

Symposium: Nutrition and Physical Performance: A Century of Progress and Tribute to the Modern Olympic Movement

Diets of Elite Athletes: Has the Discipline of Sports Nutrition Made an Impact?¹

Ann C. Grandjean

Center for Human Nutrition, 502 S. 44th Street, Suite 3007, Omaha, NE 68105-1065

ABSTRACT Although numerous descriptions exist of special diets and particular foods used by Greek athletes as early as 580 B.C., survey data on diets of Olympians of the modern era are virtually nonexistent. A survey in Helsinki in 1952 reported the diets of Olympic athletes to be high energy, high fat, and high protein. The 1952 Olympians reportedly consumed an average daily energy intake of 18,841 kJ, with 40% of energy coming from carbohydrate, 20% from protein, and 40% from fat. More recent data on elite level athletes reveal wide variation in dietary intake. For example, energy intakes of athletes from four countries ranged from 7699 to 24,845 kJ. Group percentages of energy from carbohydrate, protein, and fat ranged from 33 to 57%, 12 to 26%, and 29 to 49%, respectively. Comparing dietary intake data of athletes on an absolute basis, however, is primarily a comparison of body size. When the protein and carbohydrate intakes of elite athletes are calculated as grams per kilogram body weight, the range for protein is 1.0–4.3 g/kg body wt for protein and 3.5–6.9 g/kg body wt for carbohydrate. Interestingly, variations in carbohydrate intake diminished while protein intake varied by country. Although some data on diets of Olympians exist, the most remarkable finding when reviewing the literature is the paucity of data. The discipline of sports nutrition has arguably had a positive effect on sports performance. However, many unanswered questions remain and great strides remain to be made. *J. Nutr.* 127: 874S–877S, 1997.

KEY WORDS: • athletes • dietary intake • elite athletes • Olympics

Although the origins of athletic activities date to prehistoric times, the ancient Olympic Games were founded in 776 B.C. during the historical era. Much of the early writing on athletics was written, during the classical period of Greece, hundreds of years after the first Olympic Games. These texts, a mix of legend and fact, still attract scholars today. Once information on Olympic athletes began to be recorded in 776 B.C., numbers were assigned to the games and the date 776 B.C. would become Olympiad One. The ancient games of Greece were a religious festival to honor the gods. Stories from the Olympics and the names and descriptions of well-known ancient athletes along with their training and dietary rituals are among the most fascinating texts to survive from antiquity (Kieran et al. 1977, Messinesi 1973).

The last Olympiad of the ancient era was held in 393 A.D., and for 15 centuries no Olympic Games were held (Messinesi 1973). They were revived in the late 19th century, and on April 6, 1896, the first Olympiad of the modern era opened in Athens, Greece. The 100th celebration of the modern Olympic Games will open in Atlanta, Georgia, on July 20, 1996. The XXVI Olympiad of the modern era will be patterned

on the first modern Olympiad held in Athens, particularly in the events, the ceremony, the opening, the closing and the awarding of medals. However, there will be very significant differences: at the first Olympiad at Athens, 311 athletes, all men, participated in 10 sports and 42 events; at the XXVIth Olympiad in Atlanta, there will be an estimated 10,700 athletes, 3779 of them women, participating in 26 sports, 34 disciplines and 271 events.

IMAGES FROM THE PAST

The concept of reviewing the diets of Olympic athletes and summarizing progress during the past century seems simple at first glance. This exercise, however, proved to be daunting because there exist only a handful of qualitative descriptions of diets or specific foods used by Olympic athletes in antiquity, and data are equally sparse regarding selections and patterns of modern Olympians.

The diet of most Greeks and Romans was basically vegetarian and consisted of cereals, fruit, vegetables and legumes, and wine diluted with water. When meat was eaten, the most common source in antiquity was goat in Greece and pork for Romans (Simopoulos 1989). According to one source (Harris 1966), "The earliest Greek athlete of whose special diet we are told anything is Charmis of Sparta, who is said to have trained on dried figs."

It is impossible to identify precisely when meat became a major component of athletes' diets. One account by Pausanias

¹ Presented as part of the symposium "Nutrition and Physical Performance: A Century of Progress and Tribute to the Modern Olympic Movement" given at Experimental Biology 96, April 15, 1996, Washington, DC. This symposium was sponsored by the American Society for Nutritional Sciences and was supported by an educational grant from Mars, Inc. Guest editor for the symposium publication was Louis E. Grivetti, University of California, Davis, CA.

TABLE 1

Olympic participation and achievement of nations by different levels of energy intake¹

Daily energy intake (kcal/person)	Population (millions)	No. Olympic participants ²	Participant rate ³	Point share ⁴	Point rate ⁵	Point level ⁶
1500–1999	432	40	0.09	610	1.4	15.3
2000–2499	749	397	0.53	8709	11.6	21.9
2500–2999	82	264	3.24	5936	72.7	22.5
3000–3499	232	969	4.17	29,324	126.1	30.3

¹ From Jokl (1964).² Number of Olympic participants per country.³ Number of Olympic participants per million inhabitants.⁴ Number of points collected by athletes per country.⁵ Number of points collected per million inhabitants.⁶ Average number of points per country participation.

states that a meat diet was introduced about the middle of the fifth century by Dromeus of Stymphalos, an ex-long-distance runner (*Description of Greece* 6:7:10). Another account by Diogenes Laertius has it that Eurymenes of Samos consumed a meat diet recommended by his trainer, Pythagoras of Croton, who was a philosopher (*Lives of the Philosophers* 8:12). Perhaps the best accounts of athletic diet to survive from antiquity, however, relate to Milo of Croton, a wrestler whose feats of strength became legendary. He was an outstanding figure in the history of Greek athletics and won the wrestling event at five successive Olympics from 532 to 516 B.C. According to Athenaeus and Pausanias, his diet was 9 kg (20 pounds) of meat, 9 kg (20 pounds) of bread and 8.5 L (18 pints) of wine a day (*Deipnosophists*: 10:412:F; *Description of Greece*: 6:145). The validity of these reports from antiquity, however, must be suspect. Although Milo was clearly a powerful, large man who possessed a prodigious appetite, basic estimations reveal that if he trained on such a volume of food, Milo would have consumed approximately 57,000 kcal (238,500 kJ) per day.

While eating meat to achieve victory has a history in athletics of more than 2000 years, alcohol also has a long history of

documented use in the Olympics. Some accounts state that in the early Olympics, alcoholic beverages were used in a manner that nutritionists and physiologists today would consider as ergogenic aids, and their consumption during training and before competition was acceptable behavior. Indeed, as recently as the 1908 Olympics, marathon runners drank cognac to enhance performance, and at least one German 100-km walker reportedly consumed 22 glasses of beer and half a bottle of wine during competition (Whorton 1982).

DIETARY INTAKES OF ELITE ATHLETES: THEN AND NOW

Recent data on the dietary habits of Olympians are sparse. This is not surprising, given the relatively small number of Olympians who have participated through the years (it is estimated that the United States will send only 686 athletes to the games in Atlanta). Further, there has not been a large "pool" to draw upon for research, because many athletes qualify for their respective Olympic team only weeks before the games begin.

TABLE 2

Olympians and elite national athletes: dietary energy and percentage from protein, fat and carbohydrate

National athletes:	Total daily energy intake	Proportion of energy intake from		
		Protein	Fat	Carbohydrate
	<i>kJ</i>	<i>%</i>		
Average of Olympic athletes at Helsinki Games ¹	18,841	20	40	40
Chinese elite athletes ²				
Males	13,849–24,845	18–22	38–48	33–43
Females	9,615–19,225	16–26	42–49	35–42
Finish elite athletes ³				
Males	11,736–13,640	14–16	29–32	53–57
Czechoslovakian elite athletes ⁴				
Females	8157	15	46	39
United States elite athletes ⁵				
Males	9696–19,476	12–18	32–40	42–54
Females	7699–12,311	13–16	30–38	44–54

¹ From Jokl (1964).² From Chen et al. (1989).³ From Fogelholm et al. (1992).⁴ From Parizkova (1985).⁵ Grandjean, unpublished data, 1991.

TABLE 3

Protein and carbohydrate intake of elite athletes

Country	Protein intake		Carbohydrate intake	
	% of energy	g/kg body wt	% of energy	g/kg body wt
China ¹				
Female	16–26	2.1–3.5	35–42	4.6–6.2
Male	18–22	2.4–4.3	33–43	4.1–6.5
Czechoslovakia ²				
Female	15		39	
Finland ³				
Male	14–16	1.4–1.6	53–57	4.1–6.4
United States ⁴				
Female	13–16	1.0–2.0	44–54	4.4–6.5
Male	12–18	1.2–2.2	42–54	3.5–6.9

¹ From Jokl (1964).² From Chen et al. (1989).³ From Fogelholm et al. (1992).⁴ From Parizkova, (1985).

One of the first nutrition-related studies to appear on Olympic athletes was conducted in association with the 1952 games in Helsinki (Jokl 1964). His data represent an average for all athletes, and he did not consider sex or specific sport categories. Jokl's data show an average energy intake of 18,841 kJ (4,503 kcal), with 40% of energy coming from carbohydrate, 20% from protein, and 40% from fat. Jokl also presented summary data that correlated national Olympic achievement with levels of energy consumption (Table 1) and showed that a lower national energy intake related to poor athletic results at the Olympic Games. His findings may have been the genesis of the oft-repeated statement that the only nutritional difference between athletes and nonathletes is the need for increased energy intake. Current knowledge of sports nutrition, however, would indicate a more complex relationship.

Although current dietary survey data on athletes participating in Olympic Games are scanty, data on elite level athletes from several countries have revealed wide variations in dietary intake (Table 2). Comparing dietary intake data on an absolute basis is primarily a comparison of body size. A 350-pound (159-kg) weight lifter who consumes a daily average of 7000 kcal (29,288 kJ) and 286 g of protein seems to be significantly different from a 73-pound (33-kg) gymnast who averages 1500 kcal (6276 kJ) and 53 g of protein daily. If, however, these respective intake data are considered on a per kilogram body weight basis, a degree of correction for variance in body size is provided. When energy is calculated on a per kilogram of body weight intake basis, the weight lifter's value is 184 kJ vs. 188 kJ for the gymnast. Similarly, the weight lifter's and gymnast's values for protein average intake per day are 1.8 and 1.6 g, respectively.

When elite athletes are counseled, dietary recommendations for protein and carbohydrate are often made in terms of number of grams per kilogram body weight and since 1989 have been reported as such in the literature.² This system allows survey data to be compared with recommendations and enhances comparison of intake data on small groups of athletes that represent a wide variety of sports and training regimens.

Table 3 compares protein and carbohydrate intakes of male and female athletes. Differences appear significant when re-

ported as percentage of energy but are nearly identical when reported as grams per kilogram of body weight. For endurance athletes training aerobically, it has been generally accepted and recommended frequently that a high carbohydrate diet will optimize training adaptations and athletic performance. Despite this widely held view, the literature does not strongly support the hypothesis that short-term or long-term reduction in dietary carbohydrate will impair training or performance (Sherman and Wimer 1991). Runners or cyclists who exercised for 1 h at 75% peak oxygen consumption (VO_2), followed by five 1-min sprints, maintained muscle glycogen levels with a daily consumption of 10 g carbohydrate/kg body weight, whereas muscle glycogen was reduced 30–36% when the athletes consumed a diet that supplied 5 g carbohydrate/(kg body weight · d), their performance capabilities were maintained (Sherman et al. 1993).

Although research suggests that some athletes require more protein than their sedentary counterparts, the exact requirements remain undefined and may be 17–74% higher than the RDA (Friedman and Lemon 1989, Meredith et al. 1989).

A CENTURY OF PROGRESS

Has sports nutrition progressed during the past century? Without doubt, many elite athletes have utilized diet as a component of their training program, and dietary intervention has had a positive effect on performance. Many Olympic athletes report, however, that they formulated their "ideal diet" through trial and error.

One is struck by the fact that although progress has been made, nutrition as a discipline is still in its infancy, and sports nutrition is embryonic. Data on dietary habits of Olympians remain sketchy at best: quantitative data began to appear approximately 40 y ago, with the majority of detailed data published only during the past 10–15 y.

Research has resulted in a respectable body of knowledge for a few specific areas of nutrition and performance. Best information has related to the intricacies of fluid and electrolyte balance, physiology of thermoregulation, carbohydrate requirements for endurance athletes, weight gain, and pre-competition foods (Food and Nutrition Board 1990, Grandjean 1995, Reimers et al. 1996, Sherman and Wimer 1991). Among the many unanswered questions that still remain are protein

² Recommendation of the Nutrition and Physical Performance Committee of the International Union of Nutritional Sciences, 1989, Seoul, Korea.

requirements of athletes, carbohydrate requirements of non-endurance athletes, and vitamin and antioxidant needs (Lemon 1991, Meredith et al. 1989, Sherman and Wimer 1991, Sherman et al. 1993, Witt et al. 1992).

Throughout the present century, recommendations and practices to athletes have followed scientific findings. Whereas Olympians of the ancient games drank wine, and the Olympic marathoners of 1908 drank cognac to enhance performance, Olympians today are well aware of the virtues of hydration through water and sports beverages. Dietary recommendations in the late 1800s identified specific foods athletes should consume, specifically “two kinds of meat at all three meals, supplemented with a moderate quantity of fruits and vegetables” (Whorton 1982). Recommendations today are more precisely nutrient and subject specific, for example, 8–10 g carbohydrate/kg body wt (Sherman et al. 1993).

If the past century has been enlightening, the next century will be even more so, with better scientific understanding of sports physiology and nutrient requirements as both relate to improved athletic performance. More will be discovered about optimal nutrient level, the mysteries of genetics will be refined, and hormonal responses to diet and exercise will be better understood. In the next century, the discipline of sports nutrition will become more definitive. One hundred years from now, at the bicentennial celebration of the Olympic Games, at a presentation entitled “Diets of Elite Athletes: Has the Discipline of Sports Nutrition Made an Impact?”, today’s understanding of sports nutrition will appear to be embryonic.

LITERATURE CITED

- Chen, J. D., Wang, J. F., Li, K. J., Zhao, Y. W., Wang, S. W., Jiao, Y. & Hou, X. Y. (1989) Nutritional problems and measures in elite and amateur athletes. *Am. J. Clin. Nutr.* 49: 1084–1089.
- Fogelholm, G. M., Himberg, J. J., Alopaeus, K., Gref, C. G., Laakso, J. T., Lehto, J. J. & Rauhamaa, H. M. (1992) Dietary and biochemical indices of nutritional status in male athletes and controls. *J. Am. Coll. Nutr.* 22: 181–191.

- Food and Nutrition Board (1990) Fluid Replacement and Heat Stress. Food and Nutrition Board, National Academy of Sciences, Washington, DC.
- Friedman, J. E. & Lemon, P.W.R. (1989) Effect of chronic endurance exercise on retention of dietary protein. *Int. J. Sports Med.* 10: 118–123.
- Grandjean, A. C. (1995) Dietary strategies for modifying weight or body composition. *Strength and Conditioning* 17: 7–10.
- Harris, H. A. (1966) Nutrition and physical performance. *Proc. Nutr. Soc.* 25: 87–90.
- Jokl, E. (1964) *Physiology of Exercise*. Charles C Thomas, Springfield, IL.
- Kieran, J., Daley, A. & Jordan, P. (1977) *The Story of the Olympic Games*: 776 B.C. to 1976. J. B. Lippincott, Philadelphia, PA.
- Lemon, P.W.R. (1991) Protein and amino acid needs of the strength athlete. *Int. J. Sport Nutr.* 1: 127–145.
- Meredith, C. N., Zacklin, M. J., Frontera, W. R. & Evans, W. J. (1989) Dietary protein requirements and body protein metabolism in endurance-trained men. *Am. J. Physiol.* 66: 2850–2856.
- Messinesi, X. L. (1973) *A Branch of Wild Olive. The Olympic Movement and the Ancient and Modern Olympic Games*. Exposition Press, New York, NY.
- Parizkova, J. (1985) Body composition and nutrition of different types of athletes. In: *Proceedings of the XIII International Congress of Nutrition. Energy Metabolism* (Taylor, T. G. & Jenkins, N. K., eds.), pp. 309–311. John Libbey, London, England.
- Reimers, K. J., Ruud, J. S. & Grandjean, A. C. (1996) Sports nutrition. In: *Office Sports Medicine* (Mellion, M. B., ed.), 2nd ed., pp. 22–34. Hanley and Belfus, Philadelphia, PA.
- Sherman, W. M., Doyle, J. A., Lamb, D. R. & Strauss, R. H. (1993) Dietary carbohydrate, muscle glycogen, and exercise performance during 7 days of training. *Am. J. Clin. Nutr.* 57: 27–31.
- Sherman, W. M. & Wimer, G. S. (1991) Insufficient dietary carbohydrate during training: does it impair athletic performance? *Int. J. Sports Nutr.* 1: 28–44.
- Simopoulos, A. P. (1989) Opening address. Nutrition and fitness from the first Olympiad in 776 BC to 393 AD and the concept of positive health. *Am. J. Clin. Nutr.* 49: 921–926.
- Whorton, J. C. (1982) *Crusaders for Fitness. The History of American Health Reformers*. Princeton University Press, Princeton, NJ.
- Witt, E. H., Reznick, A. Z., Viguie, C. A., Reed, P. S. & Packer, L. (1992) Exercise, oxidative damage and effects of antioxidant manipulation. *J. Nutr.* 122: 766–773.

CLASSICAL REFERENCES

- Athenaeus. *The Deipnosophists*. (Gulick, C. B., transl.), 7 vols., Putnam’s, New York, NY, 1927–1941.
- Pausanias. *Description of Greece*. (Jones, W.H.S., transl.), 5 vols. Putnam’s, New York, NY, 1918–1935.
- Diogenes Laertius. 1925 *Lives of Eminent Philosophers*. (Hicks, R. D. & Heine-mann, W.) transl. London, England, 1925.