high potassium diet with large doses of spironolactone could be dangerous! He further proposes that with either the high potassium or the spironolactone regimen, the normal fluid intake be supplemented by the drinking of 10–15 glasses of distilled water over each of the 3 days before competition.

The effects of such mineral ion manipulation upon muscle water content are further supplemented by glycogen depletion (pushed to a state of 'borderline ketosis', as an initial allowance of $92\,g\,day^{-1}$ is tapered to $23\,g\,day^{-1}$ over the period 7–4 days before competition), with a final period of 'supercompensation', when 10 separate 40-g carbohydrate meals are taken at 90-min intervals. The sources of carbohydrate are limited to items such as bananas, raisins, dates, yams, tomatoes, apricots and peaches, the objective being to maximize the intake of potassium, and to minimize the intake of sodium. If the muscles still appear 'flat' on the day before competition, the intake of these carbohydrates is further boosted to $40\,g\,h^{-1}$. Protein ($1\,g\,kg^{-1}$ of body mass) is taken as dry curd, with the objective of further minimizing sodium intake.

After the weigh-in, the 'coach' allows no further fluids until judging has been completed. A sauna to the point of sweating is taken on the day before competition, and again on the morning of competition. The competitor is told to remain lying down for as much of the final 24 h as possible, in the hope of achieving an even distribution of oedema fluid. One hour before judging, 100 g of liquid protein is ingested, and half an hour before competition, the competitor also seeks to boost blood sugar by drinking three-quarters of a cup of liquid honey. The stated intent of this practice is to combine muscle oedema with the desired paper thin skin.

It is regrettable to see one more form of international competition where coaches are misunderstanding and abusing the expertise of the physiologist in a search for competitive advantage. Moreover, the manipulation of intracellular water content by rigorous dieting and/or the administration of spironolactone carries a considerable risk to health, especially when those who advocate such practices make no attempt to monitor blood electrolytes, and are unclear on the difference between a 100-mg dose and a 100-g poisoning with aldactone!

Most entrants in body-building contests are not of an age where cardiac problems would be anticipated, but the combination of heavy weight-lifting with high plasma potassium levels could provoke a lethal cardiac arrhythmia. I am not aware that any of the victims of this particular manipulation have yet progressed to cerebral signs of water intoxication, such as disorientation, restlessness, confusion, a reduced sensitivity to pain and partial or complete loss of consciousness[5]. However, such intoxication is not unknown in ultramarathon and triathlon events[6–8] as a consequence of an excessive intake of water and potassium. Appropriate treatment includes the administration of hypertonic saline and/or furosemide or bicarbonate.

As with other athletic abuses, attempts at prevention by a warning of the dangers to health are unlikely to have a great success. However, it would be possible to determine the extent of the problem among body-builders and to correct the worst excesses by mandatory random assessment of blood electrolytes in top competitors.

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Effects of age, training background and duration of running on abnormal urinary findings after a half-marathon race

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Sir

Exercise-induced urinary abnormalities have been reported by several studies covering a wide range of running distances [1–5] but there were insufficient data in the literature about the effects of age, duration of running and training background of subjects on urinary abnormalities after a half-marathon.

A total of 45 men marathon runners of mean(s.d.) age 29.7(11.74) years (range 16–59 years) and free from renal disease volunteered for this study. All runners filled out a questionnaire to determine their training and health background and completed the official distance of 21.1 km, as part of the annual Second Green Bursa Half Marathon on 18 April 1992.

Each subject submitted a fresh urine specimen 2 h before and immediately after the race. Analysis of these specimens included laboratory determinations of glucose, bilirubin, ketones, specific gravity, blood, protein, urobilinogen, nitrite, leucocytes using Multi stix (Ames, Miles, Slough, UK) and microscopic analysis of the spun sediment, which are commonly used both for clinical and experimental determination of nephron function. Urine analysis before and after the race was completed within 4 h of voiding using standard procedures. All these variables together with age, half-marathon race time, number of completed half-marathon races and training distance per week were run through a stepwise regression procedure to see which characteristics were related to the abnormal urinary findings.

All prerace samples were normal but postrace urine samples showed abnormal findings (*Table 1*) none of which was related to age, duration of running and training background of subjects.

Gardner[1], and Kachadorian and Johansson[2] were in agreement that the intensity of exercise affects renal response. In this study, although we found 53.3% haematuria and 73.3% proteinuria in 45 athletes who had a finishing time ranging from 66.20 to 125.34 min, these abnormal findings were not related to running duration (*Tables 1, 2*).

Renal function is commonly found to decrease significantly with age by about 30% from the age of 30 to 75 years[2,6,7]. Urine flow also shows a decrease of about 30% during prolonged heavy exercise[8]. This means that, at the same level of intensity of exercise, glomerular filtration rate and renal plasma flow during exercise can be decreased further in ageing athletes than in young athletes. Although our study had the advantage of working with subjects ranging in age from 16 to 59 years, the results gave no support to the hypothesis that urinary abnormalities induced by prolonged exercise are more likely to occur in ageing athletes.

During intensive physical activity there is, at least temporary, damage to the kidney and a 40–50% incidence of recurrence[3]. Thus, we infer that if an athlete has frequently run a half marathon or marathon, then he would have suffered more kidney damage (including hypoxic damage which may cause nephron loss), compared with the athlete who has run fewer marathons[3]. Taking into account the fact that training for marathons may cause similar damage, we hypothesize that the training load and the athletic background of an athlete may play a role in the mechanism of abnormal renal function. However, although the subjects came from a wide range of athletic backgrounds, the results showed no correlation between the parameters discussed above and the urinary abnormalities.

In conclusion, our results indicate that the intensive running conditions of a half-marathon race may cause urinary abnormalities and these may occur independently of age, duration of running, training and athletic background of athletes. Therefore, we recommend that distance runners should check their renal function before and after intensive running.

Table 1. Analysis of urine samples taken after the race (n = 45)

	No.	*%*
Haematuria	24	53.3
Trace	11	24.4
Small	8	17.8
Moderate	4	8.9
Large	1	2.2
Proteinuria	33	73.3
30 $g l^{-1}$	13	28.9
100 $g l^{-1}$	14	31.1
300 $g l^{-1}$	6	13.3
Leucocytes	6	13.3
Bilirubin	4	8.9
Ketones	3	6.7

Table 2. Age, physical characteristics and training background of subjects (n = 45)

	Mean(s.d.)	*Range*
Age (years)	29.7(11.7)	16–59
Height (cm)	172.6(6.0)	162–190
Weight (kg)	61.8(5.5)	54–76
Running age (years)	7.6(5.3)	1–22
Running distance per week (km)	110.0(59.3)	20–220
Half-marathon race time (min)	83.59(21.54)	66.20–125.34
Half-marathon record time (min) (n = 33)	75.53(16.36)	63.14–110.26
Number of completed half-marathon races (n = 33)	14.1(16.2)	1–75

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