Dietary factors associated with urinary sodium to potassium ratio in Japanese preschool children

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Abstract

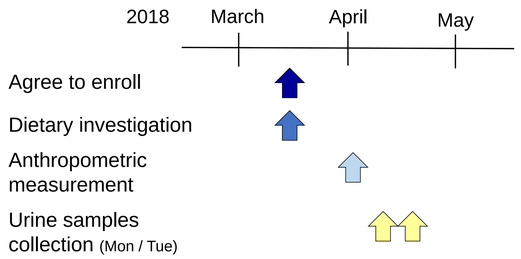
Objective: The normal range of urinary sodium level (Na) in Japanese preschool children is higher and that of potassium (K) lower than recommended by the WHO, resulting in high urinary sodium/ potassium ratio (U-Na/K). The aim of this study was to investigate the dietary factors that influence this high U-Na/K in Japanese preschool children and to create a basis for salt-reduction education.
Design: Observational study
Setting: We collected samples of the subjects' first morning urine for two consecutive days along with a dietary questionnaire called BDHQ3y (Brief-type Self-administered Diet History Questionnaire for Japanese children aged 3-6 years). The results of the dietary questionnaire were corrected by the density method (g/1000 kcal). U-Na/K was calculated using the child's target Na (mEq/L) /g Cr and K (mEq/L) /g Cr.
Participants: The study population included 4 to 5-year-old preschool children attending collaborating kindergartens whose parents agreed to participation after providing informed consent.
Results: In total, 338 preschool children were enrolled. Their averages data were: height, 103.0 cm; weight, 16.7 kg; and U-Na/K value, 4.5. Regarding U-Na/K and nutrients, positive correlation was found between sodium (β=0.2009) and potassium (β=−0.1675), significant predictors when assessed using multiple regression analysis. For food, multiple regression analysis showed: fruits (β=-0.1725); pickles (β=0.1515); soft drinks (β=0.1512); seasoning spices (β=0.1124); and noodles (β=0.1064) as significant predictors. There was no correlation with sex or between northern (Fukushima prefecture) and southern (Fukuoka prefecture) regions of Japan.
Conclusion: The U-Na/K correlated positively with consumption of pickles, soft drinks, seasoning spices and noodles and negatively with consumption of fruits in Japanese preschool children.

Background & Aim

- Heigh Na/K is known to be a high-risk factor for cardiovascular disease(Okayama A: BMJ Open, 2016).
- Even in children, high Na-intake leads to future high blood pressure (Yang Q: Pediatrics, 2012 / He FJ: Hypertension, 2006, Rangan AM: Eur J Clin Nutr, 2012), while low Na- or high K-intake prevents it (Geleijnse JM: Hypertension, 1997 / Leyvraz M: Int J Epidemiol, 2018 / Moore LL, Epidemiology, 2005).
- We have reported that almost all of the 104 Japanese preschool children studied had not cleared the recommended urinary-Na and urinary-K level as determined by measuring their first morning urine for 12 days(Yasutake K: J Clin Hypertens (Greenwich), 2017).
- Babies with high salt intake at 9 months of age will have a significantly high salt intake at 18 months (Campbell KJ: J Acad Nutr 2014).
- The preference towards sodium in humans is known to develop as early as infancy (Stein LJ: Am J Clin Nutr, 2012), and dietary patterns at 3 years of age continue thereafter (Northstone K: Br J Nutr, 2008). Thus, it is important to check sodium- and potassium-intake at these early phases of life.
- In order to solve this problem, we need to find out the dietary food that influences Na/K in Japanese preschool children.

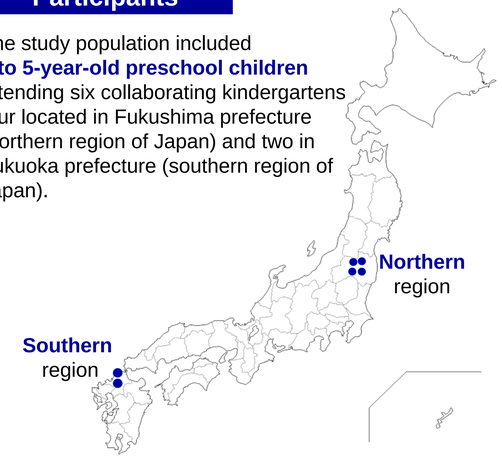
We investigate the dietary factors that influence this high U-Na/K in Japanese preschool children.

Intervention schedule



Participants

The study population included **4 to 5-year-old preschool children** attending six collaborating kindergartens four located in Fukushima prefecture (northern region of Japan) and two in Fukuoka prefecture (southern region of Japan).



452 parents attended the briefings explaining the study

Excluded → Declined to participate n=**87**

365 preschool children recruited in this study

Excluded → Did not hand in the urine samples n=**27**

Completed the study
n=338

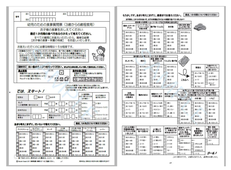
Estimation of daily urinary excretion levels from spot urine samples

Analyzed → Cr (mg/dL) Na (mmol/L) K (mmol/L)

- U-Na/K was measured by (mEq/L) /g Cr for urinary Na and K.
- We designated spot urine on Monday to reflect intake on Sundays (holiday for Kindergarten) and spot urine on Tuesday (not holiday for Kindergarten) to reflect sodium intake on Mondays. (Yasutake K: J Clin Hypertens (Greenwich), 2017).

Dietary survey

BDHQ3y consists of 89 questions on both sides of an A3-size sheet. It can calculate an individual's monthly habitual intake of nutrition and food. The intake value calculated by the BDHQ3y was used for analyses by correcting the value to per 1000 kcal by the density method. (Asakura K, J Epidemiol. 2015)

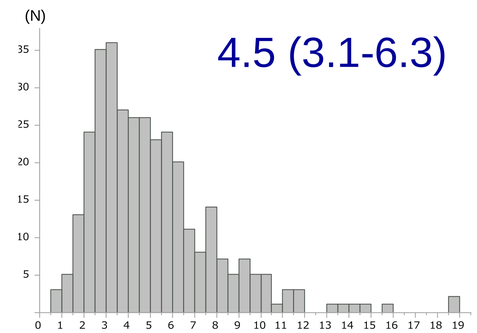


Characteristics of participants

Number	338
Sex	185/153
Age (months)	58.0 (55.0 - 61.0)
Height (cm)	103.0 (99.8 - 106.6)
Weight (kg)	16.7 (15.1 - 18.0)
Kaup index (g/cm^2)	15.7 (15.0 - 16.5)
Region (North / South)	157/181
Number of brothers and sisters (0/1/2/3/4)	63/186/74/14/1
Order of birth (1/2/3/4)	157/133/40/7/1
Living together with grandparents (yes/no)	48/290
Occupation of mother (regular/part time/unemployed)	56/82/200
Primary food preparer for the family (Mother / Others)	323/15

Data expressed as number or median (25% quartile - 75% quatile).
Kaup index=Weight (kg) ÷ Height (cm)^2×10^4
Analysis: ANOVA

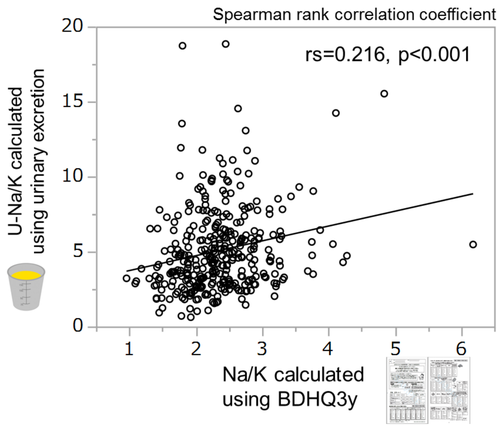
Distribution of U-Na/K



4.5 (3.1-6.3)

- The median value for U-Na/K was 4.5 and was distributed from low to high values

Correlation of U-Na/K and Na/K calculated using dietary survey



- The correlation coefficient was 0.216 and although low, it is comparable with previous studies that showed a correlation between urinary excretion and dietary estimates of habitual sodium-intake.

Correlation between U-Na/K and nutrients intake calculated using dietary survey

	rs	p value	β	p value
Energy	-0.0446	0.4135		
Protein energy ratio (%)	-0.0885	0.1042		
Fat energy ratio (%)	0.0429	0.4315		
Carbhydrate energy ratio (%)	-0.0120	0.8254		
Sodium (g/1000 kcal)	0.1412	0.0093	0.2009	0.0004
Potassium (g/1000 kcal)	-0.1231	0.0237	-0.1675	0.0198
Calcium (g/1000 kcal)	-0.1359	0.0124	0.0355	0.7840
Magnesium (g/1000 kcal)	-0.0875	0.1085		
Phosphorus (g/1000 kcal)	-0.1186	0.0293	-0.0800	0.5588
Dietary fiber	-0.0226	0.6795		

Analysis: Spearman's rank correlation coefficient
Converted by Box-Cox Y so that the residual sum of squares became minimum and then multiple regression analysis
β: standard partial regression coefficient

Correlation between U-Na/K and food intake calculated using dietary survey

	rs	p value	β	p value
Rice (g/1000 kcal)	0.0401	0.4625		
Bread (g/1000 kcal)	-0.0560	0.3046		
Noodles (g/1000 kcal)	0.1295	0.0172	0.1064	0.0445
Potatoes (g/1000 kcal)	-0.0448	0.4116		
Suger (g/1000 kcal)	-0.0049	0.9286		
Bean (g/1000 kcal)	-0.0354	0.5167		
Green and yellow vegetables (g/1000 kcal)	-0.0918	0.0921		
White vegetables (g/1000 kcal)	0.0368	0.5006		
Pickled vegetables (g/1000 kcal)	0.2061	0.0001	0.1515	0.0044
Fruits (g/1000 kcal)	-0.1765	0.0011	-0.1725	0.0010
Fish (g/1000 kcal)	-0.0355	0.5157		
Meat (g/1000 kcal)	-0.0070	0.8979		
Eggs (g/1000 kcal)	0.0108	0.8426		
Milk and dairy products(g/1000 kcal)	-0.1562	0.0040	-0.0854	0.1093
Vegetable oil (g/1000 kcal)	0.0560	0.3043		
Confectioneries (g/1000 kcal)	0.0359	0.5109		
Soft drink (g/1000 kcal)	0.1438	0.0081	0.1512	0.0042
Seasoning (g/1000 kcal)	0.1581	0.0036	0.1124	0.0334

Analysis: Spearman's rank correlation coefficient
Converted by Box-Cox Y so that the residual sum of squares became minimum and then multiple regression analysis
β: standard partial regression coefficient

- These pickles, seasoning spices, and noodles have high sodium content and are known to be high sources of salt intake for adults. (Anderson CA: J Am Diet Assoc, 2010 / Asakura K: Public Health Nutr, 2016)
- Fruits are known to have high potassium content and the estimated potassium values were close to what we had expected. Furthermore, eating habits of infants are strongly influenced by their parents. (Nicklas TA: Nutr Rev, 2001 / Fisher JO: J Am Diet Assoc, 2002)
- Salt intake and the amount of soft drink consumption of infants have a significant correlation (He FJ: Hypertension, 2008), where sodium intake increases by 0.4 g/day, soft drink-intake increases about 30 g/day (Grimes CA: Am J Clin Nutr, 2013), and increases risk of obesity by 1.4 (Grimes CA, Br J Nutr, 2016).

Conclusion

- The U-Na/K correlated positively with consumption of pickles, soft drinks, seasoning spices and noodles and negatively with consumption of fruits in Japanese preschool children.
- we need to teach parents and caregivers to prepare a proper diet for the children and lower the risk of future non-communicable diseases.

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