eLogger) ($h \cdot d^{-1}$)	1.9 ± 0.3	1.8 ± 0.3	1.5 ± 0.5 $^{aa, bb}$	0.5 ± 0.4 $^{aaa, bbb, ccc}$

^{aa} Significantly different from preparation season (Log_1) $p<0.01$ ^{aaa} $p<0.001$; ^{b} Significantly different from specific preparation season (Log_2) $p<0.05$, ^{bb} $p<0.01$, ^{bbb} $p<0.001$; ^{c} Significantly different from competition season (Log_3) $p<0.05$, ^{cc} $p<0.01$, ^{ccc} $p<0.001$.

Some associations







Conclusions (from single observations)

1. Young female skiers seem to spontaneously periodize their energy and macronutrient intake between macrocycles with different energy requirements.
   - EA and CHO intake were at a suboptimal level in most of the athletes

2. Higher CHO intake across the training year and lower fat percent and body weight may be beneficial for competition performance in cross-country distance events

3. Athletes with higher body weight and fat tended to have lower EA and carbohydrate intake
   - cause-and-effect relationships?
   - restricting dietary intake is clearly not a good way to modify body composition in young athletes

Thank you for your attention!

And special thanks for the research group (Vesa Linnamo, Johanna Ihalainen, Ritva Mikkonen, Olli Ohtonen, Jaakko Mursu, Maria Heikkilä and Maarit Valtonen) and the coaches of youth national team and Vuokatti Ruka Sport Academy for the great collaboration!

Time for some questions…


https://oonakettunen.wordpress.com

UNIVERSITY OF JYVÄSKYLÄ

REFERENCES

- Ackerman K.E, Stellingwerff, T., Elliott-Sale, K. J., Baltzel, A., Cain, M., Goucher, K., Fleshman, L. & Mountjoy, M. 2020. *British Journal of Sports Medicine* 54 (7), 369-371.
- Heikkilä, M.; Valve, R.; Lehtovirta, M.; Fogelholm, M. 2018. Development of a nutrition knowledge questionnaire for young endurance athletes and their coaches. *Scandinavian Journal of Medicine & Science in Sports 28*, 873–880.
- Ilander, O. 2014. Liikuntaravitsemus –tehoa tuloksia ja terveyttä ruoasta. VK-kustannust Oy.
- Kettunen O, Heikkilä M, Linnamo V & Ihalainen JK. 2021a. Nutrition knowledge is associated with energy availability and carbohydrate intake in young female cross-country skiers. *Nutrients* 13 (6), 1769.
- Kettunen O, Ihalainen JK, Ohtonen O, Valtonen M, Mursu J & Linnamo V. 2021b. Energy availability during training camp is associated with signs of overreaching and changes in performance in young female cross-country skiers. *Biomedical Human Kinetics* 13 (1), 246–54.
- Loucks, A. B., Kiens, B., & Wright, H. H. 2011. Energy availability in athletes. *Journal of Sports Sciences 29*(1), 7–15.
- Melin, Anna, Tornberg, Å. B., Skouby, S., Faber, J., Ritz, C., Sjödin, A., & Sundgot-Borgen, J. 2014. The LEAF questionnaire: A screening tool for the identification of female athletes at risk for the female athlete triad. *British Journal of Sports Medicine 48*, 540–545.
- Mountjoy, M., Sundgot-borgen, J. K., Burke, L. M., Ackerman, K. E., Blauwet, C., Constantini, N., Lebrun, C., Lundy, B., Melin, A. K., Meyer, N. L., Sherman, R. T., Tenforde, A. S., Torstveit, M. K., & Budgett, R. 2018. IOC consensus statement on relative energy deficiency in sport (RED-S): 2018 update. *British Journal of Sports Medicine 52*, 687–697.
- Thomas D.T., Erdman K.A., Burke L.M. (2016) American College of Sports Medicine joint position statement nutrition and athletic performance. *Medicine and Science in Sports and Exercise* 48, 543-468.