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Sugars in the Diets of Athletes

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Carbohydrates are essential for peak athletic performance. In most Western diets, the level of carbohydrate is too low to adequately replenish glycogen stores that are depleted by regular strenuous training sessions.

In seeking to improve athletes' diets, we must first convince them of the need for more dietary carbohydrates. We must then look at the practical implications of increasing carbohydrates from various foods and provide dietary advice that is acceptable to the athletes and does not produce a diet less than optimal in other respects.

In discussing sugars in the diet of athletes, the following aspects are important.

1. The role of carbohydrates in the diets of athletes
2. How much carbohydrate athletes eat in relation to the rest of the community
3. What types of carbohydrates athletes eat
4. Why athletes eat the way they do
5. What is likely to happen to their total diet if athletes make changes to
   a. increase their total carbohydrate
   b. selectively increase their intake of sugar

THE ROLE OF CARBOHYDRATES IN THE DIETS OF ATHLETES

Carbohydrate, as muscle and liver glycogen and blood glucose, is the major fuel for physical performance. For a few seconds of high power output, adenosine triphosphate (ATP) stored in muscle cells can provide the necessary energy. For slightly longer periods of muscle activity (5–8 seconds), ATP can be resynthesized by the energy generated from the anaerobic splitting of phosphate from creatine phosphate (CP). Such short, sharp bursts of activity occur in sprints of up to 100 meters and also in activities, such as tennis, golf, hockey, football, gymnastics, weightlifting, and various track and field pursuits. For periods of maximum effort lasting up to 30 seconds, energy can be supplied by the breakdown of muscle glycogen. The accumulation of lactic acid signals the end of the maximum power output. Most types of physical activity obviously require another source of energy that can operate efficiently for a longer period.

For anaerobic activity, glucose is the only fuel that can be used. As the glucose molecule is broken down to pyruvate and ATP is produced, only about 5% of the energy of the glucose molecule is released. Once oxygen is involved, the rest of the energy can be extracted from the glucose molecule via the Krebs cycle. Aerobic activity can use a mixture of fuels: muscle glycogen, blood glucose, liver glycogen, free fatty acids, and intramuscular triglycerides. However, fatty acids cannot be used to synthesize glucose, so dietary sources of carbohydrate are crucial for continued activity.

For periods of physical activity longer than 60 seconds, fuels from the diet must be oxidized. Ultimately, all energy is derived from the enzymic breakdown of carbohydrates, proteins, and fats from food. During these reactions, about 40% of the energy is captured and stored in high energy bonds in the ATP molecule for future use. The rest of the energy is lost as heat. This makes the human body an amazingly efficient piece of machinery—even a steam engine can only manage to capture about 30% of the energy it produces.

The intensity and duration of exercise determine the type of fuel used (1). At rest and for light activity, free fatty acids in the blood and triglycerides in muscles contribute about 60% of the energy used. At moderate levels of activity (around 50% of maximal oxygen intake), fat and carbohydrate contribute about equal amounts of energy. If the intensity of exercise increases, there is a greater reliance on carbohydrate as the prime energy source. At very intense levels of activity, most of the energy is supplied by carbohydrate, and stores of glycogen in muscles and liver decrease. The change to using carbohydrate is not a linear response but accelerates with the intensity of the effort. Trained endurance athletes use more fat for their activity and so conserve their glycogen stores as long as possible. Ultimately, however, it is the amount of carbohydrate present in the muscles and liver (as glycogen) and in the blood (as glucose) that limits continued performance. When stores of muscle glycogen are depleted, fatigue occurs.

In theory, the average person has enough depot and storage fat to supply energy to run for 80 hours. In reality, such a feat would be impossible because glycogen stores would soon be exhausted, fats would not be completely burned in the absence of carbohydrate, and ketosis would occur. The body's carbohydrate stores usually are sufficient only for 2 to 3 hours of physical exertion. The limiting factor for prolonged exercise is the extent of glycogen stores.

The average adult has about 90 g of glycogen in the liver and 300 g in the muscles (2). Depletion of muscle glycogen reduces exercise capacity to approximately 50% of the energy expenditure of the normal state (3). Strenuous exercise plus a low carbohydrate diet also will reduce liver glycogen stores (4).

Dietary manipulation can increase the quantity of glycogen stored in both muscle and liver (1). A number of studies have shown that the glycogen levels in muscles and liver increase when more carbohydrate is eaten (1,2).

More than 20 years ago, the practice of carbohydrate loading was used by Bergstrom and Astrand to increase muscle glycogen stores. Their technique involved 3 days of exhausting physical activity on a low-carbohydrate diet followed by 3 days of rest on a high-carbohydrate diet. Levels of glycogen in muscles doubled on this regimen, and athletes around the world began to practice the technique. Most athletes dislike the low-carbohydrate phase and report feeling mentally and physically exhausted. Most also dislike the carbohydrate-repletion phase, since the extra water that is retained along with the glycogen makes them feel uncomfortable and bloated. Some runners complain of stiff, heavy feelings in the legs. There have been cases of disturbances to heart rhythm (5).

Recently, the carbohydrate-depletion phase of carbohydrate loading has been shown to be unnecessary. Costill et al. (6) demonstrated that the same high muscle glycogen levels can be achieved by giving a diet moderately high in carbohydrate (353 g/day) during the exhaustive exercise phase, followed by a diet high in carbohydrate (542 g/day) plus rest for at least 48 hours before an endurance event. Some footballers try carbohydrate loading every week, a practice that has no benefit for activity of this duration.

For all athletes, however, it makes sense to have plenty of carbohydrate to maximize glycogen stores. Training periods of several hours a day severely deplete glycogen stores. It is more difficult to be precise about eating carbohydrate just before an event. Obviously, it is not appropriate to eat solid foods just before strenuous physical activity. However, many athletes take solutions of glucose or drink soft drinks or sweetened fruit juices for "instant energy."

Both sucrose and glucose given 50 minutes before exercise raise blood glucose and insulin and stimulate the oxidation of carbohydrate. After 10 to 15 minutes of exercise, the blood glucose rapidly falls, although this has not been shown to produce the feelings of fatigue that would be expected (4). However, those athletes with the lowest blood glucose values used much more glucose (71–100% more) than when they did not take sugar before activity. The faster depletion of muscle glycogen is undesirable in endurance athletes and causes earlier fatigue. Costill et al. have shown that fructose produces less increase in blood glucose and insulin and a slower loss of muscle glycogen than either glucose or sucrose. However, many athletes who take 50 g of fructose feel nauseated.

HOW MUCH CARBOHYDRATE DO ATHLETES EAT IN RELATION TO THE REST OF THE COMMUNITY?

There is little doubt that a high-carbohydrate diet improves glycogen stores and athletic performance. The usual Australian diet, however, is high in fat and relatively low in carbohydrate. Dietary intake data collected in 1983 (7,8) showed that various groups in the Australian community had similar intakes of macronutrients, as shown in Table 1. (These groups have been selected as most closely matching in age the athletes studied. Results for other age groups for both urban and semirural populations are similar.)

It is clear that at these levels of dietary carbohydrate, there is a progressive depletion of glycogen in athletes (1). A normal mixed diet is thus not suitable for athletes

TABLE 1. *Macronutrient intakes of selected groups*

	Adolescents[a]		University[a] students		Service[a] recruits	General population[b]	
Age, mean (years)	14–15		18		23		
Range			17–31		17–44	25–34	
	Boys	Girls	Males	Females	Males	Males	Females
Energy							
(kJ)	11,950	9,360	10,060	8,080	13,360	12,010	8,040
(cal)	2,855	2,235	2,400	1,930	3,190	2,870	1,920
% E from							
Protein	14	15	14	15	17	16	17
Fat	40	40	41	39	40	38	38
Carbohydrate							
Sugars	31	30	27	28	23	18	20
Starch	15	15	16	15	15	22	22
Alcohol	1	<1	1	1	4	5	3

[a] From Baghurst KI, Record SJ (7).
[b] From National Dietary Survey of Australians in 1983 (8).

who train hard and regularly (6). It simply does not contain enough carbohydrate. The study of Jacob et al. (9) found that soccer players consuming 48% of the kilojoules as carbohydrate were unable to regain their normal levels of glycogen within 48 hours of its depletion. Clearly, the usual levels of carbohydrate in the typical diet are insufficient for athletes.

But do athletes eat the same type of diet as the general population? Table 2 shows the macronutrient intakes for 30 athletes (15 males and 15 females) who consulted me during March and April 1989. Details of their *before* diet were collected using 3-day food diaries that were checked at individual consultations. Each consultation

TABLE 2. *Diets of athletes*

	Males	(range)	Females	(range)
Age, mean (years)	24	(17–44)	21	(15–33)
Energy				
kJ	11,960	(7,270–24,060)	6,900	(5,110–10,650)
cal	2,860	(1,740–5,750)	1,650	(1,220–2,540)
% E from				
Protein	16	(10–25)	17	(13–21)
Fat	36	(22–42)	33	(22–46)
Carbohydrate				
Sugars	22	(12–35)	23	(14–32)
Starch	23	(13–30)	25	(17–36)
Alcohol	3[a]	(0–8)	<1	(0–5)

[a] Among those who drank alcohol, the average intake contributed 5% of their kilojoules.

TABLE 3. *Comparison of athletes' diets with similar age groups in the general population*

	Athletes		Population groups	
	Males	Females	Males	Females
Age, mean (years)	24	21		
Range	17–44	15–33	14–44	14–44
Energy				
kJ	11,960	6,900	11,845	8,490
cals	2,860	1,650	2,830	2,030
% E from				
Protein	16	17	15	16
Fat	36	33	40	39
Total carbohydrate	45	48	42	43
Sugars	22	23	25	26
Starch	23	25	17	17
Alcohol	3	<1	3	2

lasted 60 to 90 minutes. The athletes included distance runners, triathletes, golfers, tennis players, ballet dancers, and skaters. Initial analysis of their diets (DIET/1 Xyris program) is shown in Table 2.

The intakes of the population groups of similar age range as the athletes have been averaged for comparison with the athletes. There are some differences, as shown in Table 3. The major differences found were the female athletes consumed nearly 20% fewer kilojoules than other women, both male and female athletes consumed significantly less fat than their peers, and total carbohydrate intakes were higher among the athletes, although the difference was not statistically significant. However, the athletes ate a significantly greater amount of their carbohydrate in the form of starch or complex carbohydrate.

The lower kilojoule intake of female athletes is a common, albeit undesirable, practice. This particular group included skaters and gymnasts, all appearing quite slim, and with body fat levels of around 20%. Most, however, were sent for dietetic appraisal because they were considered too heavy by their sports coaches. They were all under 20 years of age, often hungry, and most resented the constant references to their body fat levels. Most were trying to eat less, mainly to keep their coaches (and, in some cases, their parents) off their backs.

In a previous study (unpublished) of aerobics instructors, kilojoule intakes were even lower (3500 kJ/day) and quite inadequate for 2 to 3 hours of aerobics per day. There is a very high rate of turnover of aerobics instructors in gymnasiums, probably because they are unable to continue their high energy output on their inadequate intake.

The lower fat intake of both males and females was due to a conscious effort by many to avoid fried foods, cakes, biscuits, and desserts other than fruit. Those with the highest fat intakes ate fast foods often. Few used much fat in cooking, apart from a predilection for roast potatoes.

TABLE 4. *Sources of sugars (expressed as percentage of total sugars) in diets of athletes compared with general population*

	Athletes		General population	
	Males	Females	Males	Females
% of sugar from				
fruits/vegetables	42	50	26	33
Range	15–71	21–75		
Milk	13	14	11	13
Range	4–32	2–30		
Sucrose	45	36	63	54
Range	20–72	12–68		

The differences in starch and sugar intakes are described in greater detail in the following sections.

WHAT TYPES OF CARBOHYDRATES DO ATHLETES EAT?

From experience, many athletes shun sucrose-containing foods and try to choose a higher percentage of their carbohydrate in the form of fruits and such foods as bread, pasta, rice, and potatoes. Some, however, rely on confectionery items to make up for missed meals.

Compared with the general population, this group of athletes chose a higher percentage of their diet as starchy carbohydrates, mainly in the form of bread and cereals. Many of the males used breakfast cereals as snacks.

Table 4 shows the major sources of sugars in the athletes' diets and compares these with data from the National Dietary Survey of Adults, 1983. The sucrose figures include that added and present in purchased and processed foods. The figures from the National Dietary Survey were calculated from the sugar intake and the relative percentages of sugars in different foods. The percentages of sucrose and lactose were used for such foods as ice cream and flavored milk.

The athletes consumed significantly more of their sugar from fruits and vegetables and significantly less from sucrose compared with the general population. This was obvious also from their food diaries, which showed a heavy use of fruits and vegetables and little use of refined sugar as such.

WHY DO ATHLETES EAT THE WAY THEY DO?

Over the past few years, there has been considerable media coverage given to the nutritional needs of athletes. Once, the prevailing attitude was that if you were physically active, it did not matter what you ate. Now, there is a strong feeling among athletes that they should be paying greater attention to their diet. However, there is also a lot of confusion. Most of the advertisements in the popular fitness literature imply that athletes need only take their vitamins, amino acids, sports drinks, and protein powders for instant success.

In my experience, those athletes who alter their diets generally do so after reading some of the fitness literature, including books, magazine articles, and specialist publications put out by a variety of fitness authorities and enthusiasts. Many simply do what their coaches tell them. A few consult a dietitian or physician specializing in sports nutrition or some other interested person.

Most athletes seem to have preconceived ideas about which foods are good for them. Like most Australians, they believe that fruits and vegetables are among the best foods available. Most make an effort to eat more of these foods. Fruit, in particular, is highly regarded because it also makes a suitable snack food. Bananas and oranges (or their juice) seem to be the most popular fruits.

Some athletes say they no longer believe that sugar is as bad as they once thought (no doubt a result of extensive advertising by the sugar industry), but the majority still say they try not to use too much sugar. The lure of chocolate bars proves too much for the resolve of some!

In general, most athletes say they are trying to follow a healthier diet, although many admit that their hectic lifestyle, which often involves several hours training plus traveling as well as work or school, can make regular meals difficult.

Most athletes are aware that carbohydrates are beneficial, but they have little idea of how much they should be aiming for. Males have less trouble adapting to an increased intake of carbohydrate, since they are happy to eat bread, bread rolls, large helpings of cereal foods, and heaps of pasta and rice. Most females find it difficult to allow themselves to eat much of these foods, although they are less worried about bread than before. Although this study showed that the females had a slightly higher percentage of their diets as carbohydrate, almost all restricted everything they ate, including carbohydrate foods. Their kilojoule intakes were low in comparison with estimated requirements for their levels of physical activity. Any advice to increase their carbohydrate intake is usually countered with a fear that this would "make them fat." Females still fear carbohydrates.

RESULTS OF INCREASING TOTAL CARBOHYDRATE OR SELECTIVELY INCREASING SUGAR

Most of the athletes' diets had more than adequate levels of vitamins. About one third of the females did not meet the recommended daily intake (RDI) for retinol, and one male had a low intake of several vitamins. Many, however, failed to meet the RDIs for iron (40% of the females), calcium (over 70% of females and 60% of males), and zinc (86% of females and 33% of males). Average intake of dietary fiber was 24 g for the females (or 15 g/1,000 Cals) and 32 g (or 11 g/1,000 Cals) for the males. Many of the athletes reported that constipation was a problem.

As shown earlier, carbohydrate intake represented 45% of the energy for males and 48% for females. This is similar to other reports where carbohydrates were found to provide 46% of the energy in athletes' diets (10). A few athletes had made positive attempts to increase their carbohydrates. Most, however, thought that eating plenty of fruits and vegetables and a meal of pasta the night before an event were all that was required. Few had any concept of the amount of carbohydrate foods necessary to increase their percentage of carbohydrate to the level of 60–65% of energy, which is commonly recommended for athletes. Most were aware of the need to reduce their fat intake but also had little idea how to do this. Like most Australians, they were unaware of sources of fat in the diet, apart from fast foods, red meats, and dairy products. Most had no idea that foods, such as margarine, mayonnaise, and toasted muesli, contain significant amounts of fat.

CHANGING THE DIET

In advising athletes to eat more carbohydrate, a different approach may be needed for males and females.

Females

Most of the female athletes needed to eat more. None was overweight, and most reported feeling chronically tired. Many did not train as much as their coaches wanted because they were too tired. Although fatigue can be due to low ferritin levels, it can also be due to not eating enough, specifically carbohydrates. The simplest way to fix this would be to add carbohydrate-containing foods to their current diet.

However, the following points need consideration: (a) carbohydrate foods that are low in fat should be chosen; (b) if possible, carbohydrates that also supply minerals, such as iron, calcium, zinc, and magnesium, would be valuable; and (c) the carbohydrate foods must be acceptable to the athlete and not seen as fattening or unhealthy.

Possible sources of carbohydrate might include fruit, bread, breakfast cereals, pasta or rice, and soft drinks or sweetened beverages.

Fruit has the advantage of being acceptable to the athletes. It also supplies dietary fiber, vitamins, and some minerals.

Bread, preferably wholemeal, would also improve the mineral content of the diet. Advice to eat salad sandwiches or a banana inside a fresh bread roll (i.e., without any source of fat) is generally well received.

Breakfast cereals, served with low fat milk, also would improve the low intake of calcium.

Pasta or rice, especially wholegrain varieties, would improve the mineral content.

Soft drinks or sweetened beverages have no ability to improve the general adequacy of the diet. They are also not perceived by most athletes as part of a healthy diet.

TABLE 5. *Case study 1*

	Current diet	Addition 1	Addition 2
		1 slice wholemeal bread	3 cans soft drink
		1 banana	
		2 Weetbix with low fat milk	25 g sweets 25 g toffee
		1 cup brown rice	
Protein (g)	59 (17% E)	81 (17% E)	60 (12%)
Fat (g)	60 (37% E)	68 (28% E)	64 (29%)
Carbohydrate (g)	168 (45% E)	282 (55% E)	302 (59%)
Kilojoules	5,925	8,280	8,250
Calories	1,415	1,980	1,970
Dietary fiber (g)	18	28	18
Problems			
	Zinc 48% RDI	Zinc 95% RDI	Same as for current diet
	Calcium 59% RDI		
	Retinol 80% RDI	Retinol 83% RDI	
	Magnesium 85% RDI		

Case Study 1

As a hypothetical exercise, we can test the improvement in the diet by adding various combinations of these foods to one of the typical female athlete's diets (Table 5).

It is clear that the best way to increase carbohydrate and improve the diet is with foods that are more nutritious than sucrose.

Males

Most male athletes ate much more than females athletes. Weight was not a problem for this group, and most had no reluctance to eat bread or cereals or any other sources of carbohydrate, except sugar in some cases. They did, however, eat more of their carbohydrate as sucrose and consumed less from fruits and vegetables than females. Cake was their most commonly consumed sucrose-containing food, and some used sugar in tea and coffee. Soft drinks were popular, and half the group also consumed some of their sugar in the form of beer.

Strategies to increase carbohydrate in males should center on emphasizing the value of bread, pasta, rice, and fruit and decreasing alcohol and fat. A significant portion of fat came from foods, such as cakes, biscuits, and chocolates, which also supplied carbohydrate.

Case Study 2

Once again, as a hypothetical exercise, we can test the improvement in the male athlete's dietary pattern by replacing some high-fat/high-carbohydrate foods with

TABLE 6. *Case study 2*

	Current diet	Change 1	Change 2
		Omit 21 g alcohol 6 biscuits 30 g chocolate 15 g butter 70 g ice cream	*Omit* 21 g alcohol
		Add 4 slices wholemeal bread 2 bananas 4 Weetbix with low fat milk 1 cup rice or pasta	*Add* 1 liter soft drink
Protein (g)	83 (10% E)	113 (14% E)	81 (10%)
Fat (g)	155 (41% E)	117 (31% E)	155 (39%)
Carbohydrate (g)	359 (41% E)	462 (52% E)	433 (48%)
Alcohol (g)	38 (8%E)	17 (3%E)	17 (3%)
Kilojoules	14,000	14,180	14,540
Calories	3,345	3,390	3,475
Dietary fiber (g)	33	54	33
Problems	Riboflavin 80% RDI Thiamin 93% RDI		Riboflavin 70% RDI Thiamin 90% RDI

high-carbohydrate/low-fat foods. Case Study 2 looks at the effects such substitutions will have if different types of such foods are used (Table 6).

CONCLUSION

Clearly, we need to advise athletes to eat more carbohydrate to maximize their glycogen stores. However, we also need to be specific in advising athletes to increase carbohydrate in the context of the diet as a whole. Simply increasing the sucrose content is not always the ideal way to increase total carbohydrate.

REFERENCES

1. Gollnick PD, Matoba H. Role of carbohydrate in exercise. *Clin Sports Med* 1984;3:583–93.
2. Brotherhood JR. Nutrition and sports performance. *Sports Med* 1984;1:350–89.
3. Pernow B, Saltin B. Availability of substrates and capacity for prolonged heavy exercise in man. *J Appl Physiol* 1971;31:416–22.
4. Costill DL. Nutrition and endurance performance. In: Taylor TG, Jenkins NK. *Proc 13th International Congress of Nutrition*. London: John Libbey, 1986:300–2.
5. Mirkin G. Carbohydrate loading: a dangerous practice. *JAMA* 1973;223:1511–2.
6. Costill DL, et al. Muscle glycogen utilization during prolonged exercise on successive days. *J Appl Physiol* 1971;31:834–8.

7. Baghurst KI, Record SJ. Intake and sources, in selected Australian subpopulations, of dietary constituents implicated in the aetiology of chronic diseases. *J Food Nutr* 1983;40:1–15.
8. Department of Community Services and Health, in collaboration with the National Heart Foundation. National Dietary Survey of Adults: 1983, Report No. 2, Nutrient Intakes. Canberra: Australian Govt. Publishing Service, 1987.
9. Jacobs I, et al. Muscle glycogen and diet in elite soccer players. *Eur J Appl Physiol* 1981;48:297–302.
10. Short SH, Short WR. Four-year study of university athletes' dietary intake. *J Am Diet Assoc* 1983;82:632–45.

DISCUSSION

Dr. Truswell: Do you have any idea whether it is the carbohydrate in grams per kilogram body weight or the carbohydrate in percent of total calories that is the important factor people are trying to increase?

Mrs. Stanton: I am not sure there is any relevance in grams of carbohydrate per kilogram of body weight. Many of these athletes, such as distance runners, are very active but quite lightweight. Their intake of carbohydrate would need to be much greater per kilogram of body weight than, say, that of a weightlifter.

Dr. Holdsworth: The only difference between patients with anorexia nervosa and female athletes appears to be that female athletes admit to exercise, because one of our problems with females with anorexia nervosa is that many are covert exercisers who go to any length to hid this. Have any studies been done on the psychopathology of female athletes?

Mrs. Stanton: I do not know of studies on the psychopathology of female athletes. It is certainly my experience from many years of working with athletes that many female athletes have an eating problem. In many cases, especially in this group, this is induced by other people. As teenagers, they perform brilliantly and are then sent to sports coaches who think they will do better if they have a lower level of body fat. A further problem is that the very low body fat levels of athletes are promoted by gymnasiums and fitness centers as being ideal for all women. In fact, the very low body fat levels are unattainable by most women—including these athletes—unless they eat almost nothing.

Dr. Diamond: For comparison, in the 1968 Tour de France bicycle race, energy balance studies were performed on five competitors. The lowest average daily energy intake over 22 days was 6,500 calories, the highest was 9,000 calories. In your data, as I recall, the highest calories intake for your 15 males in the past month was somewhere around only 5,000 calories. That suggests that your athletes could go a long way by increasing their food intake.

Mrs. Stanton: I agree, but not all these athletes were endurance athletes. Some were tennis players or golfers and would not need more food. It is often a problem finding a way to get enough food into endurance athletes. Some soluble sugars can help, although too much sugar often produces nausea in athletes.

Dr. Rossi: One practical question. I am associated with a famous soccer team—the champions of Italy. Within a group of friends, also doctors, we used to discuss whether the athletes should take pasta or ham, alcohol or soft drinks, much protein or no protein, fruit or sweets at the dinner before the game, that is, 2 to 3 hours before a great physical effort of 90 minutes' duration. What is the right thing to do? You can see the responsibility involved! Some doctors give very much carbohydrate.

Mrs. Stanton: It is important to give athletes plenty of carbohydrate in their pre-event meal. It is also important not to give too much fat, or the time needed for digestion will be too long. If athletes eat too much, they may feel too sleepy to begin running at all. Pasta is a popular pre-event food because it provides about 40 g of carbohydrate per cup, and it is relatively easy to eat 3 to 4 cupfuls. To get the same quantity of carbohydrate from, say bread, would take much more chewing. Some sugar can also be used to give carbohydrate, but most athletes feel nauseated by very sweet drinks or foods. There also are individual idiosyncracies involved in pre-event meals, and these should be respected.

Dr. Kretchmer: I really don't understand what kind of sport women could do with only 850 calories a day. It sounds like they were anorexics.

Mrs. Stanton: The athletes taking 850 calories/day were another group who were referred to me because of the extreme fatigue that accompanied their low food intake. Most of the athletes in this group eating very little were gymnasts and skaters. I do not believe they were anorexics because they did not deliberately try to restrict their food intake. They actually wanted to eat. They were eating very little only because their parents and coaches kept telling them they should not eat so they would lose weight.

Dr. Kretchmer: Do you use sports beverages in Australia, and what would you approve of as a proper carbohydrate in these preparations?

Mrs. Stanton: We use glucose polymer products because they empty almost as rapidly from the stomach as water, and most athletes do not feel nauseated after using these products. Some of our common sports drinks have very high levels of sodium and potassium and are not generally recommended. Sprinters often use glucose polymer drinks. With heats, semi-finals, and finals spread throughout a day, they usually find it difficult to eat meals, but they need some replacement of carbohydrate. The major problem with glucose polymer drinks is their cost.

Dr. Hopwood: In the light of the high physical performance of these athletes and their reported low levels of food, is it possible to check that their reporting of food intake is accurate?

Mrs. Stanton: I am always concerned about the accuracy of dietary data. In this study, the athletes wanted my help, so they were not trying to hide anything. I spent 10 to 15 minutes explaining how to record their food intake over at least 3 days. When they came to see me with their food diaries, I spent about an hour and a half with each one, making sure that the information was accurate. In most dietary surveys, subjects spend only 10 to 15 minutes with a dietitian. I consider the information I have collected to be reasonably accurate. The females in this group had a low average intake of about 1,650 calories/day, but I am confident this was accurate.

Dr. Desmarchelier: I was very pleased to see from the elite athletes with whom Rosemary Stanton is dealing, that there is now an attitude that sugar is no longer seen as bad. I would like to draw attention to the way in which the attitude to sugar has changed in Australia from 1982 to 1988. The sugar industry stayed rigidly to an assertion that sugar was part of a balanced diet, and that assertion was maintained in the media through different themes such as "Sugar is natural," "Sugar is a part of life," sugar associated with "sunshine." The attitudinal change in Australia in that 8-year period, from the beginning where we had a negative attitude toward sugar, was of something like 30 to 40%. In a period of 6 years, that 35% has declined to a 10% negative attitude toward sugar. On the other hand, in 1982, only about 25% of consumers had a positive attitude toward sugar, and in a period of 6 years it has turned around, so there is something like 55% of consumers with a positive attitude toward sugar.

Mrs. Stanton: There is no doubt that you can change people's opinions if you spend enough time and money on it. Those of us working in the field of health promotion would like an equally large budget to promote our message as the sugar industry spends trying to influence consumers to eat more sugar.