

# Sports Nutrition for Athletes

## New strategies and practical application for athletic performance

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### Introduction

#### Achieving Success in Sports

"The amount, composition and timing of food intake can profoundly affect sports performance"

IOC Consensus Conference on Nutrition and Sports Performance, 2010

### Introduction

#### The field of sports nutrition continues to grow at a rapid rate.

- Traditional research focus : strategies to maximise competition performance
- Emerging data in the last decade : a prominent role in regulating those cell signalling pathways that modulate skeletal muscle adaptations to endurance and resistance training

(FreeRadicalBiologyandMedicine98(2016)144–158)

### Introduction

As is the case with much laboratory research, knowledge leads to application. This resulted in more collaboration between exercise physiologists and nutritionists,

The expertise of nutritionists was needed for translating scientific information into practical applications.

- Need "Evidence-based guidelines..."
- Individualized approach on
- the guidance of qualified sports nutrition professionals

(FreeRadicalBiologyandMedicine98(2016)144–158)

### Key elements of integrated nutrition service

#### Forest Football Academy

Teamwork Nutritionist is core member of academy staff  
Liaises across all departments  
Conducts joint review meetings with players and coaches

#### Education

Individual consultations available to all players  
Practical shopping and cooking sessions  
Workshops for all players, coaches and parents

#### Supportive environment

All meals planned and supervised catering at ground, hostel, players digs  
Water bottles and sports drinks available  
Snacks provided post training and matches

Proceedings of the Nutrition Society (2009), 68, 23–2



## Goal 1 : Practical Sports Nutrition : Nutritional Recovery Strategies

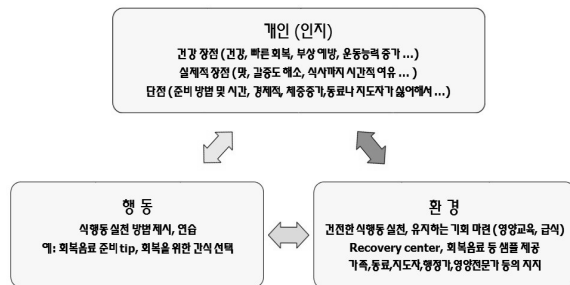
- Restoration of muscle and liver glycogen stores
- Replacement of fluid and electrolytes lost in sweat
- Regeneration, repair and adaptation processes following the catabolic stress and damage caused by the exercise

### Key Points : Nutrition for Rapid Recovery

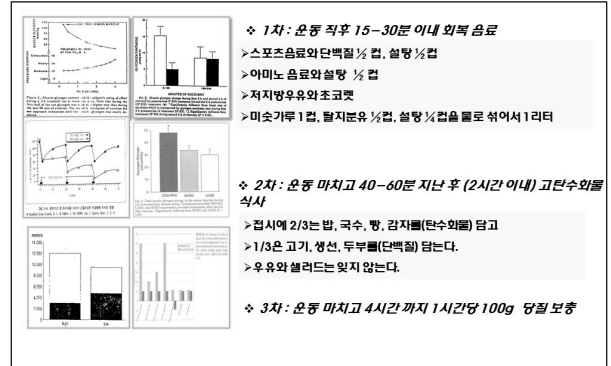
- High carbohydrate diet :  $6 \sim 10\text{g/kg/d}$  / Protein intake  $\sim 1.6\text{g/kg/d}$   
Dietary fat intake should not exceed  $2\text{g/kg/d}$ .
- Long training sessions : at least  $30 \sim 60\text{g}$  of CHO per hour (Sport drink, gels, and Bars)
- To ensure quick recovery after intense training :  $1.2 \sim 1.5\text{g}$  of CHO/kg/h begin within the first 30 min / The addition of  $15 \sim 20\text{g}$  of protein promotes muscle protein repair and synthesis (Phillips & Van Loon, 2011).
- Adequate fluids and micronutrients

### Refueling and rehydration post training and matches

- **Reciprocal determinism** → **Multiple Path 이용**
- 개인, 행동, 환경의 지속적인 상호작용



### Food & Snacks provided post training and matches



### Snacks provided post training and matches

**영양 -> 식품(음식)**

식품의 영양적 (단순당, 에너지와 체중 증가) /  
경제적(비용), 기호도, /  
임상적(알, 당뇨, 중성 지방) /  
준비(조리기술, 시간 등) 능력

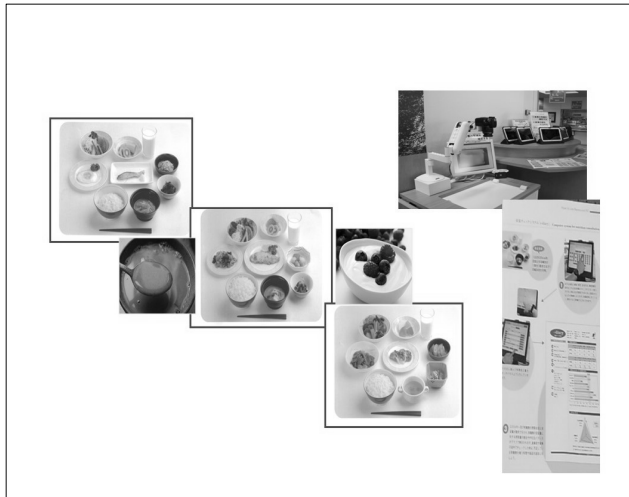
**건강한 간식**

- 견과류와 무지방 요거트 한 개
- 완속 달걀 한 개와 사과 한 개
- 스트림 치즈와 오렌지 한 개
- 근약우유
- 삶은 감자 2개

Individual	Club or squad
Physiology and roles of sport	Food preferences of team or squad
Culture of sport	Catering arrangements
Competition schedules	Available resources
Travel and tours	Supplement use
Scientific evidence base	Sponsorship

### Foods & snacks provided post training and matches





## Replacement of fluid and electrolytes lost in sweat

Issues	Education	Action Plan	
Dehydration by fluid and electrolytes lost in sweat	Fluid intake pre, during and post exercise	Accessible water bottle during game	
	땀 손실량 (ml/hr)	수분 섭취량 (ml/hr)	
시험 시	여름 겨울	1209 ± 330 1027 ± 267	516 ± 337 361 ± 195
연습 시	여름 겨울	985 ± 320 746	429 ± 319

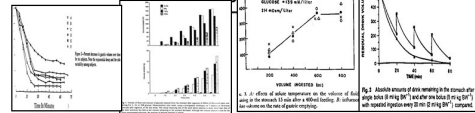
Figure 1: Dehydration and fluid intake during a 100m sprint. The graph shows % body mass change (left y-axis, 0 to -10) and fluid intake (right y-axis, 0 to 1000 ml) over time (x-axis, 0 to 1000 s). The dehydration curve (solid line) shows a decrease in body mass, while the fluid intake curve (dashed line) shows an increase in fluid intake. The fluid intake curve is higher than the dehydration curve, indicating that fluid intake is greater than fluid loss.

Figure 2: Fluid intake during a 100m sprint. The bar chart shows fluid intake (ml) for each 100m sprint (x-axis, 1 to 10). The fluid intake increases over time, with the highest intake occurring during the 10th sprint.

Figure 3: Fluid intake during a 100m sprint. The line graph shows fluid intake (ml) for each 100m sprint (x-axis, 1 to 10). The fluid intake increases over time, with the highest intake occurring during the 10th sprint.

Figure 4: Fluid intake during a 100m sprint. The line graph shows fluid intake (ml) for each 100m sprint (x-axis, 1 to 10). The fluid intake increases over time, with the highest intake occurring during the 10th sprint.

Figure 5: Fluid intake during a 100m sprint. The line graph shows fluid intake (ml) for each 100m sprint (x-axis, 1 to 10). The fluid intake increases over time, with the highest intake occurring during the 10th sprint.



## Replacement of fluid and electrolytes lost in sweat

Start exercise with good hydration!!!  
 -4hrs before : 5-7ml/kg BW  
 -2hrs before : additional 3-5ml/kg BW

Avoid excess dehydration or fluid intake. Know sweat rate!!!  
 -Minimize BW loss 2%  
 -Avoid weight gain (over hydration & hyponatremia)

Replenish fluid deficit and electrolyte loss  
 - Drink 150% fluid deficit  
 -Sodium from beverage or snacks can help fluid retention

## Replacement of fluid and electrolytes lost in sweat



## Goal 2 : Nutrition for Training and competition

Athletes must consume adequate energy to meet the demands of intense training and competition (Tarnopolsky & Gibala, 2005).

1. Determining daily energy requirements for an athlete to match the demands of training
2. Simultaneously maintaining/achieving body weight and body composition targets.
3. Determining macro- and micronutrient requirements

**훈련 프로그램**

생리적 요구      영양 요구

- 운동 종류      에너지
- 훈련 routine      탄수화물
- 에너지 사용      단백질
- 근골격계 스트레스      수분
- 체온 조절      비타민
- 체중 변화      무기질

**경 기**

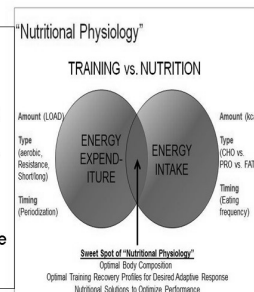
생리적 요구      영양 요구

- 운동종목      에너지
- 강도      탄수화물
- 지속 정도      단백질
- 에너지 사용      수분
- 근골격계 스트레스      비타민
- 체온 조절      무기질

## 1. Energy Requirements and Energy Balance

Factors that increase energy

exposure to cold or heat, fear, stress, high altitude exposure, some physical injuries, specific drugs or medications (eg, caffeine, nicotine), increases in fat-free mass and, possibly, the luteal phase of the menstrual cycle.2



energy requirements are lowered by aging, decreases in fat free mass (FFM), and, possibly, the follicular phase of the menstrual cycle.3

> 훈련 주기에 따른 dietary periodization  
 : 년간 훈련 계획시 주기( preparation, competition, transition)

### 운동 선수 에너지 요구량 계산

- ▶ **에너지 필요 추정량 산출 (한국영양학회 2010)**
  - ▶ 성인 남자:  $662 - 9.53 \times \text{연령(세)} + \text{PA} [15.91 \times \text{체중(kg)} + 539.6 \times \text{신장(m)}]$
  - ▶ 성인 여자:  $354 - 6.91 \times \text{연령(세)} + \text{PA} [9.36 \times \text{체중(kg)} + 726 \times \text{신장(m)}]$ 
    - ▶ PA(신체활동단계별 계수): 비활동적: 1.0, 저활동적: 1.11(남), 1.12(여), 활동적: 1.25(남), 1.27(여), 매우 활동적: 1.48(남), 1.45(여)
- ▶ **운동선수의 에너지 요구량**
  - ▶ 운동 종류, 기간(훈련, 시합)에 따라 차이
  - ▶ 하루 90분 정도 운동, 훈련하는 경우: 45kcal/kg/일(여), 50kcal/kg/일(남)
  - ▶ 식사섭취의 적절성 평가시 체중, 신체조성(체지방률) 목표도 고려
- ▶ **에너지 소비량의 간편한 추정법(성등진 저, 운동영양학)**
  - $A = B + Bx + A/10$
  - $A = B(1 + X)/0.9$  (연령지수 고려)
  - A = 1일 에너지 소비량
  - B = 1일 기초 대사량
  - X = 생활 활동지수
  - A/10 = 특이종적 작용에 의하여 쓰여지는 에너지

### 예. 남자 배구선수 31세, 82kg, 189cm

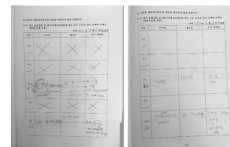
1. 성인 남자:  $662 - 9.53 \times \text{연령(세)} + \text{PA} [15.91 \times \text{체중(kg)} + 539.6 \times \text{신장(m)}]$   
PA(신체활동단계별 계수): 활동적: 1.48(남)  
에너지 추정량:  $662 - 9.53 \times 31 + 1.48 [15.91 \times 82(\text{kg}) + 539.6 \times 1.89(\text{m})]$   
= 3,806 kcal
2. 남자운동선수 :  $50 \times 82(\text{kg}) = 4,100 \text{ kcal}$
3. 1일 에너지 소비량 =  $25.3 \times 82(1 + 1.00)/0.9 \times 0.95 = 4,370 \text{ kcal}$

예: 급식 vs 상담???  
대학 축구선수 체중증가가 목표적???

### Case Study 1 : Volleyball player

남자 배구선수 31세, 189cm, 82kg 에너지 추정량 4,100kcal 외복음류? 체중증가, 무릎과 발목부상	구분	섭취량		섭취량		섭취량		섭취량	
	열량(kcal)	3,707	90.0	2,894	67.0	1,675	41.0	5,021	113.0
	단백질(g)	158.1		123.7		95.9		230.7	
	지방(g)	90.6		75.0		41.1		137.5	
	당질(g)	587.0		425.6		219.8		697.2	
	식이섬유(g)	47.7		93.4		80.8		77.5	
	비타민A(μg RE)	2,455.6	210	417.4	37	311.6	28	949.7	84
	비타민C(mg)	531.5	354	311.3	208	39.4	26	87.2	58
	비타민B1(mg)	4.1	228	1.8	98	0.6	35	2.0	109
	비타민B2(mg)	3.7	166	1.3	56	0.7	31	2.3	103
	비타민B6(mg)	5.0	224	3.1	138	1.7	76	4.2	185
	나이아신(mg)	39.6	165	14.1	59	8.3	34	50.4	210
	엽산(μg)	929.1	155	333.7	56	100.9	17	437.9	73
	칼슘(mg)	1,545.1	137	759.9	68	559.8	50	1,022.2	91
	인(mg)	2,573.3	245	1,109.2	106	644.5	61	2,134.4	203
	나트륨(mg)	10,418.1	463	4,033.1	179	2,868.8	128	6,582.2	293
	칼륨(mg)	29.0	193	11.7	78	6.6	44	23.3	155
	아연(mg)	18.9	126	8.4	56	5.5	37	25.8	172

### Case Study 2 : Taekwondo(대학선수)



사용자 ID	성명	나이	종목명	에너지(kcal)	탄수화물(g)	지질(g)	식물성 단백질(g)	동물성 단백질(g)	단백질(g)
009	신규사용자	2016-05-18	413	1173.68	145.51	47.27	7.29	39.98	37.87
015	신규사용자	2016-05-18	820.7	1494.82	193.84	56.047	34.572	21.475	53.369

#### ▶ 체중관리 필요한 종목

- 체조, 피겨 스케이팅, 발레, 싱크로나이즈드 스위밍, 다이빙 등
- 체급종목(복싱, 레슬링, 태권도, 유도 등)
- 기타종목 선수 중 일부

- 칼로리 제한, unbalanced diet 문제
- 에너지 결핍 : 여자선수에게 3가지 문제, 신체기능 감소
- 남자선수 장기적으로 건강문제?

#### ▶ 성장 발달기에 있는 청소년 운동선수 및 대학선수의 영양 및 급식

- 실제 운동선수 기본식품섭취 기준서 및 소요 식비 제한
- Position Statement
- 영양급식 지원센터

### 2. Macro and Micronutrient Requirements for Sport

영양소	권장 수준
탄수화물	<ul style="list-style-type: none"> <li>· 운동 강도, 시간에 따라 탄수화물 권장: 5-7 g/kg/일(중간강도, 1시간 이상/일), 7-12 g/kg/일(엘리트 운동선수, 5-6시간 훈련/일)</li> <li>· 탄수화물 섭취 전략: 근육 글리코겐 고갈, 회복 지연, 피로, 상해 위험</li> <li>· 단순당 섭취 : 하루 에너지 권장량의 10-15%</li> </ul>
단백질	<ul style="list-style-type: none"> <li>· 성인: 0.83 g/kg/일 (에너지 적정 섭취비율: 에너지 섭취의 7-20%)</li> <li>· Endurance athletes: 1.2-1.4 g/kg/일</li> <li>· Strength and power athletes: 1.2-1.7 g/kg/일</li> <li>· 좋은 질의 단백질(달걀, 소고기, 돼지고기 등)</li> <li>· 우유단백질은 근육 증가와 체구성분의 좋은 방향으로 변화</li> </ul>
지질	<ul style="list-style-type: none"> <li>· 에너지 적정 섭취비율(성인): 에너지 섭취의 15-25%</li> <li>· 운동선수: 에너지 요구량 증가에 따라 지질 섭취 증가</li> <li>· 포화지방 비율이 에너지의 10% 이하</li> <li>· 필수지방산 섭취에 중점(지방산이 되도록 관심) <ul style="list-style-type: none"> <li>- 단일불포화지방 (올리브유, 캐놀라유 등) : 10-15%</li> <li>- 오메가 6 불포화지방산(옥수수유, 잇꽃유) : 6-7%</li> <li>- 오메가 3 불포화지방산(생선유, 호두) : 2-3%</li> </ul> </li> </ul>

자료: Driskell JA & Wolinsky I (2011)

## 2. Macro and Micronutrient Requirements for Sport

영양소	권장 수준
비타민	<ul style="list-style-type: none"> <li>• 비타민, 무기질: 권장섭취량 참고, 일부는 충분섭취량, 상한섭취량 미만</li> <li>• 티아민, 리보플라빈, 나이아신, 비타민 B<sub>6</sub>: 에너지 대사에 관여</li> <li>• 엽산, 비타민 B<sub>12</sub>: 적혈구 합성, 조직 회복 등에 관여</li> <li>• 항산화 영양소(비타민 A, C, E): 권장섭취량 수준, 과량 섭취시 운동수행능력 향상에 관한 근거 부족</li> <li>• 비타민 D : 근력증가, 근육량 증가, 골격기능 등</li> </ul>
무기질	<ul style="list-style-type: none"> <li>• 칼슘: 권장섭취량 750mg/일(19-49세 남자), 650mg/일(19-49세 여자), 상한섭취량 2,500mg/일, 골격 건강, 특히 여자 운동선수, 성장기 운동선수</li> <li>• 철: 권장섭취량 10mg/일(19-49세 남자), 14mg/일(19-49세 여자), 상한섭취량 45mg/일</li> <li>• 아연: 권장섭취량 10mg/일(19-29세 남자), 8mg(19-49세 여자), 상한섭취량 35mg/일</li> </ul>

자료: 한국영양학회(2010), Driskell JA & Wolinsky I (2011)

## 3. Traditional periodization model

>Recommendations to periodize nutrition programs to reflect the progressive cycling of training stressors have emerged (Stellingwerf, et al., 2007; Houtkooper et al., 2007).

>Preparatory phases develop non-specific and specific physical qualities whereas competition phases maintain and stabilize the newly-developed improvements and transition phases are periods of mental and physical recuperation (Bompa & Carrera, 2005).

표 1. 전통적인 주기화 모델 (Preparatory, Competition, Transition phases)

Phase	Goal	Training Focus	Nutrition Focus
Preparatory Phase	Develop non-specific and specific physical qualities	General conditioning, aerobic base, strength training	General nutrition, hydration, electrolyte balance
Competition Phase	Maintain and stabilize newly-developed improvements	Specific skill training, competition simulation	Performance nutrition, carbohydrate loading, fluid intake
Transition Phase	Periods of mental and physical recuperation	Low intensity training, rest	Recovery nutrition, general health maintenance