

Sodium (Na) Potassium (K) 가

¹, ¹, ¹, ², ¹, ¹, ³
¹, ²,
³

= Abstract =

The effect of sodium and potassium intake on blood pressure change in Korean adolescents

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In order to investigate the effect of the urinary excretion of sodium and potassium on the change on blood pressure over 3 years, 668 adolescents aged 13 years living in Kangwha area were investigated in a longitudinal follow-up study. Two measurements were taken on each blood pressure (diastolic, systolic) and the average of the two readings was used in the analysis. Sodium and potassium intake were estimated by the determination of those electrolytes in 24hr urine. The mixed model regression analysis was used to identify the effect of urinary sodium and potassium on the change of blood pressure after controlling for BMI of each age.

On simple bivariate analysis no relationship was found between urinary sodium excretion and systolic or diastolic blood pressure among both male and female, however, a significant positive association between urinary potassium excretion and systolic blood pressure among male.

The results of mixed regression analysis showed that the body mass index (BMI) were more influential than urinary electrolytes among this study subjects. It suggested that risk factors observed from the adults, may not be identical with that of the growing aged population. After control of the BMI and age, significant association between sodium and diastolic BP among male, and association between

potassium and systolic BP among female, were found.

In summary, the results indicate that growth has been more influential than dietary factor on blood pressure for growing aged population.

Key words: blood pressure, sodium, potassium

I.

1980 가
(cerebrovascular accident, stroke) (, 1996).
가 . 1990
12.9%, 12.9%
(, 1994).
(Voors, 1977).
가
(National Heart, Lung, and Blood Institute, 1987).
1900 가 (Stocks, 1924).
가 , 가
가 (Szklo, 1979; Kotchen , 1989). 가
가
20 가
(WHO, 1985). 20 가

2.0mmHg, 1.0mmHg가 10 14 가
가 가

가

(WHO, 1985).

(Na) (K) 가
32 52 INTSALT

Yanomamo Indian Papua New Guinea 가
가 (Cutler 1991).

Whelton (1996) K 33 K 가
Na K Na/K 가

Hofman (1993) 5-6

가 가 Geleijnse (1990) 5-17 233 K
Na/K 가 가가

, 1963; , 1968; , 1989; , 1990)

Na, K 가 Na K 가

II.

1.

1993 8
2 (13) 24
가 318 , 350 .

2.

1)

1993 1996
, , . Korotkoff phase I,
Korotkoff phase IV . (1989)
(1993) .

2)

Na K 24 Na K
가 5
5 24 ,
, , , .
1 .

ion selective Na K .
가 가 .
, (creatinine) 0.4ml/kg/hour,
0.3ml/kg/hour (Ellitson , 1980). ,
300ml/day . ,
.

3.

1)

24 가 318 66 (20.8%), 350

94 (26.9%)

(Table 1).

Table 1. Number of students included in analysis

						Unit : person
Sex	Grade	Middle		High		3-year follow-up cases
		2nd	3rd	1st	2nd	
Male		252(49.6)	241(48.8)	206(46.2)	206(46.7)	194
Female		256(50.4)	253(51.2)	240(53.8)	235(53.3)	234
Total		508(100.0)	494(100.0)	446(100.0)	441(100.0)	428

2)

Na, K, Na/K

Na K 가 Na

Na/K 75 K 25

t- 3

2 3

(body mass index) Na, K,

Na/K 가 (mixed model)

$$BP_t = \alpha + \beta_1(\text{age}_t) + \beta_2(\text{BMI}_t) + \beta_3(\text{Na}) + \beta_4(\text{K}) + \beta_5(\text{Na} \cdot \text{age}_t) + \beta_6(\text{K} \cdot \text{age}_t)$$

, BP_t , Age_t , BMI_t , t , , ,

Na 75 1, 0, K 25 1, 0

(indicator function)

(compound symmetric)

III.

1.

가

2

가 (Table 2).

Table 2. Mean difference of study variables between included and excluded cases

Sex	Variable	Included	Excluded	p-value*
Male	Systolic BP (mmHg)	111.9 ± 11.2	112.0 ± 10.2	0.98
	Diastolic BP (mmHg)	66.6 ± 7.8	66.8 ± 8.2	0.83
	Height (cm)	160.3 ± 8.0	160.5 ± 8.2	0.87
	Weight(kg)	49.5 ± 10.2	51.1 ± 10.0	0.32
	BMI(kg/m ²)	19.1 ± 2.7	19.7 ± 3.6	0.26
Female	Systolic BP (mmHg)	117.7 ± 11.5	116.7 ± 11.4	0.44
	Diastolic BP (mmHg)	76.2 ± 8.0	76.4 ± 7.9	0.89
	Height (cm)	156.1 ± 5.0	154.8 ± 6.3	0.08
	Weight(kg)	49.2 ± 8.8	47.6 ± 8.3	0.13
	BMI(kg/m ²)	20.2 ± 3.1	19.8 ± 3.0	0.39

BP : blood pressure; BMI : body mass index

* : calculated by independent two sample t-test

2. Na, K, Na/K

Na, K, Na/K	(Table 3).	Na
178.6mEq/24hr,	170.6mEq/24hr	, 90
302.1mEq/24hr,	270.6mEq/24hr	. K
31.2mEq/24hr,	32.4mEq/24hr	90
51.2mEq/24hr,	54.6mEq/24hr	.
Na		K

Table 3. Distributions of urinary Na, K, and Na/K ratio according to sex

Sex	Variables	Percentiles				
		10	25	50	75	90
Male	Na (mEq/24hr)	92.9	125.6	178.6	223.0	302.1
	K (mEq/24hr)	18.6	24.0	31.2	42.6	51.2
	Na/K ratio	3.1	4.2	5.6	7.5	9.5
Female	Na (mEq/24hr)	101.3	129.2	170.6	219.1	270.6
	K (mEq/24hr)	18.7	23.8	32.4	42.5	54.6
	Na/K ratio	3.2	4.1	5.3	6.8	8.3

3. Na, K, Na/K

Table 4	5		2	Na, K, Na/K		
			가		3	
	가	가	.			
Na	가		.	K	가	
	K	가	.			
			.	K	가	3
		2.2mmHg	, K	가	4.7mmHg	
			.	Na/K		

Table 4. The mean difference of systolic blood pressure between high(or low) and normal group in urinary Na, K, and Na/K ratio according to sex and age

Sex	Variable	Group [*]	Middle		High		Change [†]
			2nd	3rd	1st	2nd	
Male	Na	High	112.8	117.9	122.3	119.4	6.5
		Normal	111.9	115.8	120.1	118.1	6.2
		p- value	0.64	0.28	0.27	0.52	0.85
	K	Low	108.8	113.1	118.1	115.3	6.5
		Normal	113.3	117.4	121.5	119.5	6.2
		p- value	0.02	0.02	0.08	0.03	0.87
	Na/K	High	113.0	117.1	121.1	117.4	4.4
		Normal	111.9	116.1	120.5	118.8	6.9
		p- value	0.56	0.60	0.75	0.47	0.15
Female	Na	High	119.5	118.5	116.5	115.1	-4.4
		Normal	117.4	117.4	114.5	113.4	-4.0
		p- value	0.23	0.50	0.27	0.31	0.76
	K	Low	114.2	115.2	113.1	112.0	-2.2
		Normal	119.1	118.5	115.7	114.4	-4.7
		p- value	0.00	0.04	0.15	0.16	0.04
	Na/K	High	116.3	116.6	113.4	111.8	-4.6
		Normal	118.4	118.0	115.5	114.4	-4.0
		p- value	0.24	0.40	0.24	0.08	0.63

* : cutoff point of Na and Na/K ratio is 75 percentiles of their distribution and K is 25 percentiles of its distribution

† : difference of blood pressure between 2nd grade in high school and 3rd grade in middle school

Table 5. The mean difference of diastolic blood pressure between high(or low) and normal group in urinary Na, K, and Na/K ratio according to sex and age

Sex	Variable	Group*	Middle		High		Change [†]
			2nd	3rd	1st	2nd	
Male	Na	High	66.1	71.7	74.6	74.0	7.9
		Normal	67.1	71.8	75.8	73.3	6.2
		p-value	0.46	0.89	0.41	0.58	0.20
	K	Low	65.5	69.0	73.5	72.8	7.3
		Normal	67.3	72.8	76.2	73.7	6.4
		p-value	0.13	0.00	0.06	0.50	0.51
	Na/K	High	65.6	70.5	74.7	73.2	7.6
		Normal	67.2	72.2	75.8	73.5	6.3
		p-value	0.23	0.22	0.45	0.79	0.35
Female	Na	High	76.7	75.5	75.0	72.5	-4.2
		Normal	76.3	75.3	73.8	71.7	-4.6
		p-value	0.74	0.87	0.39	0.48	0.72
	K	Low	76.4	73.9	73.7	72.1	-4.3
		Normal	76.4	75.8	74.3	71.8	-4.5
		p-value	1.00	0.11	0.64	0.82	0.82
	Na/K	High	75.5	74.1	72.8	71.0	-4.47
		Normal	76.7	75.8	74.5	72.2	-4.48
		p-value	0.33	0.15	0.19	0.32	1.00

* : cutoff point of Na and Na/K ratio is 75 percentiles of their distribution and K is 25 percentiles of its distribution

† : difference of blood pressure between 2nd grade in high school and 3rd grade in middle school

Na, K,

Na/K (Table 6, Table 7).

가 가

Na 가 2

2.4(-12.54+0.78·13)mmHg (p<0.1) 가

가 0.78mmHg (p<0.1). K 가

2 2.27(-11.27+0.69·

13)mmHg (p<0.1) 가

가 0.69mmHg (p<0.1). Na/K

Table 6. The effects of urinary Na, K, and Na/K ratio on blood pressure in male

Independent variable	Systolic BP		Diastolic BP	
	Model 1	Model 2	Model 1	Model 2
Age (year)	1.98 ^{***}	1.44 ^{***}	3.15 ^{***}	2.71 ^{***}
BMI (kg/m ²)	1.29 ^{***}	1.27 ^{***}	0.55 ^{***}	0.55 ^{***}
Na(1=high, 0=normal)	-4.49	-	-12.54 [*]	-
K((1=low, 0=normal)	-3.93	-	-7.62	-
Na × Age	0.17	-	0.78 [*]	-
K × Age	0.07	-	0.42	-
Na/K(1=high, 0=normal)	-	6.53	-	-9.91
Na/K × Age	-	-0.48	-	0.62

BP : blood pressure, BMI : body mass index

* : p<0.1, ** : p<0.05, *** : p<0.01

Table 7. The effects of urinary Na, K, and Na/K ratio on blood pressure in female

Independent variable	Systolic BP		Diastolic BP	
	Model 1 (Coefficient)	Model 2 (Coefficient)	Model 1 (Coefficient)	Model 2 (Coefficient)
Age (year)	-1.20 ^{***}	-2.20 ^{***}	-1.14 ^{***}	-1.73 ^{***}
BMI (kg/m ²)	1.13 ^{***}	1.17 ^{***}	0.75 ^{***}	0.74 ^{***}
Na(1=high, 0=normal)	-2.38	-	-5.32	-
K((1=low, 0=normal)	-11.27 [*]	-	-5.05	-
Na × Age	0.17	-	0.35	-
K × Age	0.69 [*]	-	0.37	-
Na/K(1=high, 0=normal)	-	5.25	-	0.29
Na/K × Age	-	-0.44	-	0.07

BP : blood pressure, BMI : body mass index

* : p<0.1, ** : p<0.05, *** : p<0.01

Na K 가

, Na
. K
. Na/K , 가

24
Na
(Beaton, 1986), 3 1
24
Na 98% , 86%가
(Holbrook , 1984), 24
가 Caggiula (1985)
6 24 Na
(r=0.61) , Holbrook (1984) (r=0.76)
. , 24 Na
, 4 . 24

Brookhaven 1954 Dahl and Lover가
가 가
, 28 ,

. Na Belgium
(Joosens). (1314)
, (713)
가
, (JNC
VI, 1997),
(Simon, 1994).
가 가
, 24

Swaye (1972) 가 .
(Dawber, 1967), (Grim, 1970), (Langford, 1975)
. 가
(Sasak,1964; Prior,1968; Freis,1976;
Page, 1976). , ,
가 가 가 ,
가 .
K
(Langford,1983).
K 가
(Tannen, 1983; Cappuccio, 1991). ,
K 가 ,
(Whelton, 1997). JNC (1997) , 50
90 mmol K . ,
K (Zwiauwer, 1991; Krishna,
1989). K .
Na/K . Langford
and Watson(1975) 6 24 Na/K
. Na/K
(Walker, 1978). (Cooper, 1980)
Na K (r=0.731), K가
. 24 Na, K, Na/K
가
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가
. 가
가
. 가
(Ellitson,1980). 가
가
. ,
가 (Jacobsen, 1979),

가

(Cooper, 1980),
가 . ,
가 가 가 .
가 . , 가 .

가 . ,
가 (Alexander,1962). , Na ,
가 , Na , 가
. , Na

Voors(1977) 가 ,
Na K가 .
가 가 , Na가 .
가 . , Na
가 가 .

Na Na Na
, 24 Na (, 1995)
Na 24 Na
가 .
(Dr. Kestloot,1996:)
, 가 . ,
Belgium Na 0.995, K
0.987 .
가 . ,
Na Na 가

Na
(Cooper,1980).

3

Na

가

가

(prevalent

incidence bias)

가

24

가

가

가

Na

K

가

가

JNC

(NIH, 1997)

6g, Na

2.4g

(, 1989),

가

가

1993
318 potassium (K) 가 350 (668) 4 sodium (Na)

24 Na K , Na K

Na K

Na

K

. Na/K

Na, K Na/K

가

Na

K

Na K

: , Na, K

- 1993;26(3):347-358
- Sodium, Potassium
1995;24(4):493-501
- 1989;11(2):232-45
- 1989;22(3):303-312
- 1963;6:35-39
- 1968;11:65-71
- Sodium, potassium
1995;24(4):493-501.
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- , 1996.
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