Potassium Needed for Maintaining its Balance in Healthy Male Subjects Residing in an Area of Low Potassium Intake and with a High Environmental Temperature

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Abstract

Low potassium (K) intake and high prevalence of hypokalemia and hypokaliuria among rural dewellers in the northeast region of Thailand have been repeatedly reported and they were speculated to be in a state of low K status. In this communication we studied K balance of 10 rural (R) and 5 urban (U) male subjects in this region during a 10-day period of semi-free-living and eating group-selected diets. While K in intake, 24- h urine and feces were measured daily in all subjects, the direct measurement of K lost in sweat was made only in one subject coded R3. These parameters were then used to calculate the K balance. The results showed that mean K intakes were 1731±138 and 1839±145 mg/day for R and U subjects, respectively. Their mean K balances, calculated by subtracting the K excretions in 24-h urine (721±129 mg/day for R and 919±186 mg/day for U) and in feces (148±25 mg/day for R and 164±21 mg/day for U) from intakes, were +860±140 and +756±222 mg/day for R and U, respectively. In the subject R3, his mean K balances without and with subtracting the sweat K excretion (451±57 mg/day), were +847±373 and +396±344 mg/day, respectively. Regression of K balance versus intake indicated that R and U subjects needed K of 832 and 884 mg/day to stay in balance. Since the study was performed during the hot season (average temperature=35.2±2.0°C at 3 pm) and sweating was clearly observed (estimated sweat volume per day was 1927±420 ml for R and 1759±408 ml for U), therefore, K balance calculated without sweat K was overestimated. This was apparently seen in the subject R3 where he actually needed K of 1203 mg/day, instead of 814 mg/day calculated without sweat K, to stay in balance. The similarities in K balance data among the two groups suggested they both had the same food habit and K status. Our results indicate that any calculation for the levels of dietary K, or probably also for other minerals, to achieve the balance could be underestimated if loss *via* sweat is not taken into consideration.

Key word : Potassium Intake, Potassium Balance, Urinary Potassium, Fecal Potassium, Sweat Potassium

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Low urinary output of potassium (K) among rural dwellers in the northeast region of Thailand, both healthy normals and renal stone formers, have been repeatedly reported(1-3). Fasting blood with a hypokalemic serum was also frequently detected, especially during the hot season(1,3). These findings suggest that the rural people might be in a state of K depletion. Some metabolic diseases are commonly found in the region and their pathogenesis related to K deficiency has been proposed(4,5). Recently the authors studied their K intake(3) and observed that the values were very much lower than the estimated safe and adequate daily dietary intake (ESADI) of K established by the Food and Nutrition Board of the US National Research Council(6). At the beginning, it was thought that foods available in this region might have low K contents probably as a consequence of its soil quality as in the case of selenium (Se), an essential trace element(7). Latterly, however, from the data of food analysis(8) it was found that the real cause of their low K intake was due to the high consumption of foods in those of low K content groups especially rice, the main staple in their diets. Since the studied subjects were in good health with normal renal function, therefore the low urinary K excretion may merely reflect their low intake. In other words, they may have K status in a good balance, not having a deficiency as might be expected. In the present study, K intakes, excretions, and balances in semi-free-living adult males who consumed group-selected diets over a 10-day period were examined. The study was part of a major project named "Study of K in northeastern Thai population".

MATERIAL AND METHOD

This study was approved by the Ethical Committee of the Faculty of Medicine, Khon Kaen University and written informed consent was obtained from all participating subjects.

Subjects

There were 15 healthy adult male subjects, 10 from rural villages and 5 from urban areas of Khon Kaen city, who volunteered for a 10-day period of K balance study. They were between 25-50 years

Table 1. Description of studied subjects.

Subject no.	Age	Weight	Height	Serum K,mEq/ l	
	(yr)	(kg)	(cm)	Day 1	Day 10
R1	50	59	159	4.5	3.5
R2	49	60	160	3.5	4.1
R3	49	82	172	3.6	4.0
R4	46	68	165	4.1	3.7
R5	45	65	162	3.8	3.5
R6	45	54	163	3.7	3.5
R7	44	54	165	4.2	3.5
R8	33	54	169	3.5	4.3
R9	33	51	158	3.5	3.8
R10	29	61	161	4.1	3.5
Mean ± SD	42.3±7.3	60.8±8.6	163.4±4.2	3.8±0.3	3.7±0.3
U1	49	70	166	4.1	3.9
U2	40	75	170	4.0	4.2
U3	38	74	172	4.6	4.0
U4	28	63	170	4.1	3.9
U5	23	53	162	3.5	3.5
Mean ± SD	35.6±9.2	67.0±8.2	168±3.6	4.1±0.3	3.9±0.3

R, rural subject; U, urban subject

old and were neither taking vitamin nor mineral supplements. Before the study, all subjects were given physical and clinical examinations, and were in good health. Details of all subjects are shown in Table 1.

Study design

For convenience in preparing foods and measuring the food intake, and collecting the specimens, all subjects stayed together in a rented house located in a village about 5 km from the University campus. Kind of food taken at each meal was prepared on request of the whole group of subjects. This meant that all subjects had to make an agreement about what kind of food they wanted to have for each meal, provided that all dishes must be their own typical northeast region meals and the numbers should not be more than 3 kinds. A list of foods consumed over the 10-day period is shown in Table 2. Foods were weighed both before and after consumption separately for each subject and they were allowed to take as much as they wished. Aliquots of foods consumed were kept frozen in a refrigerator for further analysis. To measure the water intake, each subject was provided daily with five 1-l bottles of distilled water in the morning and the actual amount of intake was calculated by subtracting the amount of water left the next morning. Besides walking, the subjects were not allowed to take any exercise during the study. Their main activities were

Table 2. Daily foods consumed by 10 rural and 5 urban subjects during a 10-day period.

Day	Breakfast	Lunch	Supper
1	Sticky rice (SR) Fish (carp) soup with chili Leadtree (young leaves) (LT)	SR Boiled egg Papaya salad (PS) Chinese cabbage (CC)	SR Roasted cat fish Jack fruit salad
2	SR,LT Ant egg salad (AE)	Rice with fried pork *Lod chong Coconut (meat,young)	SR,CC Cucumber salad Bamboo shoot salad
3	SR,AE Omelet	Rice noodle with curried chicken sauce	SR Curry of cassia leaves with salty fish Bamboo shoot salad (BS)
4	SR Raw beef with some spice and fish sauce (RB)	Rice noodle with meat and meat balls (RN)	SR,LT Fish (carp) curry (FC) Roated lizard (*yae)
5	SR,RB Neem (young leaves) (NY)	SR,PS Roasted chicken (RC) Orange (OR)	SR Chili sauce (CS) Egg plant
6	SR,LT Pork cooked with some spice and fish sauce	SR,PS,RC Boiled mungbean with sugar (BM)	SR,FC,CS
7	SR,NY Chicken cooked with some spice and fish sauce	RN,BM,OR	SR Chicken curry with some vegetables Mushroom salad
8	SR,RB,NY,LT	SR,PS,NY Duck cooked with some spice and fish sauce (DC)	SR,AE Fish (cat fish) curry
9	SK Beef curry with some vegetables	SK,RC Banana Dried squid	SK,BS Roasted pork
10	SK,FC	RM,BM	SK,DC,LT Dried chilli

* local name

sedentary, for instance, chatting, watching television and making their fishing nets.

Urine collection

Daily 24-h urine was collected in 3.5-l plastic bottles with thymol as a preservative. The first morning collection went into the sample of the previous day. When collections arrived at the laboratory they were measured for volume and pH and aliquots were kept frozen in a refrigerator for further analysis.

Fecal collection

Two gelatin capsules containing 50 mg of brilliant blue dye, for marking the feces, were taken by each subject at breakfast of the first and last day of the study period. All fecal samples were collected in a plastic bag placed as lining inside strong plastic box containers over which the subjects sat during defecation. The collection started from when the first marker appeared, one defecation per container, until the second marker had passed. The subjects were asked to pour a 300 ml solution of formalin over their feces before closing the container caps. While 14 subjects had normal daily defecation during the 10-day period, the R2 subject could defecate only once during the first 2-day. The values of his fecal K content belonging to each day, therefore were proportionately calculated to the corresponding intakes. Under a laboratory hood, these formalined fecal bags were removed from the containers, weighed, and briefly homogenized in an electric blender. Portions of the fecal homogenate were taken and kept frozen in a refrigerator for further analysis.

Sweat collection

Due to difficulty in the management of a large number of specimens, sweat collection was made only from the subject coded R3 and the method was as previously described[3] with some modification. A pair of trousers and socks, underwear, a long-sleeved shirt, a small piece of towel and a piece of handkerchief were provided to the subject each day. These clothes were detergent cleaned, soaked for an hour in 5 l of 0.03 N HCl then overnight in 5 l of distilled water and finally air-dried. After taking a bath in the morning (before breakfast), the subject wore these clothes for the whole day. Sweating in the face and other parts outside clothing areas were wiped off from time- to-time with the handkerchief. All his resting places including his bed were lined with clean plastic sheets. The clothes were allowed to be taken off briefly in the evening and his whole body was cleaned by wiping off with a moist towel (soaked in distilled water). The same clothes were then put on again until the next morning. These used clothes were then taken off and his whole body was wiped off again with the same moist towel, then all clothes were soaked in 5 l of 0.03 N HCl for an hour. Before removing, the clothes were hand-rubbed for a few minutes. About 5 ml of soaked water was taken for K analysis.

Analysis for K in collected specimens

K contents in foods and feces. Food samples were analyzed for K content using the dry ashing method. The samples were thoroughly homogenized in an electric blender, and if the samples were too dry, a known amount of distilled water was added before homogenization. About 5-10 g of the homogenate was accurately weighed in a 25-ml crucible cup and organic matter was removed by putting the cup on a hot plate under a fume-hood until the sample became thoroughly charred without fume and then was further burned overnight at 800°C in a muffle furnace. The ash was determined for K by atomic absorption spectrophotometer as described by Oiso and Yamaguchi[9]. Fecal samples were treated and analyzed in the same manner.

K contents in urine and sweat. The samples of 24-h urine and sweat in soaked water of the used clothes were determined for K directly using the method of flame photometry.

Calculations

1. Per cent apparent absorption of K = (K intake-fecal K) X 100 / K intake.

2. K balance = K intake - K excretions (urinary K + fecal K) or for the R3 subject = K intake - K excretions (urinary K + fecal K + sweat K).

RESULTS

Table 3 shows data of environmental temperatures and the mean volumes of 24-h urine, water intake and estimated sweat of all subjects during the 10-day study period. The sweat volume was roughly estimated by subtracting the daily water intake with 24-h urine volume without considering the water content in the food and fecal specimens. Although the study design did not allow the subjects to take any moderate or heavy exercise, a considerable

Table 3. Environmental temperatures and 24-h urinary excretion, water intake and estimated sweat volumes of 10 rural and 5 urban subjects during a 10-day period.

Day	Temperature °C *		24-h Urine, ml		Water intake, ml/day		Estimated sweat, ml/day	
	1200 AM	0300 PM	Rural	Urban	Rural	Urban	Rural	Urban
1	28.2	32.5	1517±713	2317±725	3410±558	3700±785	1894±660	1383±798
2	28.5	32.5	1498±483	2063±439	2690±450	3140±520	1192±417	1077±552
3	31.0	35.5	1275±470	1732±403	2930±576	3380±371	1695±662	1648±474
4	32.1	36.0	1525±340	1566±398	3720±675	3920±808	2195±712	2354±044
5	30.8	34.0	1553±489	2165±687	2950±415	3400±574	1455±311	1235±451
6	30.0	35.5	1330±368	1745±500	3230±431	3700±510	1809±616	1755±731
7	29.6	33.0	1339±497	1584±527	3290±461	3300±187	1917±617	1857±716
8	32.5	37.0	1305±405	1549±348	3400±537	3733±613	2091±483	2213±488
9	32.8	38.0	1262±392	1750±892	4050±470	3940±459	2788±527	2190±532
10	33.4	37.5	1483±275	1590±737	3720±917	3100±100	2237±720	1882±711
Mean±SD	30.9±1.7	35.2±2.0	1411±99	1806±262	3339±395	3531±291	1927±420	1759±408

* Kindly provided from the Khon Kaen meteorological center.

Table 4. Pooled K balance data for each subject (10 rural and 5 urban subjects) in a 10-day period.

Subject	K, mg/day*				% Apparent absorption
	Intake	Urinary	Fecal	Balance	
R1	1745±292	771±138	131±58	+843	92.49
R2	1515±268	452±97	160±107	+903	89.44
R3	1712±199	705±133	160±52	+847	90.65
R4	1788±200	734±169	96±64	+958	94.63
R5	1575±320	777±50	159±72	+639	89.90
R6	1575±291	822±178	155±70	+598	90.16
R7	1824±396	760±248	163±80	+901	91.06
R8	1761±527	513±153	142±67	+1106	91.94
R9	1803±404	781±167	138±82	+884	92.35
R10	2008±487	892±269	191±94	+925	90.49
Mean±SD	1731±138	721±129	148±25	+860±140	91.31±1.48
W1	1971±471	1246±237	187±44	+538	90.51
W2	1969±466	908±168	139±73	+922	92.94
W3	1605±262	961±338	191±62	+453	88.10
W4	1915±471	745±177	148±59	+1022	92.27
W5	1736±507	734±252	156±110	+846	91.01
Mean±SD	1839±145	919±186	164±21	+756±222	90.97±1.67

R, rural subject; U, urban subject / * mean± SD, except balance amount of sweat was observed, i.e., 1927±420 and 1759±408 ml/day for rural and urban subjects, respectively. Sweating was probably due to the high temperature during the study which averaged 30.9± 1.7°C at 12 AM and 35.2±2.0°C at 3 PM.

Details of K balance data for each subject are shown in Table 4. The range of K intakes were between 1515±268 to 2008±487 mg/day wih a mean of 1731±138 mg/day for rural subjects and between 1605±262 to 1971±471 mg/day with a mean of 1839±145 mg/day for urban subjects. The mean K intakes of the two subject groups were not significantly different and were both lower than the range of ESADI of the U.S.A. (1875-5625 mg/day)[6]. Although the K intakes in the present study were higher than our previous assessment[3], urinary K excretions were still low similar to the former reports[1-3]. If the cut-off point for normal urinary K excretion was set at 1173 mg/day (30 m Eq/day), all but one of the urban subjects had mean urinary K excretions well below this level and were classified to be hypokaliuric urine[1]. Fecal excretions of K in our subjects were low in both groups as seen from a high percentage of apparent K absorptions of 91.31±1.48 per cent and 90.97±1.67 per cent for rural and urban subjects, respectively. Since our subjects had low K excretions in both 24-h urine and feces, in relaton to its intakes, the calculated K balances, therefore became highly positive, i.e., + 860±140 and + 756±222 mg/day for rural and urban subjects, respectively.

When the balanced data of each day was averaged according to the groups, the results are shown in Fig. 1A for rural subjects and in Fig. 1B for urban subjects. While the mean K intakes that fell within the ESADI range of the U.S.A. were day 4 of the rural subjects and day 1, 4, 5 and 7 of the urban subjects, no mean urinary K excretion in both groups could reach the cut-off level for normal[1]. It is noteworthy that the fecal K excretions and variability in both groups were small during the 10-day period.

Fig. 2 shows the regression lines when the data of all subject-days were plotted between the K intake and balance. The regression equations were : K balance = 0.91 intake-757 (at zero balance, K intake = 832 mg/day) and K balance = 0.80 intake-707 (at zero balance, K intake = 884 mg/day) for rural and urban subjects, respectively. If sweat K was included in the calculation of K balance as in the case of subject R3, the mean balance of a period

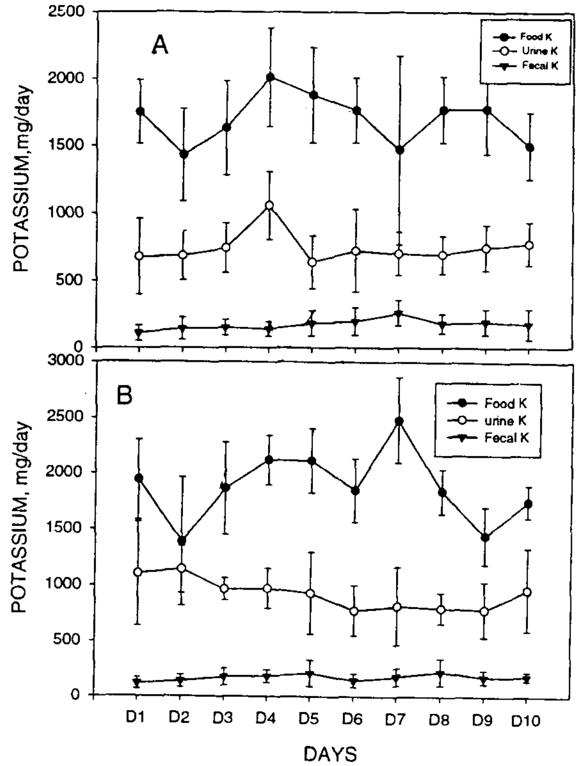

Fig. 1. Means of Potassium intake (food K) and output (urinary K and fecal K) of 10 rural (A) and 5 urban subjects (B) during the 10-day period.

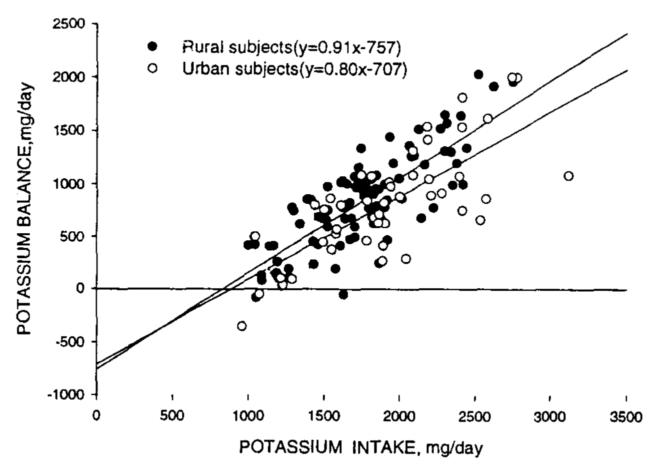

Fig. 2. Regression lines for potassium (K) balance *versus* K intake for 10 rural (●) and 5 urban (○) subjects consuming group-selected diets for a 10-day period.

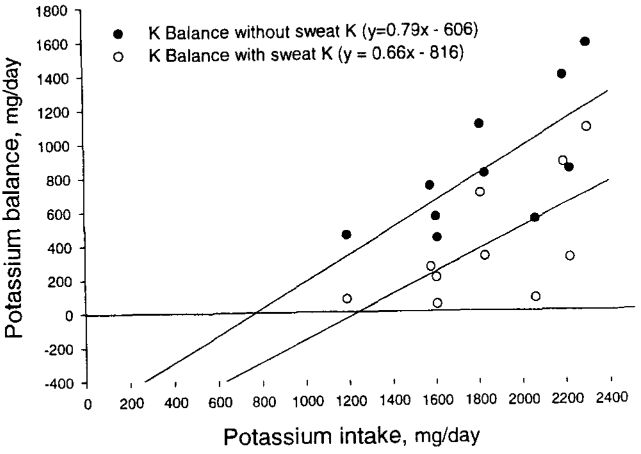

Fig. 3. Regression lines for potassium (K) balance *versus* K intake for the subject coded R3 during a 10-day period. K balances were calculated both with (○) and without (●) sweat K.

of 10 days was significantly decreased from + 847± 373 to + 396±344 mg/day as shown in Table 5. This made the regression equation shift from : K balance = 0.79 intake-606 (at zero balance, K intake = 767 mg/day) to K balance = 0.66 intake-816 (at zero balance, K intake = 1236 mg/day) as shown in Fig. 3.

DISCUSSION

In our previous food survey it was found that the intake of K among rural dwellers was less than 1000 mg/day(3) which was apparently lower than the range of ESADI of the U.S.A.(6). In the present metabolic balance study, K intake was almost double in amount due to the study design that allowed them to take as much food as they wished and of their own preference. However, the mean intakes in both rural and urban subjects were still lower than the range of ESADI and those reported in other countries(10-12). Probably due to the food habit of consumption of food of low nutrient K density in a large amount among people in this region(8). The bioavailability of K in food taken by our subjects was high similar to other reports(17,19), evidenced from the low fecal K excretions and high percentage of apparent K absorptions.

Serum K of participating subjects was within a normal range, both before and after the study, indicating they had normal K status. However, their mean urinary K excretions in all but one of the urban subjects were lower than that of the cut-off value for normal. Furthermore, as the mean urinary K excretions were only about half of the intakes (Table 4), it suggests that there were losses other than urine or physiological conservation of K. It has been demonstrated that healthy young men undergoing intensive training in hot weather could sweat as much as 12 l per day(13,14). If the average K concentration in sweat, after acclimatization to heat, is 250 mg/l(15), K losses through sweat alone could exceed the normal dietary intake. Recently the authors have shown that farmers working in the field for 9 hours during the hot season could lose K in sweat as high as half of their 24-h urinary K excretion(3). A similar observation was also made by Knochel who studied K deficiency during training in the heat(16). Although the subjects in the present report had low activity during the study period, the environmental temperature was high and sweating was clearly observed during the investigation. A considerable amount of K loss through sweat was therefore, inevitable. The means of estimated sweat volume of our subjects were 1927±420 and 1759±408 ml/day (Table 3) for rural and urban subjects, respectively. If the concentration of sweat K was similar to that reported by Consolazio et al(15), one could expect the mean K losses through sweat of the studied subjects of about 482 and 440 mg/day for rural and urban subjects, respectively. These values of estimated sweat K agreed well with that of the mean of sweat K measured for a 10-day period in the subject R3, i.e., 451 mg/day (Table 5). Thus, the amounts of sweat K are about half of urinary K similar to a previous report(3). This suggests that K loss through sweat could not be ignored especially when the study was carried out in the hot season or in a tropical country like Thailand. Besides the low intake, the high K excretion through skin as sweat was probably a main cause of low urinary K excretion commonly seen in the studied cases(1-3). A similar finding was also reported by Holbrook et al(17) when K balance was studied during the summer. The mean K balances of the subjects in both the studied groups were all positive similar to other reports(15,17,18). The results, therefore, suggest either immediate intracellular K retention or loss of K via sweat or both. Since there were no significant serum K changes during the studied period, this further suggests an uptake of K as if

Table 5: Potassium (K) in intake, 24-h urine, feces and sweat and K balance of the subject coded R3 for a period of 10-day.

Day	K, mg/day					
	Intake	24-h Urine	Feces	Sweat	Balance (without sweat)	Balance (with sweat)
1.	2062	1328	187	470	547	77
2.	1812	696	13	404	1103	699
3.	1192	552	183	380	457	77
4.	2221	1002	379	525	840	315
5.	1609	888	284	392	437	45
6.	1829	782	232	490	815	325
7.	2305	720	10	495	1575	1080
8.	2194	729	77	510	1388	878
9.	1606	943	101	360	562	202
10.	1578	686	147	480	745	265
Mean±SD	1841±337	933±208	161±112	451±57	847±373	396±344

these subjects had a subclinical deficiency of intracellular K. Normally in the healthy and well nourished adult who is not growing, and who keeps approximately the same weight over long periods of time, body composition must be approximately constant. That is, the intake of various nutrients including K must approximate the amounts that are lost from the body. Therefore, the regression line of K intake *versus* balance should plateau at the intake above that needed to maintain balance, but instead the K balance of the studied subjects in both groups became highly positive as K intake increased. The explanation for this phenomenon may be due to the balance study period being too short, compared to as long as 50 weeks in another study(19), and the real balance would never be reached or may be due to the degree of K depletion of these subjects being too severe. Furthermore, Forbes(20) has suggested that the balance could be erroneous because modification of body composition after a dietary change may occur slowly and exponentially with time.

From the regression lines between balance and intake of K in Fig 2, to stay in zero balance the intake of K would be 832 and 884 mg/day for rural and urban subjects, respectively. These are the amounts of K needed to replace fecal and urinary loss and maintain plasma level and body stores. The amount must be higher when sweat K is included into calculation. If one accepts the values of sweat K loss of 482 and 440 mg/day of both groups of subjects as calculated earlier, the regression line of K balance and intake must be shifted to the right and, therefore, the need of K to stay in balance would be 1314 and 1324 mg/day for rural and urban subjects, respectively. This is apparently seen in the case of subject R3 where the need of K to stay in balance was shifted from 767 to 1236 mg/day, when sweat K was included in the balance calculation. The discrepancy between these values with that of intakes (Table 4) therefore, reflect the true amount of physiological retention. Although the K intake was lower than the range of ESADI of the U.S.A., the subjects studied could maintain positve K balance. It is not known whether the low K intake needed to maintain K balance in the studied case represents a true adaptive mechanism to conserve body K stores. Study in an essential trace element demonstrated that New Zealanders, who had consumed low Se diets all their lives apparently have smaller total Se pools than do Americans and, as a result, clearly need less dietary Se to maintain these pools. It was concluded that the Se needed to achieve balance in humans appears to be partially a function of a previous history of dietary Se exposure, i.e., persons used to low Se intakes need less to stay in balance than people used to high Se intakes(21).

Rural northeast Thai people have long experience of high intake foods of low nutrient K density(8) and they might have smaller K pools as in the case of Se pools of the New Zealanders(7,21), consequently, they need less K to maintain the pool. Thus, the frequently reported low urinary K excretion among these subjects(1-3) probably reflects their small K pools rather than recent intake.

It is likely that the dietary K recommendation for Americans(6) is not altogether appropiate for other groups. The studied subjects, for example, who are not only living in a high temperature environment but also are accustomed to the consumption of large amounts of foods with low nutrient K density, have a low urinary K excretion and therefore if the cut-off value for the Americans is used as a reference, an abnormally high prevalance of hypokaliuria is always encountered. It is probably considered to be normal, in the case of the studied subjects, to have urinary K excretion-say 780 mg/day (20 mmol/day) instead of 1170 mg/day (30 mmol/day) as is often used(1-3). This seems to be true because no adverse human health effects have been clearly identified in these people that can be attributed to their low K intake. In the present study, both rural and urban subjects stayed in the same environment during investigation and their data on K balance were not different, this suggested the two groups had similarities not only in food habits but also in K status at the beginning and during the studied period.

Although low urinary K excretion may only reflect small body pools as such, however, low intake and high sweat loss of K as indices of true total body K depletion among rural northeast Thai people can not be ruled out. Therefore, direct measurement of K contents in skeletal muscle, the main pool of body K, should be performed to prove if these people were really in a state of K depletion or mere adaptation.

ACKNOWLEDGEMENT

This study was supported by a grant from the National Research Council of Thailand 1997.

(Received for publication on June 10, 1998)

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ปริมาณโพแทสเซียมที่ต้องการเพื่อรักษาดุลในประชากรปกติเพศชายที่อาศัยอยู่ในพื้นที่ที่ได้รับโพแทสเซียมในอาหารต่ำและมีอุณหภูมิสูง

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มักมีรายงานว่าประชากรชาวชนบทของภาคตะวันออกเฉียงเหนือของประเทศไทยได้รับโพแทสเซียม (K) ในอาหารต่ำตลอดจน มีระดับ K ต่ำทั้งในเลือดและปัสสาวะ จนกระทั่งทำให้สงสัยว่าประชากรเหล่านี้น่าจะมีภาวะทางโภชนาการของ K ต่ำ ในการศึกษาครั้งนี้ ได้ทำการวัดดุล K (K balance) ในประชากรเพศชาย 2 กลุ่ม คือ กลุ่มชาวชนบท (R) 10 คน กับกลุ่มในเมือง (U) 5 คน เป็นระยะเวลา 10 วัน ขณะอาศัยอยู่ร่วมกันและรับประทานชนิดอาหารในแต่ละมื้อตามความตกลงร่วมกันของกลุ่ม โดยทำการวัดปริมาณ K ในอาหารที่รับประทานในปัสสาวะ 24 ชั่วโมง และในอุจจาระของแต่ละวัน แล้วนำมาคำนวณดุล K นอกจากนี้ยังได้ทำการวัด K ที่ขับออกมากับเหงื่อในแต่ละวันเพียงหนึ่งคนระหัส R3 ด้วย ผลการศึกษาพบว่าค่าเฉลี่ยของ K ที่ได้รับในอาหารประจำวันของประชากรกลุ่ม R และ U คือ 1731±138 และ 1839±145 มก./วัน ตามลำดับ ส่วนค่าเฉลี่ยดุล K ซึ่งคำนวณโดยการหักค่า K ที่ขับถ่ายออกมาในปัสสาวะ 24 ชั่วโมง (721±129 มก./วันสำหรับกลุ่ม R และ 919±186 มก./วันสำหรับกลุ่ม U) และในอุจจาระ (148±25 มก./วันสำหรับกลุ่ม R และ 164±21 มก./วันสำหรับกลุ่ม U) ออกจาก K ที่ได้รับในอาหารจะมีค่าเท่ากับ +860±140 และ +756±222 มก./วัน สำหรับกลุ่ม R และ U ตามลำดับ ในกรณีของบุคคลระหัส R3 ค่าดุล K ที่คำนวณโดยการหักและไม่หักค่า K ของเหงื่อ (451±57 มก./วัน) มีค่าเท่ากับ +847±373 และ +396±344 มก./วัน ตามลำดับ จากกราฟความสัมพันธ์ระหว่างดุล K และ K ที่ได้รับในอาหารประจำวัน แสดงให้เห็นว่าประชากรกลุ่ม R และ U มีความต้องการ K ในอาหารเพื่อรักษาดุลวันละ 832 และ 884 มก. ตามลำดับ แต่เนื่องจากการศึกษาครั้งนี้กระทำในช่วงฤดูร้อน (อุณหภูมิเฉลี่ยเท่ากับ 35.2±2.0°ซ ณ เวลา 15.00 น.) และสังเกตเห็นมีเหงื่อขับออกมาชัดเจน (ปริมาตรเหงื่อเฉลี่ยต่อวันเท่ากับ 1929±420 มล. สำหรับกลุ่ม R และ 1759±408 มล. สำหรับกลุ่ม U) ดังนั้นการคำนวณดุล K โดยไม่คำนึงถึง K ที่ขับถ่ายออกมากับเหงื่อจึงได้ค่ามากเกินความเป็นจริง ซึ่งจะเห็นได้ชัดเจนในกรณีของบุคคลระหัส R3 ที่เขาจะต้องได้รับ K ในอาหารมากถึงวันละ 1203 มก.เพื่อรักษาดุล K แทนที่จะเป็นเพียง 814 มิลลิกรัม ซึ่งคำนวณโดยไม่คิดค่า K ในเหงื่อ สำหรับการที่ประชากรทั้ง 2 กลุ่มมีข้อมูลต่าง ๆ เกี่ยวกับดุล K ไม่แตกต่างกันนั้นแสดงว่าทั้ง 2 กลุ่ม มีนิสัยการบริโภคอาหารตลอดจนมีภาวะทางโภชนาการของ K เหมือนกัน ผลการศึกษานี้บ่งชี้ว่า การคำนวณหาปริมาณ K หรือแร่ธาตุอื่นที่ควรได้รับในอาหารประจำวันเพื่อให้เกิดดุลพอดีนั้น น่าจะมีความผิดพลาดหากไม่คำนึงถึงปริมาณการขับถ่ายแร่ธาตุเหล่านี้ในเหงื่อร่วมด้วย

คำสำคัญ : ดุลโพแทสเซียม, โพแทสเซียมที่ได้รับในอาหาร, โพแทสเซียมในปัสสาวะ, โพแทสเซียมในอุจจาระ, โพแทสเซียมในเหงื่อ

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