Sodium and Potassium Balances in Japanese Young Adults

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(Received November 5, 2004)

Summary  This study was conducted to estimate the requirements of sodium (Na) and potassium (K) in Japanese young adults. From 1986 to 2000, 109 volunteers (23 males, 86 females), ranging from 18 to 28 y old, took part in 11 mineral balance studies after written informed consent had been obtained. The duration of the study periods ranged from 5 to 12 d, with a 2–4 d adaptation period. Foodstuffs used in each study were selected from those commercially available. The Na and K content of the diet, feces, urine and sweat were measured by atomic absorption spectrophotometer. The results of a study in which Na intake was 6.87g/d (ca. 300mmol/d), the highest of all the studies, showed apparent positive Na balances. In contrast, another study in which Na intake was 2.21g/d (ca. 100mmol/d), the lowest of all the studies, showed apparent negative Na balances. These two studies seemed to differ from the other studies, as shown by regression equations calculated from either data of all the studies (n=109) or data that did not include the two studies (n=90). The dietary intakes of Na and K ranged between 38.56–142.23 and 26.77–74.42mg/kg body weight (BW)/d, or 2.21–6.87 and 1.83–3.61g/d, respectively in the complete data, and 43.71–96.40 and 26.77–63.70mg/kg BW/d, or 3.06–4.06 and 1.83–2.68 g/d, respectively in the data that did not include the two studies. The intakes of the two minerals were positively correlated. Na intake (Intake) was correlated positively with apparent absorption (AA) of Na, which was also correlated with Na urinary output (Urine). In the data that did not include the two studies, as shown by regression equations calculated from either data of all the studies (n=109) or data that did not include the two studies (n=90). The dietary intakes of Na and K ranged between 38.56–142.23 and 26.77–74.42mg/kg body weight (BW)/d, or 2.21–6.87 and 1.83–3.61g/d, respectively in the complete data, and 43.71–96.40 and 26.77–63.70mg/kg BW/d, or 3.06–4.06 and 1.83–2.68 g/d, respectively in the data that did not include the two studies. The intakes of the two minerals were positively correlated. Na intake (Intake) was correlated positively with apparent absorption (AA) of Na, which was also correlated with Na urinary output (Urine). In the data that did not include the two studies, as shown by regression equations calculated from either data of all the studies (n=109) or data that did not include the two studies (n=90). However, analysis of the all data showed a significant correlation between Na Balance and both Na Intake and K Balance. There was a significant correlation between K Intake and K Balance in both the complete data (r2=0.213) and the data that did not include the two studies (r2=0.116). In all the cases, mean, upper and lower limits for K were 39.161, 41.782 and 36.540mg/kg BW/d, respectively. Intakes of Na and K did not correlate with their respective AA rates (%). Within the ranges of K Intake in this study, K Balance was affected markedly by K Intake itself as well as by Na Intake. However, in the case of Na, when the data of the highest and lowest Na intake studies were excluded from the analysis, Na Balance did not correlate with Na Intake, whereas the data of all the studies showed Na Balance was affected strongly by Na Intake. The data of this study allowed the estimated average requirements (EARs) for both minerals to be derived.

Key Words  human, sodium, potassium, intake, urine, balance

It is generally recognized that there are three levels of dietary intake of a nutrient, namely excess, adequate and deficit. The border between excess and adequate is classified as the upper limit, while the border between adequate and deficit is termed the requirement. To determine an upper limit and a requirement for a nutrient, it is necessary to understand the scientific evidence on quantitative information about dietary intake and the signs and symptoms of excess or deficit of the nutri-
Table 1. Subjects and dietary intake of energy minerals.

| Exp. No. | Sex | Subjects | Duration (d) | Energy (kcal/d) | Protein (g/d) | Fat (g/d) | % of energy | Na (g/d) | K (g/d) | Ca (mg/d) | Mg (mg/d) |
|----------|-----|----------|--------------|----------------|--------------|-----------|-------------|----------|---------|-----------|-----------|
| 1        | f   | 6        | 10           | 1,950          | 89           | 54        | 25          | 2.21     | 2.71   | 802       | 283*      |
| 2        | f   | 7        | 8            | 1,800          | 76           | 53        | 26          | 3.06     | 2.20   | 653       | 216*      |
| 3        | f   | 2        | 8            | 1,800          | 76           | 53        | 26          | 3.06     | 2.20   | 653       | 216*      |
| 4        | m   | 5        | 10           | 2,150          | 71           | 57        | 24          | 3.08     | 2.20   | 671       | 243*      |
| 5        | m   | 5        | 10           | 2,150          | 71           | 57        | 24          | 3.20     | 1.96   | 676       | 154       |
| 6        | f   | 12       | 10           | 1,650          | 65           | 64        | 35          | 3.27     | 2.06   | 495       | 194       |
| 7        | f   | 12       | 8            | 1,850          | 64           | 68        | 33          | 3.40     | 1.86   | 347       | 186       |
| 8        | f   | 8        | 12           | 1,750          | 78           | 49        | 25          | 3.69     | 2.47   | 719       | 279*      |
| 9        | f   | 12       | 8            | 1,550          | 75           | 66        | 38          | 3.90     | 2.55   | 672       | 261*      |
| 10       | f   | 8        | 12           | 1,950          | 87           | 57        | 27          | 4.06     | 2.68   | 629       | 261*      |
| 11       | m   | 13       | 5            | 3,250          | 136          | 101       | 28          | 6.87     | 3.61   | 1,131     | 379       |

* Mg (180 mg/d) was added to the diet as magnesium oxide (MgO).
** Mineral lost during exercise was estimated (n=49).

SUBJECTS AND METHODS

From 1986 to 2000, 109 volunteers (23 males, 86 females), ranging from 18 to 28 y old, took part in mineral balance studies after written informed consent was obtained. The ethical committee, established by the National Institute of Health and Nutrition in 1990, approved the studies. All the studies were carried out in the Humanities Ward of the National Institute of Health and Nutrition.

The duration of the balance study periods ranged from 5 to 12 d, with a 2–4 d adaptation period. Body temperature and weight in the morning were measured throughout the experiment in all subjects. However, the timing of menstrual cycles in female subjects was not taken into consideration in these studies.

In each study, the same quantity of diet, which varied in each experiment, was supplied to each of the subjects during the balance period without consideration of body weight. However, small changes to the diet were carried out during the adaptation period to ensure consumption of all the food supplied.

The subjects ingested a coloring marker for their feces (Carmine 0.5 g: Merck KGaA, Germany) just before breakfast in the morning at the beginning and end of the balance period. In one study (No. 4, Table 1), magnesium oxide was added to the diet (6). In six studies (Nos. 1–3, and 8–10, Table 1) (n=49), sweat from the arm was collected during exercise on a bicycle ergometer (intensity: 1–1.5 kp, velocity: 50–60 rpm, duration: 30–60 min/trial, frequency: once or twice a day, room temperature: 22–29°C, humidity: 40–65 RH) in order to estimate loss of the elements by sweating (Table 1).

The foodstuffs used in each study were selected from those commercially available. Some foodstuffs were avoided because of the heterogeneous content of nutrients revealed by chemical measurements taken before the studies. Both processed and nonperishable foodstuffs were purchased at the same time from the same lot before the studies to ensure the same content of nutrients. Fresh foodstuffs were obtained from the same district by purchasing from the same market. Dietary menus were designed by a registered dietician so that they meet the dietary allowances in Japan (11), with the exception of the low calcium studies (Nos. 6 and 7, Table 1) for which food composition tables were used (12).

All foodstuffs were washed if necessary with ion-free water that had been passed through an ion-exchange resin, and then weighed, cooked separately, and distributed uniformly to dishes for the subjects and diet sample(s). The subjects were required to consume all of the diet and were allowed no other food, but could drink as much ion-free water as required. The weight of water...
consumed was measured and recorded.

Duplicated diet samples were obtained throughout the studies and kept in a refrigerator for 1 d before being blended. For blending, the refrigerated diet samples were weighed and put into a blender (MX150S, National, Japan). An adequate volume of ion-free water was added, and then the mixture was homogenized gradually for approximately 30 min using a slide trans (RIKO-SLIDETRANS RSA-5, TOKYO-RIKOSHA, Japan) attached to the blender. The homogenized diet samples were prepared in triplicate and weighed in polypropylene bottles. Five milliliters of nitric acid (UGR grade, Kanto Chemical Co., Inc., Japan) was then added and the mixture kept at room temperature until digestion. Digestion was carried out in hard glass beakers (Pyrex, Iwaki Glass, Japan) on a hot plate at temperatures below 140°C, using nitric acid and hydrogen peroxide for trace analysis (Wako Pure Chemical Ind., Ltd., Japan). The interior of the bottle was washed with nitric acid that was then added to the sample in the beakers.

After digestion, an adequate volume of pure water (Milli-Q, MILLIPORE, Japan) was added to the samples, which were then put on a hot plate at temperatures below 90°C for one night to measure the phosphorus content. Then 0.5 M nitric acid was added to attain a fixed volume. Na and K concentrations were measured by an atomic absorption spectrophotometer (AAS, Varian AA-5, Australia) after the mixture had been diluted to an appropriate concentration with 0.5 M nitric acid (10).

Fecal specimens were collected throughout the experiment and were separated into those originating from the diet during the balance periods based on the appearance of the ingested coloring marker in the feces. The fecal samples were analyzed in the same way as the diet samples. Urine samples were diluted directly by 0.5 M nitric acid, and measured in the same way as the other samples.

Arm sweat during exercise was collected by covering the whole arm with a long polyethylene bag wrapped with tape after the skin surface of one side of the hand and arm had been cleaned with pure water and ion-free gauze treated with ethylene-diamine-tetraacetic acid diammonium salt (EDTA: Wako Pure Chemical Ind., Ltd.). In order to remove any solids the collected sweat was passed through a 0.10 μm pore size Teflon filter (Fluoro pore, Sumitomo Electric Ind., Ltd., Japan) and ethanol for trace analysis (Wako Pure Chemical Ind., Ltd.). The volume of sweat was calculated by measuring weight loss during exercise using a balance with a sensitivity of 10 g (1, 10). Total sweat loss of minerals during exercise throughout the balance period was divided by the days of the balance period and expressed as sweat loss in mg/kg BW/d.

In order to standardize various characteristics of the subjects, such as sex, weight and other traits, all data were expressed as mg/kg BW/d. Using these data, the apparent absorption and balance of the minerals were calculated, and regression equations were computed for Na and K. Statistical analyses were carried out using StatView-J5.0.

The indicators in this paper are defined as follows;

Apparent absorption
$$=[(\text{Intake})-(\text{Fecal output})]/(\text{Intake})\times 100\text{%}$$

Apparent absorption (mg/kg BW/d)
$$=[(\text{Intake})-(\text{Fecal output})/(\text{Intake})\times 100\%]$$

Balance (mg/kg BW/d)
$$=+(\text{Urine output})+(\text{Sweat loss})$$

Fig. 1. Relationship between dietary intakes of sodium (Na) and potassium (K) (mg/kg BW/d). Data of the lowest and the highest Na intake studies (Nos. 1 and 11, n=6 and 13, respectively, Table 1) are shown as open circles. The data of the remaining studies (Nos. 2 to 10, n=90, Table 1) are shown as filled circles (n=90) with the correlation equation shown within the margin. The equation for all the data (n=109) is shown outside the margin. The Na/K ratio of the diets in these studies was homogeneous with the exception of the study with the lowest Na intake.

RESULTS

The results of the study in which sodium intake was 6.87 g/d (ca. 300 mmol/d), the highest among all the studies, showed apparent positive Na balances (4). On the other hand, results from another study in which sodium intake was 2.21 g/d (ca. 100 mmol/d), the lowest among all the studies, showed apparent negative Na balances (10). These data appeared to be different from the remainder of the studies with regression equations being calculated in two ways, that is in all eleven studies (n=109) and in the nine studies that did not include the two studies with the highest and lowest Na intake (n=90).

The dietary intakes (Intake) of Na and K ranged between 38.56–142.23 and 26.77–74.42 mg/kg BW/d, or 2.21–6.87 and 1.83–3.61 g/d, respectively in all the data, and 43.71–96.40 and 26.77–73.70 mg/kg BW/d, or 3.06–4.06 and 1.83–2.68 g/d, respectively in the data with the two studies excluded (Table 1). Intakes of these two minerals were correlated positively with each other (Fig. 1).

The relationships between Intake, apparent absorption (AA), urine output (Urine) and balances (Balance) for Na and K are shown in Figs. 2 and 3. Na Intake was correlated positively with AA of Na, which was also correlated positively with Urine Na in two ways. In the data without Na and K Balances in Japanese Young Adults 163

In order to standardize various characteristics of the subjects, such as sex, weight and other traits, all data were expressed as mg/kg BW/d. Using these data, the apparent absorption and balance of the minerals were calculated, and regression equations were computed for Na and K. Statistical analyses were carried out using StatView-J5.0.

The indicators in this paper are defined as follows;

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$$=[(\text{Intake})-(\text{Fecal output})]/(\text{Intake})\times 100\text{%}$$

Apparent absorption (mg/kg BW/d)
$$=[(\text{Intake})-(\text{Fecal output})/(\text{Intake})\times 100\%]$$

Balance (mg/kg BW/d)
$$=+(\text{Urine output})+(\text{Sweat loss})$$

*Only when sweat loss during exercise was estimated.

RESULTS

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The dietary intakes (Intake) of Na and K ranged between 38.56–142.23 and 26.77–74.42 mg/kg BW/d, or 2.21–6.87 and 1.83–3.61 g/d, respectively in all the data, and 43.71–96.40 and 26.77–73.70 mg/kg BW/d, or 3.06–4.06 and 1.83–2.68 g/d, respectively in the data with the two studies excluded (Table 1). Intakes of these two minerals were correlated positively with each other (Fig. 1).

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Fig. 2. Relationships between dietary intake (Intake), apparent absorption (AA), urine output (Urine) and balance (Balance) of Na (mg/kg BW/d) in Japanese young adults. Data of the lowest and the highest Na intake studies (Nos. 1 and 11, n=6 and 13, respectively, Table 1) are shown as open circles. The data of the remaining studies (Nos. 2 to 10, n=90, Table 1) are shown as filled circles (n=90), with the correlation equation shown within the margin. The equation of all the data (n=109) is shown outside the margin. The relationship between Na intake and Na balance showed a positive correlation only when all the data were used for the calculation. The mean value and upper and lower limits of the 95% confidence interval for the regression equation between Intake and Balance, when balance for Na was equal to zero, were 55.824, 60.787 and 50.862 mg/kg BW/d, respectively.

Fig. 3. Relationships between dietary intake (Intake), apparent absorption (AA), urine output (Urine) and balance (Balance) of K (mg/kg BW/d) in Japanese young adults. Data of the lowest and the highest Na intake studies (Nos. 1 and 11, n=6 and 13, respectively, Table 1) are shown as open circles. The data of the remaining studies (Nos. 2 to 10, n=90, Table 1) are shown as filled circles (n=90), with the correlation equation shown within the margin. The equation of all the data (n=109) is shown outside the margin. The mean value and upper and lower limits of the 95% confidence interval for the regression equation between Intake and Balance, when balance for K was equal to zero (n=109), were 39.161, 41.782 and 36.540 mg/kg BW/d, respectively.

the two studies, Na Balance was not correlated significantly with either Na Intake ($r^2=0.005$) or AA of Na ($r^2=0.006$). However, in all cases, Na Balance was significantly correlated with both Na Intake ($r^2=0.361$) and AA of Na ($r^2=0.360$). In the complete data, the mean value and upper and lower limits of the 95% confidence interval for the regression equation between Intake and Balance for Na, when balance was equal to zero, were 55.824, 60.787 and 50.862 mg/kg BW/d, respectively (Fig. 2).

K Intake was correlated positively with AA of K, which was also correlated with both Urine K and K Balance. Intake of K was correlated significantly with K Balance ($r^2=0.019$, n=109; $r^2=0.116$, n=90). In all cases the mean value and upper and lower limits of the 95% confidence interval for the regression equation between Intake and Balance for K, when balance was equal to zero, were 39.161, 41.782 and 36.540 mg/kg BW/d, respectively.

The relationships between Intake and AA rate (%) of...
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Fig. 4. Relationships between intakes of Na and K (mg/kg BW/d) and apparent absorption (%) of the respective minerals. Data of the lowest and the highest Na intake studies (Nos. 1 and 11, n=6 and 13, respectively, Table 1) are shown as open circles. The data of the remaining studies (Nos. 2 to 10, n=90, Table 1) are shown as filled circles (n=90), with the correlation equation shown within the margin. The equation of all the data (n=109) is shown outside the margin. There were no significant correlations between any of these variables.

Fig. 5. Relationships between intake of Na and K, and balance and urine output of the other elements (mg/kg BW/d). Data of the lowest and the highest Na intake studies (Nos. 1 and 11, n=6 and 13, respectively, Table 1) are shown as open circles. The data of the remaining studies (Nos. 2 to 10, n=90, Table 1) are shown as filled circles (n=90), with the correlation equation shown within the margin. The equation of all the data (n=109) is shown outside the margin. The degree of correlation between Na intake and K balance is stronger than that between K intake and K balance $[r^2=0.213 (n=109), r^2=0.116 (n=90)]$. On the other hand, the correlation between K intake and Na balance is not as strong as that between Na intake and Na balance $[r^2=0.361 (n=109), r^2=0.006 (N.S., n=90)]$.

Fig. 6. Relationships between the balances and urine output of Na and K (mg/kg BW/d). Data of the lowest and the highest Na intake studies (Nos. 1 and 11, n=6 and 13, respectively, Table 1) are shown as open circles. The data of the remaining studies (Nos. 2 to 10, n=90, Table 1) are shown as filled circles (n=90), with the correlation equation shown within the margin. The equation of all the data (n=109) is shown outside the margin. The relationship between the balances of Na and K was positively correlated only when all the data were used for the calculation. Urine Na output was correlated positively with K output.

The minerals are shown in Fig. 4. Intake of Na and K was not correlated with their respective AA rates (%) $(r^2=0.002$ for Na, $r^2=0.007$ for K, $n=109$). The AA for Na and K was $97.8\pm 1.9$ and $85.5\pm 5.0\%$ (mean±SD), respectively.

Figure 5 shows the relationship between Intake of Na and K, and Balance and Urine of the other elements. K Balance was correlated positively with Na Intake $(r^2=0.322, n=109)$. On the other hand, in all the cases Na Balance was correlated positively with K Intake $(r^2=0.088, p=0.0017)$. However in the data without the two studies this correlation was not significant. In
data with and without the two studies. Na Intake was correlated positively with Urine K; however, adding the two data sets weakened the degree of correlation. K Intake was also correlated with Urine Na.

The loss of Na in sweat ranged from 0.53 to 7.64 \((2.49 \pm 0.01, \text{mean} \pm \text{SD})\) mg/kg BW/d, and contributed a little to Na Balance. Loss of K ranged from 0.73 to 3.89 \((1.68 \pm 0.66, \text{mean} \pm \text{SD})\) mg/kg BW/d and also contributed a little to K Balance.

The relationship between Balance and Urine of Na and K are shown in Fig. 6. In all the cases, Na and K Balance correlated with each other; however, this correlation was not significant when the data of the two studies were excluded. Without the data of the two studies urinary excretion of Na and K correlated each other, with this correlation still being significant in the data of all the studies.

**DISCUSSION**

This is the first report on the relationship between dietary intake and balance of Na and K in young Japanese adults based on experimental data of 109 subjects. The Na and K content in the diets used in the studies correlated with each other (Fig. 1). This correlation may have occurred as a consequence of a registered dietician designing all the menus for the diets using limited foodstuffs that were distributed uniformly in order to meet the recommended dietary allowances in Japan (fourth to sixth revised editions), with the exception of the diets used in the low Ca studies (Nos. 5 and 6, Table 1). In addition, an early observation in our laboratory revealed that the concentrations of nutrients for most items in both our experimental diets \((13, 14)\) and in the nutritional survey \((15, 16)\) were correlated with each other. Therefore we consider that these correlations may be a characteristic of the typical casual Japanese diet. However in the low Na experiment (No. 1, Table 1), this relationship shifted towards a decreased Na/K ratio.

Of the 109 subjects in our studies 86 were female. In addition to this gender imbalance, the male subjects ingested a high-Na diet (No. 11, Table 1), and high- or low-Mg diets (No. 4, Table 1). It is possible these heterogeneous experimental conditions may have affected the results of our analyses. However, these data are important as they cover a wide range of dietary intake of minerals. In this paper, the results of the balances studied were expressed relative to body weight (kg) in order to partially compensate for the difference in sex distribution.

**Relationships between dietary intakes and balances of Na and K**

There were significant correlations between Intake and Balance for Na and K in all cases, although when the data of the two studies with the highest and the lowest Na intake were omitted this correlation for Na became non-significant.

Na Intake was correlated strongly with AA of Na in all cases \((r^2=0.996)\). Similarly, there was a strong degree of correlation between AA of Na and Urine Na in all cases \((r^2=0.937)\). These correlations resulted in a significant positive correlation between the intake and balance of Na \((r^2=0.361)\). The mean value, upper and lower limits of the 95% confidence interval of the dietary intake of Na when the balance of Na was equal to zero were 55.824, 60.787 and 50.862 mg/kg BW/d, respectively. The EAR for Na in this paper was 55.824 mg/kg BW/d. For a standard Japanese male \((169.1 \text{ cm height}, 67.0 \text{ kg weight})\) the EAR for salt \((\text{NaCl})\) was calculated to be 9.5 g/d. This value is more than five times higher than the recent Japanese requirement of Na \((600 \text{ mg/d or 10 mg/kg BW/d})\), but within the limits of the recommendation \((less \ than \ 10 \text{ g/d})\) \((11)\).

On the other hand, without the data of the two studies with the highest and lowest Na intake this correlation for Na was not significant. This finding suggested that there are three categories with two borders for the status of dietary intake of Na namely, short (deficit), safe (neutral) and excess.

A dietary intake of Na between 43.71–96.40 mg/kg BW/d may be in the safe or neutral range against deficiency or excess, whereas a Na intake of between 38.56–46.56 mg/kg BW/d or less may be deficient and lower than the Na requirement and may produce a slight negative Na balance. In contrast, a dietary intake of Na between 91.73–142.23 mg/kg BW/d or more may be excessive and higher than the upper limit of Na intake and may produce retention of Na.

When Na intake is deficient, not only does restriction of renal Na excretion occur but Na is also released from bone where it is stored as a physiological pool in the body. It has been shown previously \((10)\) that restriction of renal Na excretion does not fully compensate for shortage of Na. Our study showed Na urinary output was the same as intake even when Na Intake was as low as 100 mmol/d (No. 1, Table 1; Fig. 2). It therefore appears that some unknown mechanism may move Na from bone to the blood-stream \((7, 10, 17)\). On the other hand, when Na intake is excessive, not only does acceleration of Na excretion in urine and sweat occur but Na concentrations also increase in body fluid and bone. As has been shown previously \((4)\), Urine Na output is the same as that ingested even when intake is as high as 300 mmol/d (Table 1, No. 1; Fig. 2).

We found a strong degree of correlation between AA of K and both K Intake \((r^2=0.941)\) and Urine K \((r^2=0.789)\) in all cases. These correlations resulted in a significant positive correlation between K Balance and AA of K \((r^2=0.258, n=109)\) and K Intake \((r^2=0.213, n=109)\). The mean value, upper and lower limits of the 95% confidence interval of the dietary intake of K when the balance of K was equal to zero were 39.161, 41.782 and 36.540 mg/kg BW/d, respectively. The EAR for K in this paper was 39.161 mg/kg BW/d, with the EAR for a standard Japanese male \((169.1 \text{ cm height}, 67.0 \text{ kg weight})\) being calculated as 2.6 g/d. This value is 35% higher than the recently reported Japanese RDA of 29 mg/kg BW/d \((11)\). These relationships were similar when analyzed without the data of the two studies with the highest and lowest Na intake.
According to the correlation coefficients ($r^2$), dietary intake of Na and K explained 36.1 and 21.3% of the balance for these minerals, respectively. In both cases, the AAs were correlated strongly with respective dietary intakes and urine output, a finding that suggests that regulation of intestinal absorption is weak for these minerals, similar to that for phosphorous which we reported previously (1). Urinary Na output in the study with the highest Na intake seemed lower than ingestion, while in the study with the lowest intake, urinary output appeared somewhat higher than ingestion. These results may be a consequence of dermal loss of Na being affected by Na intake (7, 17).

**Relationship between intake and AA (%) of Na and K (Fig. 4)**

This study showed there was no significant correlation between Intake and AA (%) for either Na or K. We reported similar findings for phosphorous (1). Almost all Na ingested may be absorbed, while the origin of fecal K is from intestinal excretion, although the absorption of ingested K remains obscure.

**Effects of intake on balance and urine of the other minerals (Fig. 5)**

Although the relationship between the intake of Na and K was significant, Na Intake was correlated significantly with K Balance with and without the data of the two studies with the highest and lowest Na intake. Na Intake also correlated with Urine K. These results may have been influenced by the strong correlation between intakes of the two minerals, and also by the fact that Na ingestion leads to uresis of K (18). However, Na Intake itself may have contributed to K Balance, as the correlation between Na Intake and K Balance was stronger than the correlation between K Intake and K Balance. Further studies may reveal the relationship between Na Intake and metabolism of K. On the other hand, K Intake was correlated significantly with Na Balance only in the data of all the studies. When the data of the two studies were excluded this correlation became non-significant. In a previous study we found increased K intake induced uresis of Na (10), and it is possible that further studies may reveal a relationship between K Intake and metabolism of Na.

K Balance was correlated significantly with Na Balance only in the data of all the studies. Without the data of the two studies with the highest and lowest Na intake, this correlation was not significant. Within the dietary intake range of Na between 43.71–96.40 mg/kg BW/d or neutral Na intake, balances of Na and K may be independent.

When the data of the two studies with extremes of Na intake were excluded, Urine K correlated significantly with Urine Na. This correlation remained significant in the data of all the studies (Fig. 6).

In conclusion, within the ranges of K Intake in this study, K Balance was affected markedly by K Intake itself as well as by Na intake. However, in the case of Na, when the data of the highest and lowest Na intake studies were excluded from the analysis, Na Balance did not correlate with Na Intake, whereas the data of all the studies showed Na Balance was affected strongly by Na Intake. The data of this study allowed the EARs for both minerals to be derived.

**Acknowledgments**

Grant funding for this study was received from the Environmental Agency, Health Science Foundation, Uehara Memorial Foundation, the Salt Science Research Foundation (Japan) and the Ministry of Health Labor and Welfare.

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