

# THE URINARY SODIUM AND POTASSIUM EXCRETION AFTER PHYSICAL EXERCISE



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## INTRODUCTION

The dehydration, hyperkalemia, hypo- and hypernatremia are observed after a long exercises like ultramarathon. These abnormalities in subjects with normal kidney function are relatively rare. The activation of renin-angiotensin-aldosterone, vasopressin, and sympathetic systems help to preserve electrolyte balance during a long exercise. In presented study we measured sodium, potassium, creatinine, urea and uric acid in blood and urine after every 25 km of 100 km run to establish changes in the fractional excretion of electrolytes and metabolites after ultramarathon.

## METHODS

20 healthy, amateur runners (males, mean age 40.75years, mean weight 76,87 kg) took part in the 100km run on the track. Blood and urine were collected before run, after every 25 km and 12 hours after run (a rest). Creatinine clearance (CrCl) was calculated from the timed urine collections. Urine Na to K ratio were calculated. Fractional excretion (Fe) of sodium, potassium, urea and uric acid during the race were calculated using the formula: Fractional excretion of parameter = [(parameter in urine x creatinine in serum) / (parameter in serum x creatinine in urine)].

## RESULTS

17 runners completed the study. The significant increase of creatinine, urea and uric acid was observed after 100km (p< 0.05). Na and K slightly increased during the run. There was a significant decreased of sodium after the rest (p<0.05). The increase of FeK as well as decrease of FeNa and Na/K ratio were observed during the run (p<0.05). The low Na/K ratio and increased FeK were observed also during the rest (12 hours after the run was completed). FeUA remain stable during and after the run.

## CONCLUSIONS

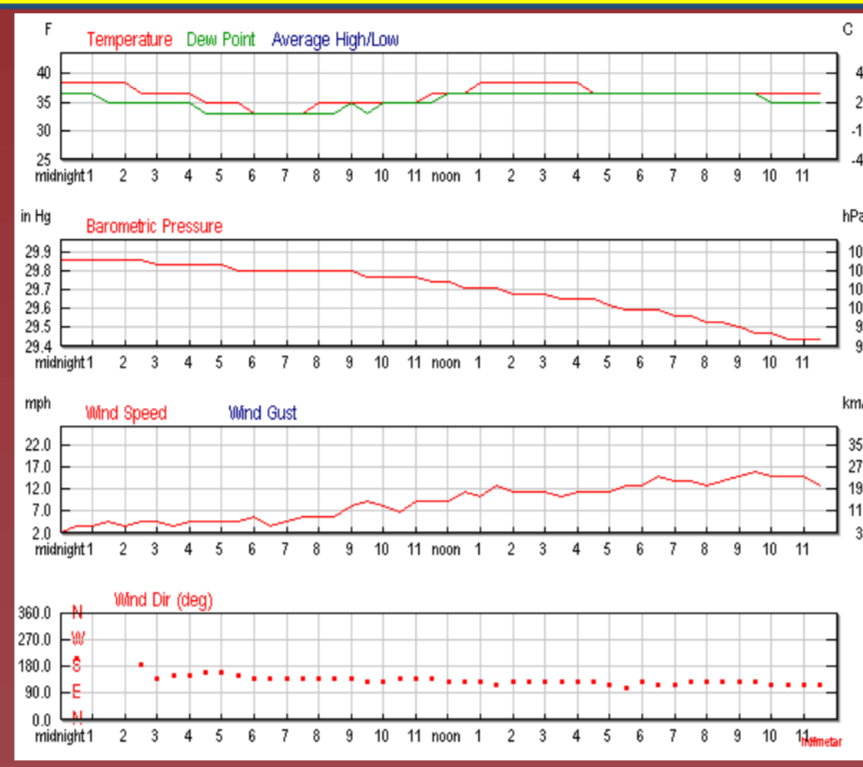
The deep changes in electrolytes excretions were observed during the study. There was no cases of severe serum electrolyte abnormalities, probably because all runners were well trained and very experience. The most important finding is that some abnormalities were still found after the 12 hours rest. It is of special interest for those runners who repeatedly performed intensive exercise day by day. These subjects are of the high risk of hypokalemia.



The rout was based in the university stadium track (400 m track circumference).



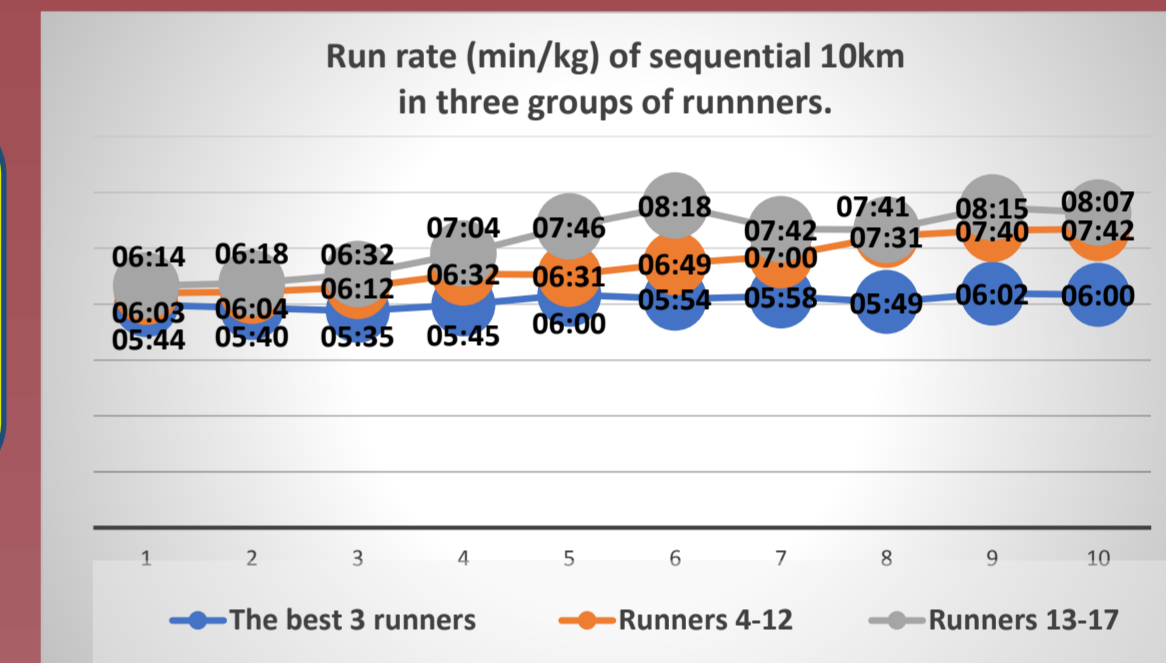
During the race the organizer provided a station offering a food and beverages such as hypotonic sports drinks, caffeinated drinks, water, fruits, chocolate, energy bars and bread.



The temperature during the run rose from 1°C (7 am) to 4°C (1-4 pm) and then dropped to 3°C at the end of the study (4-7 pm).



The first runner finished 100km run after 9h 52 min, the last after 13h 34 min. The mean run rate was 6:47 min/km and decreases from 6:03 min/km during the first 10km to 7:24 min/km during the last 10 km. The run rate of the best three runners was stable during the whole test but decreased gradually in the group of the slowest runners (right).



## General characteristics of all study participants

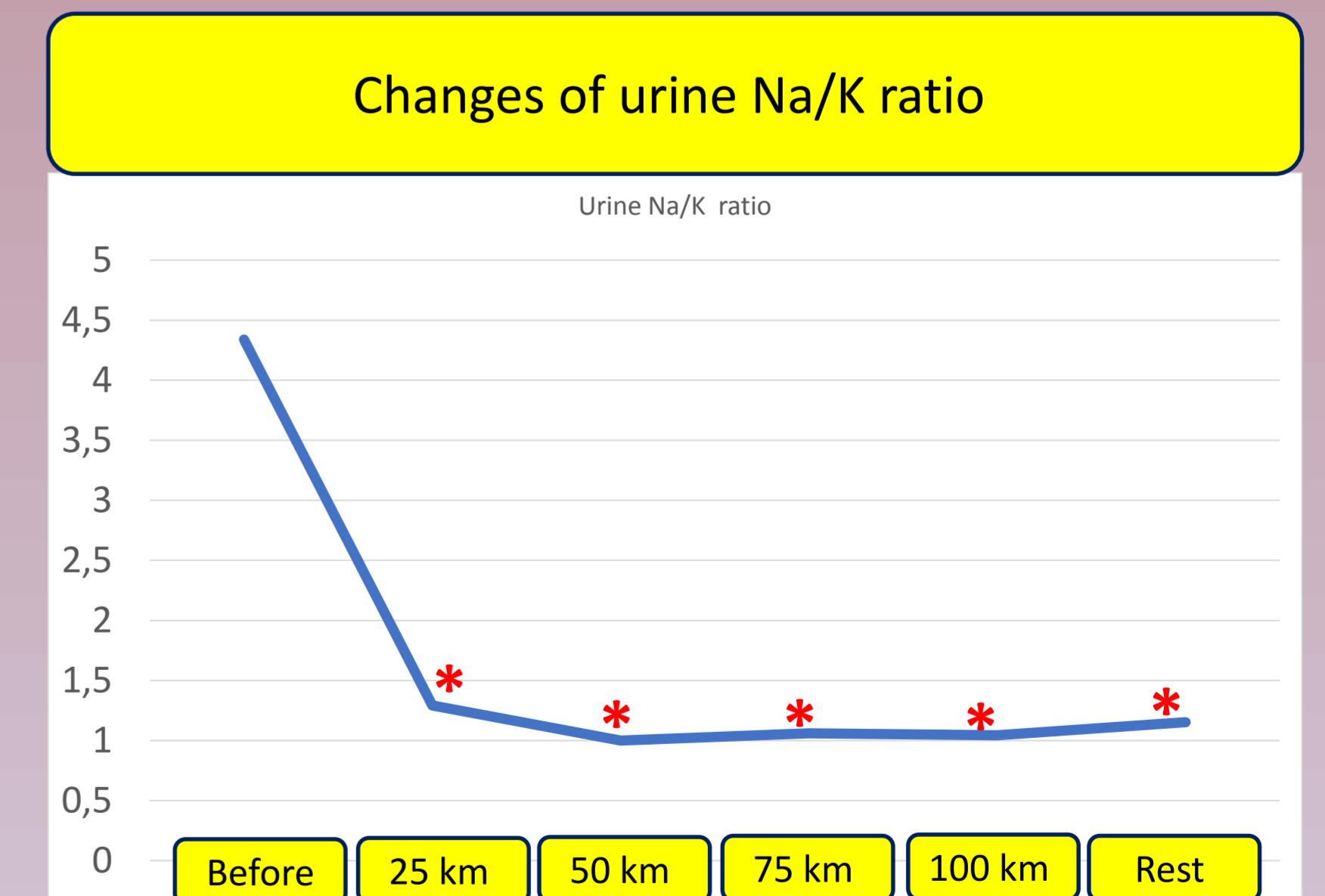
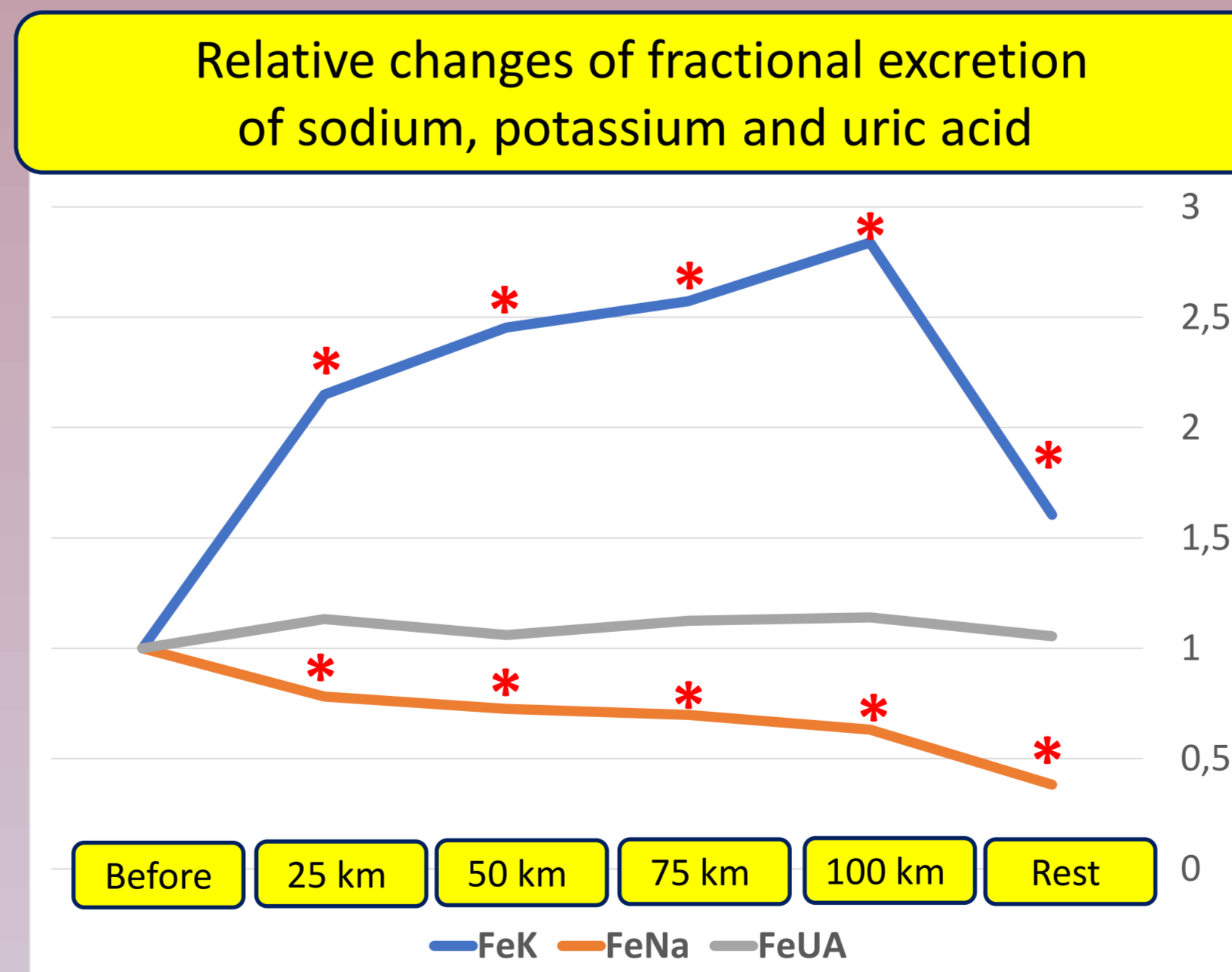
	All runners	Finishers
Number of subjects	20	17
Age (years)	40,75 ± 7,15	40,18 ± 4,57
Male sex (%)	100%	100%
Height (m)	177,75 ± 6,58	178,59 ± 6,21
Weight (kg)	76,87 ± 8,39	77,47 ± 8,80
Body mass index (kg/m <sup>2</sup> )	24,31 ± 2,15	24,26 ± 2,28
Body fat percentage (%)	13,76 ± 5,42	13,56 ± 5,80
WHR	0,81 ± 0,06	0,81 ± 0,06
Pre-race systolic BP (mmHg)	137,82 ± 16,93	136,12 ± 10,62
Pre-race diastolic BP (mmHg)	82,4 ± 9,17	82,12 ± 7,92
Pre-race heart rate (bpm)	66,65 ± 7,70	66,41 ± 8,69
Systolic BP (mmHg) 12h after race	129,67 ± 18,12	129,94 ± 11,09
Diastolic BP (mmHg) 12h after race	75,72 ± 9,86	75,56 ± 8,12
Heart rate (bpm) 12h after race	72,61 ± 8,13	71,81 ± 8,29
Duration of regular running (years)	6,11 ± 7,19	6,31 ± 7,57
Mean training (days/month)	16,70 ± 6,69	17,11 ± 7,04
Average training km/month	225,38 ± 98,33	228,4 ± 105,22
Marathons finished (n)	43,89 ± 110,11*	48,38 ± 116,39
Ultramarathons races finished (n)	15,06 ± 13,54	15,75 ± 13,99
Marathon personal best time (h:min)	3:24 ± 0:22	03:23 ± 00:23
100km run personal best time (h:min)	12:24 ± 2:50**	12:36 ± 02:41

\* one of the runners completed 477marathons. All other runners completed 21,64 marathons on average.  
\*\*most of the 100km ultramarathons were mountains trail runs. Abbreviations: WHR - waist-hip ratio, BP - blood pressure 00

## Results of the study

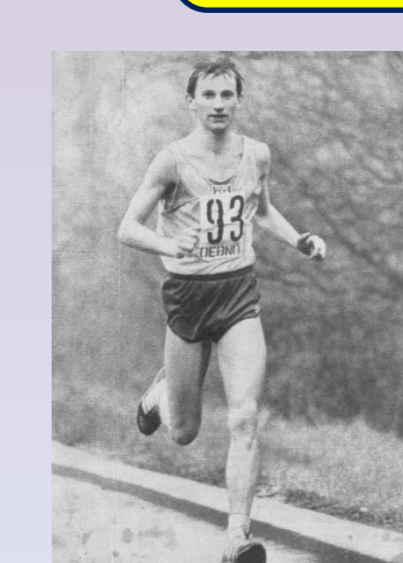
	Before	25 km	50 km	75 km	100 km	Rest
Diuresis (ml/min)	1,725 ± 0,72	1,85 ± 1,27	1,20 ± 0,55	1,59 ± 2,01	1,60 ± 1,82	1,07 ± 0,41
Sodium (mmol/l)	141,65 ± 1,90	<b>144,24 ± 1,86*</b>	<b>143,83 ± 2,33*</b>	<b>144,29 ± 3,65*</b>	142,59 ± 2,29	<b>139,47 ± 1,62*</b>
Potassium (mmol/l)	4,53 ± 0,34	<b>5,01 ± 0,47*</b>	<b>5,04 ± 0,38*</b>	<b>5,03 ± 0,42*</b>	4,65 ± 0,39	4,32 ± 0,38
Creatinine (mg/dl)	0,88 ± 0,11	0,97 ± 0,11	1,00 ± 0,14	<b>1,07 ± 0,17*</b>	<b>1,10 ± 0,20*</b>	0,97 ± 0,12
Urea (mg/dl)	34,29 ± 7,25	40,12 ± 7,91	45,35 ± 10,85	<b>51,65 ± 13,42*</b>	<b>55,94 ± 5,34*</b>	<b>49,88 ± 12,02*</b>
Uric acid (mg/dl)	5,15 ± 0,87	<b>5,32 ± 0,96*</b>	<b>5,62 ± 1,19*</b>	<b>5,82 ± 1,37*</b>	<b>5,94 ± 1,50*</b>	<b>6,09 ± 1,43*</b>
Urine Na/K ratio	4.34 ± 1.71	<b>1.29 ± 0.41*</b>	<b>1 ± 0.38*</b>	<b>1.06 ± 0.51*</b>	<b>1.04 ± 0.97*</b>	<b>1.15 ± 0.61*</b>
FeNa (%)	0.86 ± 0.29	<b>0.67 ± 0.37*</b>	<b>0.63 ± 0.44*</b>	<b>0.60 ± 0.51*</b>	<b>0.54 ± 0.4*</b>	<b>0.33 ± 0.13*</b>
FeK (%)	6.66 ± 2.79	<b>14.31 ± 5.51*</b>	<b>16.33 ± 7.49*</b>	<b>17.13 ± 9.14*</b>	<b>18.9 ± 10.01*</b>	<b>10.68 ± 4.10*</b>
FeUrea (%)	46.95 ± 10.02	38.28 ± 9.03	<b>31.82 ± 10.74*</b>	<b>31.55 ± 12.43*</b>	<b>33.87 ± 12.97*</b>	<b>43.76 ± 8.99</b>
FeUA (%)	5.34 ± 1.51	6,05 ± 1,71	5.66 ± 2,1	6.01 ± 2,28	6.10 ± 2,34	5.63 ± 1,66
CrCl (ml/min)	141,81 ± 25,08	136,93 ± 47,55	144,04 ± 28,20	120,33 ± 38,83	137,78 ± 41,04	150,50 ± 43,33

\*significant differences between pre race value and result in particular phases, p < 0.05  
Abbreviations: CrCl - creatinine clearance; Fe - fractional excretion, UA - uric acid



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## Authors



Wojciech Ratkowski won a Polish Championship in Marathon in 1984 (left).  
WR and WW during 78-km mountain marathon in Bieszczady Mountains in 2015 (right).

