日本人を代表する集団におけるカリウム摂取量とこれに関連する食事因子
：NIPPON DATA80/90 栄養研究

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目的

カリウム摂取量の増加には血圧低下効果があり、循環器疾患死亡の減少に関連する。高血圧管理のガイドラインでは、カリウム含有量の多い食品、特に野菜や果物の摂取が推奨されているが、カリウムは肉・魚など動物性食品にも豊富に含まれるものであり、食事パターンとの関連は食塩ほど単純ではない。欧米と比べて食塩摂取量の多い本邦においては、減塩を図りつつカリウム摂取量を増加させる必要があるが、有効な食事パターンを提案するためには、日本人の食事におけるカリウム摂取と食事パターンの関連を明らかにする必要がある。

本研究では、我が国国民を代表する循環器疾患基礎調査受検者の長期追跡コホート研究である NIPPON DATA 80/90 と、この受検者が同時に対象となった国民健康調査結果の統合データセットを用いて、わが国の食生活におけるカリウム摂取量と、他の栄養素および食品群摂取量の関連を検討することとした。

方法

1980 年および 1990 年実施の循環器疾患基礎調査受検者の長期コホートデータセットである NIPPON DATA80 および 90 と、同年実施の国民栄養調査結果の統合データセットを用いた。調査実施当時の国民栄養調査では、世帯単位で秤量記録法により調査した食品摂取量が世帯単位で集計されたが、1995 年実施の同調査で調査、公表された性・年齢別平均の栄養素および食品群別摂取量を、1980 年、1990 年当時の調査対象世帯の世帯員性・年齢構成にあてはめて、按分した値を個人の推定摂取量として使用した。また、1990 年国民栄養調査ではカリウム摂取量は集計、公表されたが、1980 年の調査ではカリウムは集計されなかった。このため、国民栄養調査で用いられた食品群分類について、高度に標準化された国際共同栄養疫学調査（INTERMAP）の調査結果を用いて、各食品群の標準カリウム含有量を求め、これと 1980 年国民栄養調査結果の食品群別摂取量を用いて各世帯分のカリウム摂取量を計算し、さらに按分法を用いて個人分のカリウム摂取量を推定計算した。

こうして計算したカリウム摂取量(mg/1000kcal)を用いて五分位を男女別に作成し、五分位別の栄養素および食品群摂取量を計算しカリウム摂取量との関連を検討した。

結果

NIPPON DATA80/90 それぞれ、男女別に鉄摂取量(mg/1000kcal)五分位別の食品群別摂取量を表 1,2,3,4 に示した。男女ともに、NIPPON DATA80/90 の両方で、カリウム摂取量(mg/1000kcal)と年齢の有意な正の相関を認めた。カリウムを多く摂取することは、高齢であることおよび、タンパク質、鉄、カルシウム、ナトリウム、各種ビタミン、食物繊維摂取量の多いことと関連した。食品群摂取量でみると、カリウムを多く摂取することは、穀類、米、油脂摂取量の少ないことと関連した。逆に、種実類、芋類、大豆、果物、野菜、きのこ、海藻、魚介類摂取量の多いことと関連した。

結論

NIPPON DATA80 と 90 の対象集団である日本人成人のデータセットを用いて、平均カリウムの摂取状況と、鉄摂取量と食品摂取量との関連を検討できた。

表１. Nutrient intakes of different food group according to quintiles of dietary potassium intake for men: NIPPON DATA80

Range	Potassium intake quintiles (mg/1000kcal)										p diff	p trend
	548-1079		1080-1195		1196-1310		1311-1452		1453-2433			
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*		
N	920		915		913		921		916			
Cereals (g/1000kcal)	178.7	*30.5*	166.4	*27.0*	160.0	*26.3*	153.2	*26.2*	142.6	*30.2*	<0.001	<0.001
Rice (g/1000kcal)	139.3	*35.8*	129.2	*32.6*	126.1	*33.5*	123.0	*31.9*	114.2	*34.4*	<0.001	<0.001
Flour product (g/1000kcal)	42.1	*28.4*	39.8	*24.3*	36.6	*24.3*	33.2	*22.9*	30.3	*23.6*	<0.001	<0.001
Nuts (g/1000kcal)	0.3	*1.0*	0.6	*1.8*	0.6	*2.2*	0.6	*1.5*	0.7	*1.7*	0.009	<0.001
Potatoes (g/1000kcal)	16.2	*12.7*	23.2	*13.8*	26.6	*14.9*	31.1	*17.6*	41.3	*25.0*	<0.001	<0.001
Sugar & sweetener (g/1000kcal)	5.3	*4.0*	5.8	*4.2*	5.7	*4.1*	5.9	*4.0*	5.9	*4.1*	0.007	0.007
Sweet & snacks (g/1000kcal)	5.8	*6.7*	6.0	*6.1*	6.3	*7.0*	6.7	*7.5*	6.9	*8.4*	0.004	0.005
Fats & Oils (g/1000kcal)	7.9	*5.1*	7.6	*4.4*	7.1	*4.1*	6.9	*3.9*	6.0	*4.0*	<0.001	<0.001
Soy beans & product (g/1000kcal)	26.7	*19.3*	31.4	*17.6*	34.1	*19.8*	38.2	*20.9*	43.2	*23.8*	<0.001	<0.001
Fruit (g/1000kcal)	34.0	*25.0*	48.8	*27.9*	56.1	*31.8*	67.5	*35.9*	89.0	*50.2*	<0.001	<0.001
Green & yellow vegetable (g/1000kcal)	14.5	*9.9*	19.5	*11.4*	23.1	*12.7*	26.5	*15.4*	35.5	*22.2*	<0.001	<0.001
Other vegetable (g/1000kcal)	69.7	*23.8*	84.7	*27.2*	92.3	*28.8*	108.0	*34.1*	128.7	*48.9*	<0.001	<0.001
Mushrooms (g/1000kcal)	3.2	*4.3*	3.4	*4.5*	4.1	*5.3*	4.6	*5.7*	5.5	*6.9*	<0.001	<0.001
Sea algae (g/1000kcal)	1.5	*1.5*	1.9	*2.1*	2.4	*2.5*	3.1	*3.5*	4.6	*5.4*	<0.001	<0.001
Condiment & beverage (g/1000kcal)	84.7	*88.2*	75.6	*60.5*	86.5	*79.0*	81.9	*68.9*	82.7	*76.7*	0.025	0.835
Fish & shellfish (g/1000kcal)	42.2	*20.1*	46.2	*21.4*	51.8	*22.6*	56.3	*23.8*	65.0	*31.6*	<0.001	<0.001
Meat (g/1000kcal)	30.4	*15.8*	30.6	*15.7*	30.2	*16.6*	28.5	*15.7*	27.7	*18.3*	<0.001	0.014
Egg (g/1000kcal)	16.1	*9.3*	17.5	*9.2*	17.1	*9.0*	17.4	*9.3*	17.8	*11.0*	0.002	0.017
Milk & dairy (g/1000kcal)	21.7	*19.8*	27.4	*21.6*	30.7	*21.5*	33.4	*25.8*	38.5	*31.5*	<0.001	<0.001
Other food (g/1000kcal)	2.7	*5.8*	3.1	*6.9*	2.7	*5.5*	2.8	*6.0*	2.7	*9.7*	0.709	0.952

P diff values obtained by ANOVA statistics. P trend obtained by contrast statement of analysis of variance.

表2. Nutrient intakes of different food group according to quintiles of dietary potassium intake for women: NIPPON DATA80

Range	Potassium intake quintiles (mg/1000kcal)										p diff	p trend
	481-1211		1212-1348		1349-1484		1485-1648		1649-2847			
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*		
N	1168		1170		1165		1168		1166			
Cereals (g/1000kcal)	171.7	*29.1*	159.8	*26.6*	154.4	*26.6*	149.0	*26.1*	137.5	*29.2*	<0.001	<0.001
Rice (g/1000kcal)	117.3	*32.9*	109.3	*32.3*	110.1	*32.0*	107.8	*32.2*	101.2	*33.0*	<0.001	<0.001
Flour product (g/1000kcal)	51.8	*30.6*	49.0	*29.3*	42.8	*27.8*	40.0	*26.6*	35.4	*27.3*	<0.001	<0.001
Nuts (g/1000kcal)	0.7	*3.0*	0.7	*1.9*	0.9	*2.7*	0.9	*2.3*	1.1	*2.7*	<0.001	0.051
Potatoes (g/1000kcal)	20.5	*14.7*	27.7	*16.4*	31.7	*18.2*	37.6	*21.6*	50.1	*31.3*	<0.001	<0.001
Sugar & sweetener (g/1000kcal)	6.9	*5.2*	6.9	*4.8*	6.8	*4.7*	6.7	*4.6*	6.7	*4.7*	0.850	0.443
Sweet & snacks (g/1000kcal)	13.9	*14.4*	13.8	*13.3*	13.3	*13.2*	13.8	*13.8*	11.8	*13.5*	<0.001	0.617
Fats & Oils (g/1000kcal)	8.8	*5.3*	8.7	*5.0*	7.9	*4.3*	7.6	*4.4*	6.9	*4.5*	<0.001	<0.001
Soy beans & product (g/1000kcal)	28.8	*19.2*	33.1	*19.0*	37.3	*21.5*	40.7	*22.5*	46.9	*25.8*	<0.001	<0.001
Fruit (g/1000kcal)	60.2	*38.2*	78.3	*41.9*	94.1	*48.6*	109.6	*58.1*	138.4	*75.4*	<0.001	<0.001
Green & yellow vegetable (g/1000kcal)	18.4	*12.5*	25.1	*14.2*	29.0	*16.7*	34.6	*19.8*	46.3	*28.7*	<0.001	<0.001
Other vegetable (g/1000kcal)	78.0	*27.0*	95.5	*29.8*	106.1	*32.8*	120.8	*39.5*	147.3	*53.4*	<0.001	<0.001
Mushrooms (g/1000kcal)	3.5	*4.8*	3.8	*4.9*	4.5	*5.8*	5.4	*6.3*	6.2	*7.8*	<0.001	<0.001
Sea algae (g/1000kcal)	1.6	*1.8*	2.2	*2.3*	2.9	*3.1*	3.7	*4.3*	5.5	*6.6*	<0.001	<0.001
Condiment & beverage (g/1000kcal)	34.5	*36.7*	35.3	*44.7*	35.0	*34.0*	34.7	*32.6*	36.3	*51.0*	0.843	0.964
Fish & shellfish (g/1000kcal)	40.1	*19.5*	44.7	*20.0*	50.0	*22.4*	53.8	*23.2*	63.3	*29.7*	<0.001	<0.001
Meat (g/1000kcal)	28.3	*15.3*	28.8	*14.5*	27.8	*15.2*	27.7	*16.2*	27.0	*18.3*	0.092	0.232
Egg (g/1000kcal)	18.3	*11.1*	18.3	*9.4*	18.3	*9.8*	18.5	*10.0*	18.5	*11.1*	0.927	0.535
Milk & dairy (g/1000kcal)	35.6	*27.1*	45.6	*31.3*	48.4	*34.0*	50.2	*38.1*	57.4	*47.0*	<0.001	<0.001
Other food (g/1000kcal)	3.4	*7.2*	3.3	*6.5*	3.1	*6.7*	3.0	*6.3*	3.0	*8.2*	0.660	0.222

P diff values obtained by ANOVA statistics. P trend obtained by contrast statement of analysis of variance.

表 3. Nutrient intakes of different food group according to quintiles of dietary potassium intake for men: NIPPON DATA90

Range	Potassium intake quintiles (mg/1000kcal)										p diff	p trend
	534-1091		1091-1230		1230-1356		1356-1518		1518-2999			
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*		
N	697		698		698		698		697			
Cereals (g/1000kcal)	160.9	*28.5*	149.9	*24.2*	147.2	*27.1*	141.6	*26.2*	134.2	*28.4*	<0.001	<0.001
Rice (g/1000kcal)	122.5	*32.5*	116.1	*29.2*	111.3	*28.3*	107.9	*29.9*	102.5	*30.8*	<0.001	<0.001
Flour product (g/1000kcal)	40.1	*26.4*	35.7	*21.7*	36.9	*26.0*	34.3	*24.2*	32.4	*25.0*	<0.001	<0.001
Nuts (g/1000kcal)	0.3	*1.2*	0.5	*1.5*	0.7	*2.0*	0.7	*1.5*	1.1	*2.4*	<0.001	<0.001
Potatoes (g/1000kcal)	19.7	*12.1*	24.7	*14.4*	28.0	*14.7*	34.3	*18.2*	41.3	*23.2*	<0.001	<0.001
Sugar & sweetener (g/1000kcal)	4.8	*3.7*	5.3	*3.5*	5.3	*3.9*	5.3	*3.8*	5.6	*3.9*	0.007	0.025
Sweet & snacks (g/1000kcal)	5.0	*6.4*	5.8	*7.0*	5.9	*7.8*	6.4	*8.0*	5.7	*8.2*	0.014	0.001
Fats & Oils (g/1000kcal)	8.5	*4.6*	7.7	*3.7*	7.6	*3.8*	7.2	*3.8*	6.4	*3.6*	<0.001	<0.001
Soy beans & product (g/1000kcal)	28.6	*18.1*	34.6	*20.9*	36.5	*20.6*	41.0	*20.7*	47.2	*24.1*	<0.001	<0.001
Fruit (g/1000kcal)	29.7	*26.3*	44.5	*35.0*	52.2	*36.7*	61.7	*39.6*	76.8	*46.8*	<0.001	<0.001
Green & yellow vegetable (g/1000kcal)	21.6	*12.0*	29.3	*14.4*	36.5	*17.1*	43.1	*19.6*	58.7	*30.3*	<0.001	<0.001
Other vegetable (g/1000kcal)	61.0	*23.2*	74.1	*24.8*	82.2	*29.2*	93.2	*33.0*	105.0	*40.6*	<0.001	<0.001
Mushrooms (g/1000kcal)	3.7	*4.5*	4.5	*5.2*	5.4	*5.6*	6.0	*6.4*	7.4	*8.6*	<0.001	<0.001
Sea algae (g/1000kcal)	2.1	*4.0*	2.4	*2.6*	3.0	*3.7*	3.6	*3.7*	5.4	*5.8*	<0.001	<0.001
Condiment & beverage (g/1000kcal)	119.5	*111.6*	118.3	*98.0*	98.9	*76.8*	100.4	*89.9*	84.4	*77.1*	<0.001	<0.001
Fish & shellfish (g/1000kcal)	47.0	*23.3*	52.0	*22.9*	54.5	*23.1*	58.6	*25.1*	62.8	*26.0*	<0.001	<0.001
Meat (g/1000kcal)	31.7	*16.5*	32.2	*16.1*	31.4	*15.1*	29.4	*16.5*	27.3	*15.8*	<0.001	0.004
Egg (g/1000kcal)	20.1	*9.8*	19.6	*9.5*	19.4	*9.1*	19.9	*10.2*	19.5	*9.9*	0.595	0.664
Milk & dairy (g/1000kcal)	25.0	*22.6*	34.0	*25.6*	39.2	*28.3*	42.9	*32.1*	58.5	*47.6*	<0.001	<0.001
Other food (g/1000kcal)	2.2	*3.5*	1.9	*3.0*	2.2	*3.9*	1.5	*2.6*	1.4	*2.5*	<0.001	0.003

P diff values obtained by ANOVA statistics. P trend obtained by contrast statement of analysis of variance.

表 4. Nutrient intakes of different food group according to quintiles of dietary potassium intake for women: NIPPON DATA90

Range	Potassium intake quintiles (mg/1000kcal)										p diff	p trend
	583-1232		1233-1350		1381-1526		1527-1413		1714-3407			
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*		
N	970		971		971		971		971			
Cereals (g/1000kcal)	154.4	*28.2*	147.4	*29.1*	141.4	*24.6*	135.7	*25.0*	128.8	*28.5*	<0.001	<0.001
Rice (g/1000kcal)	103.6	*30.8*	101.4	*30.9*	97.4	*27.9*	96.1	*28.1*	91.3	*29.6*	<0.001	<0.001
Flour product (g/1000kcal)	48.3	*29.0*	44.2	*26.4*	42.6	*25.9*	37.7	*24.9*	36.4	*27.2*	<0.001	<0.001
Nuts (g/1000kcal)	0.5	*1.5*	0.7	*2.0*	0.7	*1.9*	1.0	*2.4*	1.3	*2.8*	<0.001	<0.001
Potatoes (g/1000kcal)	23.8	*14.8*	30.5	*17.4*	34.1	*18.6*	39.7	*22.1*	50.1	*28.1*	<0.001	<0.001
Sugar & sweetener (g/1000kcal)	5.9	*4.2*	6.3	*4.5*	6.4	*4.4*	6.4	*4.8*	6.5	*4.6*	0.029	0.013
Sweet & snacks (g/1000kcal)	11.8	*13.6*	12.2	*13.3*	12.2	*13.5*	11.6	*13.6*	10.6	*13.5*	0.057	0.793
Fats & Oils (g/1000kcal)	9.8	*5.2*	8.8	*4.2*	8.5	*4.0*	7.9	*4.1*	7.3	*4.1*	<0.001	<0.001
Soy beans & product (g/1000kcal)	31.2	*19.6*	35.1	*20.4*	38.9	*20.2*	43.9	*23.0*	49.1	*26.8*	<0.001	<0.001
Fruit (g/1000kcal)	48.3	*35.6*	68.3	*45.7*	81.3	*50.2*	98.6	*58.5*	115.8	*66.3*	<0.001	<0.001
Green & yellow vegetable (g/1000kcal)	28.0	*15.1*	36.6	*18.3*	44.6	*21.2*	54.0	*24.0*	73.4	*36.0*	<0.001	<0.001
Other vegetable (g/1000kcal)	70.6	*27.2*	84.4	*29.6*	92.5	*32.3*	104.6	*37.6*	118.6	*46.2*	<0.001	<0.001
Mushrooms (g/1000kcal)	4.4	*6.2*	5.2	*5.9*	6.1	*6.2*	6.7	*7.2*	8.4	*9.6*	<0.001	<0.001
Sea algae (g/1000kcal)	2.3	*4.2*	3.0	*3.6*	3.6	*4.2*	4.2	*4.3*	6.6	*7.0*	<0.001	<0.001
Condiment & beverage (g/1000kcal)	49.5	*51.2*	46.8	*36.5*	45.9	*40.0*	41.9	*37.3*	39.6	*34.2*	<0.001	<0.001
Fish & shellfish (g/1000kcal)	44.3	*19.3*	48.5	*20.8*	54.1	*22.4*	56.2	*24.2*	61.5	*25.2*	<0.001	<0.001
Meat (g/1000kcal)	31.2	*15.7*	30.4	*15.4*	29.9	*15.3*	28.2	*15.7*	26.7	*16.0*	<0.001	<0.001
Egg (g/1000kcal)	21.7	*10.5*	21.2	*10.6*	21.1	*10.2*	20.8	*10.8*	20.6	*10.2*	<0.001	<0.001
Milk & dairy (g/1000kcal)	41.9	*34.1*	52.9	*38.5*	59.1	*41.3*	65.3	*48.4*	78.1	*55.6*	0.219	0.071
Other food (g/1000kcal)	2.6	*4.0*	2.5	*4.0*	2.1	*3.8*	2.0	*3.5*	1.7	*3.0*	<0.001	<0.001

P diff values obtained by ANOVA statistics. P trend obtained by contrast statement of analysis of variance.

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Dietary Intake of Potassium and Associated Dietary Factors among Representative Samples of Japanese General Population: NIPPON DATA 80/90

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ABSTRACT

Objective: The purpose of this study was to investigate the dietary potassium intake and associated other dietary factors among a representative sample cohort of Japanese population.

Methods: We obtained data from NIPPON DATA80 and 90 that were conducted with the National Nutrition Surveys in 1980 and in 1990. Then we estimated nutrient and food intakes of individuals in the National Nutrition Survey of 1980 and that of 1990, which were adjusted on the basis of data of the National Nutrition Survey of 1995. We analyzed data for 10 422 participants (4585 men and 5837 women) in NIPPON DATA80 and 8342 participants (3488 men and 4854 women) in NIPPON DATA90 having dietary potassium intake information.

Results: In NIPPON DATA80 and 90 it was observed that there was a significant relationship between the dietary potassium intake and age for both men and women. Higher potassium intake was associated with higher age, intake of protein, iron, calcium, sodium, vitamins, and fiber. Regarding food groups, lower amount of dietary cereals, rice, flour, fats and oils were associated with higher dietary potassium for both men and women. On the other hand, higher intake of nuts, potatoes, soy beans, fruits, vegetables, mushrooms, sea algae, fish and shellfish were associated with higher dietary potassium.

Conclusions: We obtained the mean dietary potassium intake and its association with other dietary nutrient intake in Japanese adults as the baseline data in NIPPON DATA80 and in NIPPON DATA90.

Key words: nutrition; diet; potassium; mean intake; daily intake; density intake; population

INTRODUCTION

Adequate dietary potassium intake exerts a blood pressure lowering effect and is associated with a decreased risk of cardiovascular disease.[1,2] The beneficial effects of potassium intake also include decreased risk bone demineralization and kidney stones.[3] Most guidelines on the prevention of chronic diseases and the management of hypertension emphasize the necessity to increase the consumption of potassium-rich foods.[4–6] However, little information is available on the dietary potassium intake pattern and its different correlates among Japanese general population. Accumulation of reliable data obtained from cohort studies in Japan, with the highest longevity of the world, using representative population groups is needed to establish strategies in Japan for health promotion and prevention of lifestyle-related diseases that take into account the differences between dietary habits and prevalence of diseases in Japan and other countries.

The National Nutritional Survey (NNS) is household-based food consumption survey with the purposes of obtaining information on the nutritional health, actual food consumption and food requirements in Japan.[7] Two cohort studies based on the National Survey on Circulatory Disorders in 1980 and 1990,[8] using the majority of the participants for NNS, have been named as the National Integrated Project for Prospective Observation of Non-communicable Disease and Its Trends in the Aged (NIPPON DATA80 and NIPPON DATA90). Data linkage was performed between NNS and NIPPON DATA with the objective to investigate fundamental data in relation between the dietary nutritional intake and the health.

The purpose of this study was to investigate the dietary potassium intake and associated dietary factors utilizing the aforementioned pooled data which is a representative sample cohort of the Japanese general population.

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PARTICIPANTS AND METHODS

National nutritional survey

Food intake survey by weighed food records in three consecutive representative days were conducted by specially trained dietary interviewers. These surveys were performed for all household members from randomly selected 300 survey districts throughout Japan. Dietary interviewers visited participants' houses at least once during the survey. Weekends and holydays were avoided. In the NNS before 1994, nutrient and food intakes per capita were calculated by dividing the amount of food intake by the number of household members. However, since 1995, nutrient and food intakes of individual household members have been calculated by proportional division method for one day, in which the amount of food intake is proportionally divided by the consumption rate of each household member. Average intakes by gender and age class could be calculated by this method. The average intakes in NNS of 1995 were calculated by a combination method of household-based food weighing record and an approximation of proportions by which family members shared each dish or food in the household. In this study, we estimated nutrient and food intakes of individuals in the NNS of 1980 (NNS-80) and that of 1990 (NNS-90), which were adjusted on the basis of data of the NNS of 1995. We estimated nutrient intakes of each household member by dividing household intake data of NNS-80 and -90 proportionally using average intakes by sex and age groups calculated for NNS of 1995.[9] For each person, means of the estimated individual nutrients from the three days records were used in the analyses. Detailed nutrient that were not included in the NNS were complemented via imputation method. Details of the nutrient intake calculation were descried elsewhere.[10]

NIPPON DATA80 and 90

Participants for the NIPPON DATA80 and NIPPON DATA90 studies were the residents aged 30 years or older in 300 census tracts, which were selected using the stratified random sampling method, based on the national census of 1975, throughout Japan. Details of these studies have been described elsewhere.[11–15] The participants for NIPPON DATA80 and 90 were those persons surveyed for the 3rd and 4th National Survey on Circulatory Disorders, conducted in 1980 and 1990, respectively. During the baseline survey, there were 10546 participants for NIPPON DATA80 and 8383 participants for NIPPON DATA90. The survey consisted of history taking, physical examinations, blood test, and a self-administered questionnaire on lifestyle, including dietary habit using the food-frequency method. Trained staff at local health centers in the respective districts performed the examinations in community centers.

Analyses

After excluding the participants who had missing data or total energy intake of less than 500 kcal or more than 5000 kcal, a remaining total of 10422 participants (men: 4585 & women: 5837) of NIPPON DATA80 and 8342 participants (men: 3488 & women: 4854) of NIPPON DATA90 with dietary potassium intake information were included in the present study. Data were analyzed in men and women separately. Potassium intake was calculated as crude intake (mg per day) and density intake (mg per 1000 kcal). Dietary potassium intake was classified into quintiles and physical, life-style, and dietary parameters were examined across the quintiles. Data are presented as means and standard deviations. Chi-squared tests were used for the categorical variables. To detect differences in continuous variables in groups, analysis of variance (ANOVA) was used. The "contrast" option for analysis of variance was used to detect deviation from linearity in the association between continuous variables and the five potassium intake groups, and trend P was obtained. All statistical analyses were performed using SAS® version 9.1 (SAS Institute, Cary, NC.).

RESULTS

For the participants of NIPPON DATA80 the mean dietary potassium intake for men and women was 3042.4 (SD 792.3) mg/day and 2768.5 (SD 736.2) mg/day, respectively. The mean dietary potassium density intake was 1274.4 (SD 239.8) mg/1000 kcal for men and 1442.8 (SD 278.3) mg/1000 kcal for women. From the data obtained from NIPPON DATA90, the estimated mean dietary potassium intake for men and women was 3033.5 (SD 804.3) mg/day and 2751.8 (SD 751.4) mg/day, respectively. The mean dietary potassium density intake was 1316.5 (SD 263.4) mg/1000 kcal for men and 1486.0 (SD 302.8) mg/1000 kcal for women.

NIPPON DATA80 participant characteristics and nutrient intakes according to quintiles of dietary potassium intake are shown in Table 1 for men and in Table 2 for women. Higher potassium intake was associated with higher age and intakes of protein, iron, calcium, sodium, and vitamins for both men and women. On the other hand, BMI and total dietary fat did not show any association with the dietary potassium.

Tables 3 and 4 shows the food group intakes according to quintiles of dietary potassium intake for men and women of NIPPON DATA80, respectively. Regarding food groups, lower intakes of dietary cereals, rice, flour, fats and oils were associated with higher dietary potassium for both men and women. On the other hand, higher intake of nuts, potatoes, soy beans, fruits, vegetables, mushrooms, sea algae, fish and shellfish were associated with higher dietary potassium.

Tables 5 and 6 shows participant characteristics and nutrient intakes according to the quintiles of dietary potassium intake for men and women from NIPPON DATA90, respectively. Higher potassium intake was associated with higher age and intake of protein intake, fiber, iron, calcium, sodium, phosphorus, magnesium, and

Table 1. Participant characteristics and nutrient intake according to quintiles of dietary potassium intake for men: NIPPON DATA80

Range	Potassium intake quintiles (mg/1000 kcal)										*P* diff	*P* trend
	548–1079		1080–1195		1196–1310		1311–1452		1453–2433			
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*		
n	920		915		913		921		916			
Age (year)	45.4	*12.1*	46.8	*12.2*	49.0	*13.0*	52.4	*13.3*	56.1	*13.4*	<0.001	<0.001
BMI (kg/m^2)	22.4	*2.8*	22.4	*2.9*	22.5	*2.9*	22.5	*2.9*	22.7	*2.9*	0.215	0.593
Current smoking (%)	69.2		66.2		60.5		61.7		57.4		<0.001	
Current drinking (%)	78.9		75.1		75.5		72.5		69.2		<0.001	
Total energy (kcal)	2474.6	*556.7*	2458.7	*488.7*	2416.5	*451.1*	2374.1	*462.9*	2282.3	*521.2*	<0.001	<0.001
Carbohydrate (%kcal)	60.3	*6.4*	59.8	*6.1*	59.5	*6.3*	59.5	*6.2*	59.6	*7.2*	0.021	0.003
Protein (%kcal)	13.6	*1.5*	14.5	*1.6*	15.0	*1.7*	15.6	*1.9*	16.7	*2.3*	<0.001	<0.001
Total fat (%kcal)	20.1	*5.7*	20.2	*5.2*	20.1	*5.0*	20.0	*4.8*	19.5	*5.2*	0.047	0.740
Animal protein (%kcal)	7.5	*1.9*	8.2	*2.1*	8.7	*2.2*	9.0	*2.4*	9.8	*3.1*	<0.001	<0.001
Vegetable protein (%kcal)	6.9	*0.9*	7.1	*0.9*	7.2	*0.9*	7.4	*0.9*	7.8	*1.1*	0.027	0.028
SFA (%kcal)	5.5	*1.5*	5.8	*1.5*	5.7	*1.4*	5.7	*1.4*	5.6	*1.5*	0.007	0.124
MUFA (%kcal)	7.5	*2.1*	7.6	*1.9*	7.5	*1.9*	7.4	*1.8*	7.2	*2.0*	0.002	0.339
PUFA (%kcal)	5.2	*1.6*	5.3	*1.3*	5.3	*1.3*	5.3	*1.3*	5.3	*1.4*	0.870	0.540
Iron (mg/1000 kcal)	5.2	*0.7*	5.8	*0.7*	6.2	*0.8*	6.7	*0.9*	7.5	*1.2*	<0.001	<0.001
Calcium (mg/1000 kcal)	172.7	*40.0*	204.6	*38.2*	225.1	*37.0*	249.7	*42.4*	294.8	*59.2*	<0.001	<0.001
Sodium (mg/1000 kcal)	2019.5	*624.1*	2278.7	*635.1*	2447.0	*674.9*	2672.1	*728.7*	3035.0	*1023.1*	<0.001	<0.001
Vitamin A (IU/1000 kcal)	508.1	*191.1*	637.7	*211.6*	714.2	*236.3*	789.3	*277.9*	983.8	*399.8*	<0.001	<0.001
Vitamin B1 (mg/1000 kcal)	0.4	*0.1*	0.5	*0.2*	0.5	*0.2*	0.5	*0.2*	0.5	*0.2*	<0.001	<0.001
Vitamin B2 (mg/1000 kcal)	0.4	*0.1*	0.5	*0.1*	0.5	*0.1*	0.6	*0.1*	0.6	*0.2*	<0.001	<0.001
Vitamin C (mg/1000 kcal)	29.9	*9.7*	39.1	*10.0*	44.6	*11.7*	52.1	*13.7*	65.9	*20.2*	<0.001	<0.001

P diff values obtained by ANOVA or Chi square statistics. *P* trend obtained by contrast statement of analysis of variance. BMI, body mass index; SFA, saturated fatty acid; MUFA, mono unsaturated fatty acid; PUFA, poly unsaturated fatty acid.

Table 2. Participant characteristics and nutrient intake according to quintiles of dietary potassium intake for women: NIPPON DATA80

Range	Potassium intake quintiles (mg/1000 kcal)										*P* diff	*P* trend
	481–1211		1212–1348		1349–1484		1485–1648		1649–2847			
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*		
n	1168		1170		1165		1168		1166			
Age (year)	44.3	*12.3*	46.3	*13.0*	50.0	*13.2*	53.0	*12.9*	56.7	*12.1*	<0.001	<0.001
BMI (kg/m^2)	22.7	*3.4*	22.7	*3.3*	22.7	*3.4*	22.9	*3.3*	23.2	*3.4*	0.001	0.074
Current smoking (%)	11.8		11.0		8.6		8.8		8.8		0.019	
Current drinking (%)	24.7		22.6		18.6		17.4		18.4		<0.001	
Total energy (kcal)	1987.3	*428.7*	1956.5	*373.5*	1944.5	*371.2*	1910.8	*389.5*	1848.20	*431.5*	<0.001	<0.001
Carbohydrate (%kcal)	62.5	*6.8*	61.7	*6.6*	62.1	*6.6*	62.2	*6.7*	61.8	*7.3*	0.033	0.555
Protein (%kcal)	14.0	*1.5*	14.8	*1.6*	15.4	*1.7*	15.9	*1.9*	17.2	*2.3*	<0.001	<0.001
Total fat (%kcal)	21.9	*6.2*	22.3	*5.8*	21.7	*5.5*	21.5	*5.5*	21.2	*5.8*	<0.001	0.022
Animal protein (%kcal)	7.7	*1.9*	8.4	*2.0*	8.8	*2.2*	9.2	*2.4*	10.1	*3.0*	<0.001	<0.001
Vegetable protein (%kcal)	7.1	*0.9*	7.2	*0.9*	7.4	*0.9*	7.6	*0.9*	8.0	*1.1*	<0.001	0.007
SFA (%kcal)	6.1	*1.7*	6.4	*1.6*	6.2	*1.6*	6.1	*1.6*	6.1	*1.7*	<0.001	0.392
MUFA (%kcal)	8.2	*2.3*	8.3	*2.2*	8.1	*2.0*	8.0	*2.1*	7.9	*2.2*	<0.001	0.007
PUFA (%kcal)	5.7	*1.6*	5.8	*1.5*	5.7	*1.4*	5.7	*1.5*	5.8	*1.6*	0.444	0.409
Iron (mg/1000 kcal)	5.9	*0.8*	6.5	*0.9*	6.9	*0.9*	7.4	*1.0*	8.4	*1.3*	<0.001	<0.001
Calcium (mg/1000 kcal)	209.4	*40.7*	248.1	*42.5*	271.9	*46.4*	297.4	*50.8*	352.8	*70.6*	<0.001	<0.001
Sodium (mg/1000 kcal)	2171.7	*618.8*	2449.6	*696.9*	2630.9	*709.4*	2802.1	*745.8*	3269.3	*1055.6*	<0.001	<0.001
Vitamin A (IU/1000 kcal)	606.0	*229.8*	749.7	*251.0*	828.8	*293.2*	931.9	*322.2*	1168.3	*491.0*	<0.001	<0.001
Vitamin B1 (mg/1000 kcal)	0.5	*0.2*	0.6	*0.2*	0.6	*0.2*	0.6	*0.2*	0.7	*0.2*	<0.001	<0.001
Vitamin B2 (mg/1000 kcal)	0.3	*0.1*	0.3	*0.1*	0.4	*0.1*	0.4	*0.1*	0.5	*0.1*	<0.001	<0.001
Vitamin C (mg/1000 kcal)	39.8	*12.5*	50.9	*12.6*	59.1	*15.2*	68.5	*17.1*	88.2	*26.8*	<0.001	<0.001

P diff values obtained by ANOVA or Chi square statistics. *P* trend obtained by contrast statement of analysis of variance. BMI, body mass index; SFA, saturated fatty acid; MUFA, mono unsaturated fatty acid; PUFA, poly unsaturated fatty acid.

Table 3. Nutrient intakes of different food group according to quintiles of dietary potassium intake for men: NIPPON DATA80

Range	Potassium intake quintiles (mg/1000 kcal)										*P* diff	*P* trend
	548–1079		1080–1195		1196–1310		1311–1452		1453–2433			
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*		
n	920		915		913		921		916			
Cereals (g/1000 kcal)	178.7	*30.5*	166.4	*27.0*	160.0	*26.3*	153.2	*26.2*	142.6	*30.2*	<0.001	<0.001
Rice (g/1000 kcal)	139.3	*35.8*	129.2	*32.6*	126.1	*33.5*	123.0	*31.9*	114.2	*34.4*	<0.001	<0.001
Flour product (g/1000 kcal)	42.1	*28.4*	39.8	*24.3*	36.6	*24.3*	33.2	*22.9*	30.3	*23.6*	<0.001	<0.001
Nuts (g/1000 kcal)	0.3	*1.0*	0.6	*1.8*	0.6	*2.2*	0.6	*1.5*	0.7	*1.7*	0.009	<0.001
Potatoes (g/1000 kcal)	16.2	*12.7*	23.2	*13.8*	26.6	*14.9*	31.1	*17.6*	41.3	*25.0*	<0.001	<0.001
Sugar & sweetener (g/1000 kcal)	5.3	*4.0*	5.8	*4.2*	5.7	*4.1*	5.9	*4.0*	5.9	*4.1*	0.007	0.007
Sweet & snacks (g/1000 kcal)	5.8	*6.7*	6.0	*6.1*	6.3	*7.0*	6.7	*7.5*	6.9	*8.4*	0.004	0.005
Fats & Oils (g/1000 kcal)	7.9	*5.1*	7.6	*4.4*	7.1	*4.1*	6.9	*3.9*	6.0	*4.0*	<0.001	<0.001
Soy beans and product (g/1000 kcal)	26.7	*19.3*	31.4	*17.6*	34.1	*19.8*	38.2	*20.9*	43.2	*23.8*	<0.001	<0.001
Fruit (g/1000 kcal)	34.0	*25.0*	48.8	*27.9*	56.1	*31.8*	67.5	*35.9*	89.0	*50.2*	<0.001	<0.001
Green & yellow vegetable (g/1000 kcal)	14.5	*9.9*	19.5	*11.4*	23.1	*12.7*	26.5	*15.4*	35.5	*22.2*	<0.001	<0.001
Other vegetable (g/1000 kcal)	69.7	*23.8*	84.7	*27.2*	92.3	*28.8*	108.0	*34.1*	128.7	*48.9*	<0.001	<0.001
Mushrooms (g/1000 kcal)	3.2	*4.3*	3.4	*4.5*	4.1	*5.3*	4.6	*5.7*	5.5	*6.9*	<0.001	<0.001
Sea algae (g/1000 kcal)	1.5	*1.5*	1.9	*2.1*	2.4	*2.5*	3.1	*3.5*	4.6	*5.4*	<0.001	<0.001
Condiment & beverage (g/1000 kcal)	84.7	*88.2*	75.6	*60.5*	86.5	*79.0*	81.9	*68.9*	82.7	*76.7*	0.025	0.835
Fish & shellfish (g/1000 kcal)	42.2	*20.1*	46.2	*21.4*	51.8	*22.6*	56.3	*23.8*	65.0	*31.6*	<0.001	<0.001
Meat (g/1000 kcal)	30.4	*15.8*	30.6	*15.7*	30.2	*16.6*	28.5	*15.7*	27.7	*18.3*	<0.001	0.014
Egg (g/1000 kcal)	16.1	*9.3*	17.5	*9.2*	17.1	*9.0*	17.4	*9.3*	17.8	*11.0*	0.002	0.017
Milk & dairy (g/1000 kcal)	21.7	*19.8*	27.4	*21.6*	30.7	*21.5*	33.4	*25.8*	38.5	*31.5*	<0.001	<0.001
Other food (g/1000 kcal)	2.7	*5.8*	3.1	*6.9*	2.7	*5.5*	2.8	*6.0*	2.7	*9.7*	0.709	0.952

P diff values obtained by ANOVA statistics. *P* trend obtained by contrast statement of analysis of variance.

Table 4. Nutrient intakes of different food group according to quintiles of dietary potassium intake for women: NIPPON DATA80

Range	Potassium intake quintiles (mg/1000 kcal)										*P* diff	*P* trend
	481–1211		1212–1348		1349–1484		1485–1648		1649–2847			
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*		
n	1168		1170		1165		1168		1166			
Cereals (g/1000 kcal)	171.7	*29.1*	159.8	*26.6*	154.4	*26.6*	149.0	*26.1*	137.5	*29.2*	<0.001	<0.001
Rice (g/1000 kcal)	117.3	*32.9*	109.3	*32.3*	110.1	*32.0*	107.8	*32.2*	101.2	*33.0*	<0.001	<0.001
Flour product (g/1000 kcal)	51.8	*30.6*	49.0	*29.3*	42.8	*27.8*	40.0	*26.6*	35.4	*27.3*	<0.001	<0.001
Nuts (g/1000 kcal)	0.7	*3.0*	0.7	*1.9*	0.9	*2.7*	0.9	*2.3*	1.1	*2.7*	<0.001	0.051
Potatoes (g/1000 kcal)	20.5	*14.7*	27.7	*16.4*	31.7	*18.2*	37.6	*21.6*	50.1	*31.3*	<0.001	<0.001
Sugar & sweetener (g/1000 kcal)	6.9	*5.2*	6.9	*4.8*	6.8	*4.7*	6.7	*4.6*	6.7	*4.7*	0.850	0.443
Sweet & snacks (g/1000 kcal)	13.9	*14.4*	13.8	*13.3*	13.3	*13.2*	13.8	*13.8*	11.8	*13.5*	<0.001	0.617
Fats & Oils (g/1000 kcal)	8.8	*5.3*	8.7	*5.0*	7.9	*4.3*	7.6	*4.4*	6.9	*4.5*	<0.001	<0.001
Soy beans and product (g/1000 kcal)	28.8	*19.2*	33.1	*19.0*	37.3	*21.5*	40.7	*22.5*	46.9	*25.8*	<0.001	<0.001
Fruit (g/1000 kcal)	60.2	*38.2*	78.3	*41.9*	94.1	*48.6*	109.6	*58.1*	138.4	*75.4*	<0.001	<0.001
Green & yellow vegetable (g/1000 kcal)	18.4	*12.5*	25.1	*14.2*	29.0	*16.7*	34.6	*19.8*	46.3	*28.7*	<0.001	<0.001
Other vegetable (g/1000 kcal)	78.0	*27.0*	95.5	*29.8*	106.1	*32.8*	120.8	*39.5*	147.3	*53.4*	<0.001	<0.001
Mushrooms (g/1000 kcal)	3.5	*4.8*	3.8	*4.9*	4.5	*5.8*	5.4	*6.3*	6.2	*7.8*	<0.001	<0.001
Sea algae (g/1000 kcal)	1.6	*1.8*	2.2	*2.3*	2.9	*3.1*	3.7	*4.3*	5.5	*6.6*	<0.001	<0.001
Condiment & beverage (g/1000 kcal)	34.5	*36.7*	35.3	*44.7*	35.0	*34.0*	34.7	*32.6*	36.3	*51.0*	0.843	0.964
Fish & shellfish (g/1000 kcal)	40.1	*19.5*	44.7	*20.0*	50.0	*22.4*	53.8	*23.2*	63.3	*29.7*	<0.001	<0.001
Meat (g/1000 kcal)	28.3	*15.3*	28.8	*14.5*	27.8	*15.2*	27.7	*16.2*	27.0	*18.3*	0.092	0.232
Egg (g/1000 kcal)	18.3	*11.1*	18.3	*9.4*	18.3	*9.8*	18.5	*10.0*	18.5	*11.1*	0.927	0.535
Milk & dairy (g/1000 kcal)	35.6	*27.1*	45.6	*31.3*	48.4	*34.0*	50.2	*38.1*	57.4	*47.0*	<0.001	<0.001
Other food (g/1000 kcal)	3.4	*7.2*	3.3	*6.5*	3.1	*6.7*	3.0	*6.3*	3.0	*8.2*	0.660	0.222

P diff values obtained by ANOVA statistics. *P* trend obtained by contrast statement of analysis of variance.

vitamins for both men and women. Intake of fats did not show any association with the dietary potassium. Table 7 and Table 8 show the food groups according to quintiles of dietary potassium intake for men and women of NIPPON DATA90 cohort, respectively. Regarding food groups, lower amount of dietary cereals, rice, flour, fats and oils were associated with higher dietary potassium for both men and women. On the other hand, higher intake of nuts, potatoes, soy beans, fruits, vegetables, sea algae, milk and dairy, and fish and shellfish were associated with higher dietary potassium.

Table 5. Participant characteristics and nutrient intake according to quintiles of dietary potassium intake for men: NIPPON DATA90

Range	Potassium intake quintiles (mg/1000 kcal)										*P* diff	*P* trend
	533.6–1090.7		1090.8–1229.8		1229.9–1356.1		1356.2–1518.3		1518.4–2999.7			
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*		
n	697		698		698		698		697			
Age (year)	47.1	*12.4*	50.7	*12.5*	51.9	*13.7*	55.9	*13.5*	60.8	*12.3*	<0.001	<0.001
BMI (kg/m^2)	22.8	*3.0*	23.0	*2.9*	22.9	*3.0*	22.9	*3.1*	23.0	*3.1*	0.653	0.610
Current smoking (%)	67.3		59.3		54.7		49.0		42.6		<0.001	
Current drinking (%)	59.0		61.6		55.3		58.2		52.1		0.004	
Total energy (kcal)	2366.4	*483.5*	2364.4	*434.6*	2326.4	*460.4*	2304.3	*448.8*	2218.0	*463.5*	<0.001	0.004
Total carbohydrate (%kcal)	56.3	*5.8*	56.3	*5.4*	56.6	*5.6*	56.9	*5.9*	57.4	*6.1*	0.003	0.049
Dietary fiber (g/1000 kcal)	5.2	*1.0*	6.1	*1.0*	6.9	*1.2*	7.7	*1.4*	9.3	*2.0*	<0.001	<0.001
Protein (%kcal)	14.4	*1.7*	15.1	*1.6*	15.5	*1.6*	16.0	*1.8*	16.8	*2.0*	<0.001	<0.001
Animal protein (%kcal)	8.6	*2.0*	9.2	*2.1*	9.5	*2.0*	9.6	*2.3*	10.0	*2.4*	<0.001	<0.001
Vegetable protein (%kcal)	6.7	*0.8*	6.9	*0.9*	7.1	*0.9*	7.3	*0.9*	7.6	*1.0*	<0.001	<0.001
Total fat (%kcal)	22.6	*4.7*	22.5	*4.4*	22.5	*4.3*	22.2	*4.4*	21.8	*4.6*	0.002	0.068
Animal fat (%kcal)	10.6	*3.1*	10.9	*3.3*	11.0	*3.1*	10.8	*3.3*	11.0	*3.4*	0.069	0.236
Vegetable fat (%kcal)	12.1	*3.7*	11.6	*3.1*	11.6	*3.0*	11.4	*3.0*	10.8	*3.1*	<0.001	<0.001
Dietary cholesterol (mg/1000 kcal)	180.7	*53.5*	180.4	*49.7*	183.6	*50.2*	185.7	*56.7*	188.9	*56.1*	0.014	0.042
SFA (%kcal)	5.8	*1.3*	6.0	*1.3*	6.0	*1.3*	5.9	*1.4*	5.9	*1.5*	0.008	0.027
MUFA (%kcal)	8.1	*1.9*	8.0	*1.7*	8.0	*1.7*	7.8	*1.8*	7.6	*1.8*	<0.001	0.039
PUFA (%kcal)	5.6	*1.4*	5.5	*1.2*	5.6	*1.2*	5.6	*1.3*	5.5	*1.4*	0.539	0.843
Iron (mg/1000 kcal)	4.6	*0.8*	5.1	*0.7*	5.4	*0.8*	5.8	*0.8*	6.6	*1.3*	<0.001	<0.001
Calcium (mg/1000 kcal)	182.6	*46.3*	216.0	*51.8*	231.0	*50.2*	260.7	*58.2*	313.5	*80.4*	<0.001	<0.001
Magnesium (mg/1000 kcal)	112.7	*20.9*	127.3	*24.1*	131.7	*21.3*	143.3	*23.5*	161.8	*31.4*	<0.001	<0.001
Sodium (mg/1000 kcal)	2231.2	*580.8*	2391.0	*573.3*	2531.5	*726.0*	2626.7	*708.4*	2751.3	*747.9*	<0.001	<0.001
Phosphorus (mg/1000 kcal)	520.2	*51.8*	555.1	*53.5*	574.3	*50.1*	600.6	*56.5*	644.4	*66.9*	<0.001	<0.001
Vitamin A (IU/1000 kcal)	880.6	*842.6*	1102.5	*1009.7*	1275.2	*1170.9*	1369.9	*1133.0*	1644.4	*1625.1*	<0.001	<0.001
Vitamin B1 (mg/1000 kcal)	0.5	*0.2*	0.6	*0.2*	0.6	*0.2*	0.6	*0.2*	0.6	*0.2*	<0.001	<0.001
Vitamin B2 (mg/1000 kcal)	0.5	*0.1*	0.6	*0.1*	0.6	*0.1*	0.6	*0.1*	0.7	*0.2*	<0.001	<0.001
Niacin (mg/1000 kcal)	7.7	*1.5*	8.2	*1.5*	8.5	*1.4*	8.8	*1.8*	9.3	*2.0*	<0.001	<0.001
Vitamin C (mg/1000 kcal)	36.2	*22.9*	46.9	*18.9*	53.1	*17.2*	62.3	*18.4*	77.7	*30.7*	<0.001	<0.001
Vitamin D (mg/1000 kcal)	46.0	*52.6*	56.3	*55.7*	54.4	*47.0*	60.6	*54.6*	70.5	*59.0*	<0.001	<0.001
Vitamin E (mg/1000 kcal)	3.9	*0.8*	4.1	*0.8*	4.3	*0.8*	4.5	*0.9*	4.8	*1.0*	<0.001	<0.001

P diff values obtained by ANOVA or Chi square statistics. *P* trend obtained by contrast statement of analysis of variance. BMI, body mass index; SFA, saturated fatty acid; MUFA, mono unsaturated fatty acid; PUFA, poly unsaturated fatty acid.

Table 9 shows the potassium and other nutrients intake by age-group for men and women in cohorts of NIPPON DATA80 and 90, respectively. The dietary potassium intake and major food group intakes were significantly associated with age (all *P*s < 0.001). Similar was also observed for the men and women participants of NIPPON DATA90 (Table 10).

DISCUSSIONS

This cross-sectional study was initiated to describe the dietary potassium intake and its relation with other dietary factors and clinical characteristics among a representative sample cohort of Japanese population. We found significant relationship between the age and the dietary potassium intake. For both men and women, older aged people had higher potassium. Dietary intake of fruits, vegetables, milk and dairy products were associated with potassium intake where as fat intake did not show any association. On the other hand, lower intake of dietary cereals, rice, flour were associated with higher dietary potassium for both men and women. Higher intake of nuts, potatoes, soy beans, mushrooms, sea algae, fish and shellfish were also associated with higher dietary potassium. Regarding minerals, significant relationship was observed to intakes of iron, calcium, sodium, phosphorus, magnesium, vitamins and dietary potassium intake for both men and women. These dietary patterns had not been highlighted adequately in prior nutrition surveys, and should be confirmed by additional analysis of NIPPON DATA and NNS or other studies. Our findings are potentially useful for the development of hypothesis in future NIPPON DATA studies to examine and interpret interactions in detail between potassium intake and other nutritional factors, food groups, risk factors, comorbidities and mortality from various cardiovascular outcomes.

Potassium, the most abundant intracellular cation, is important for membrane transport, energy metabolism, fluid balance and proper cell functioning. Potassium has a crucial role in membrane polarization and abnormal potassium homeostasis can result in disorders in cardiac, muscle and neurological function.[16,17] Available evidences from animal studies, observational epidemiological studies, clinical trials, and meta-analyses of these trials have associated potassium

Table 6. Participant characteristics and nutrient intake according to quintiles of dietary potassium intake for women: NIPPON DATA90

Range	Potassium intake quintiles (mg/1000 kcal)										P diff	P trend
	582.8–1232.4		1232.5–1380.5		1380.6–1526.4		1526.5–1713.5		1713.6–3406.6			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
n	970		971		971		971		971			
Age (year)	46.1	13.3	49.4	14.0	52.6	14.2	56.6	13.1	59.4	11.7	<0.001	<0.001
BMI (kg/m^2)	22.5	3.3	22.7	3.5	22.7	3.3	23.1	3.2	23.1	3.3	<0.001	<0.001
Current smoking (%)	15.4		10.3		7.9		7.8		5.7		<0.001	
Current drinking (%)	8.5		7.7		6.8		5.3		4.1		<0.001	
Total energy (kcal)	1908.9	379.2	1865.6	349.5	1855.9	352.3	1855.0	377.5	1808.4	367.6	<0.001	0.001
Total carbohydrate (%kcal)	58.0	6.4	58.8	5.9	58.7	5.8	59.3	5.9	59.7	6.5	<0.001	<0.001
Dietary fiber (g/1000 kcal)	6.2	1.2	7.3	1.2	8.1	1.3	9.2	1.5	11.0	2.3	<0.001	<0.001
Protein (%kcal)	14.7	1.7	15.3	1.6	16.0	1.7	16.4	1.8	17.3	2.1	<0.001	<0.001
Animal protein (%kcal)	8.9	2.0	9.3	2.1	9.8	2.1	9.9	2.3	10.3	2.5	<0.001	<0.001
Vegetable protein (%kcal)	6.9	0.9	7.1	0.8	7.2	0.9	7.5	0.9	7.8	1.0	<0.001	<0.001
Total fat (%kcal)	25.2	5.4	24.6	5.0	24.4	4.8	24.1	4.7	23.7	5.1	<0.001	<0.001
Animal fat (%kcal)	11.3	3.4	11.4	3.4	11.4	3.3	11.4	3.6	11.5	3.7	0.857	0.644
Vegetable fat (%kcal)	14.0	4.1	13.2	3.6	13.0	3.3	12.7	3.3	12.2	3.7	<0.001	<0.001
Dietary cholesterol (mg/1000 kcal)	196.6	57.0	196.2	58.5	201.6	55.1	201.1	61.2	205.0	63.5	0.005	0.026
SFA (%kcal)	6.5	1.5	6.5	1.5	6.5	1.5	6.4	1.5	6.4	1.6	0.259	0.225
MUFA (%kcal)	9.0	2.1	8.7	1.9	8.7	1.9	8.5	1.9	8.3	2.0	<0.001	<0.001
PUFA (%kcal)	6.2	1.5	6.0	1.3	6.1	1.3	6.0	1.3	6.0	1.5	0.001	0.010
Iron (mg/1000 kcal)	5.1	0.9	5.5	0.8	5.9	0.8	6.4	0.9	7.3	1.4	<0.001	<0.001
Calcium (mg/1000 kcal)	219.5	55.5	252.4	55.4	279.9	64.6	308.0	67.5	367.0	92.3	<0.001	<0.001
Magnesium (mg/1000 kcal)	120.3	22.9	133.3	22.3	141.1	23.1	151.8	26.1	173.1	36.2	<0.001	<0.001
Sodium (mg/1000 kcal)	2426.7	597.4	2601.1	699.1	2743.8	772.9	2833.3	766.3	3013.2	880.6	<0.001	<0.001
Phosphorus (mg/1000 kcal)	540.7	54.2	574.9	53.0	602.5	53.8	626.2	58.5	672.9	74.0	<0.001	<0.001
Vitamin A (IU/1000 kcal)	1081.9	1183.2	1231.0	1035.5	1375.4	1090.1	1555.4	1219.8	1929.9	1955.8	<0.001	<0.001
Vitamin B1 (mg/1000 kcal)	0.6	0.2	0.6	0.2	0.6	0.2	0.6	0.2	0.7	0.2	<0.001	<0.001
Vitamin B2 (mg/1000 kcal)	0.6	0.1	0.6	0.1	0.7	0.1	0.7	0.1	0.8	0.2	<0.001	<0.001
Niacin (mg/1000 kcal)	7.4	1.4	7.9	1.4	8.3	1.4	8.5	1.6	9.2	1.9	<0.001	<0.001
Vitamin C (mg/1000 kcal)	45.7	18.7	60.6	25.9	68.4	20.4	80.9	23.9	100.7	38.7	<0.001	<0.001
Vitamin D (mg/1000 kcal)	47.0	44.4	53.6	52.8	61.3	53.3	61.8	52.2	74.1	63.7	<0.001	<0.001
Vitamin E (mg/1000 kcal)	4.3	0.9	4.6	0.9	4.8	0.9	5.0	1.1	5.4	1.1	<0.001	<0.001

P diff values obtained by ANOVA or Chi square statistics. *P* trend obtained by contrast statement of analysis of variance. BMI, body mass index; SFA, saturated fatty acid; MUFA, mono unsaturated fatty acid; PUFA, poly unsaturated fatty acid.

Table 7. Nutrient intakes of different food group according to quintiles of dietary potassium intake for men: NIPPON DATA90

Range	Potassium intake quintiles (mg/1000 kcal)										P diff	P trend
	533.6–1090.7		1090.8–1229.8		1229.9–1356.1		1356.2–1518.3		1518.4–2999.7			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
n	697		698		698		698		697			
Cereals (g/1000 kcal)	160.9	28.5	149.9	24.2	147.2	27.1	141.6	26.2	134.2	28.4	<0.001	<0.001
Rice (g/1000 kcal)	122.5	32.5	116.1	29.2	111.3	28.3	107.9	29.9	102.5	30.8	<0.001	<0.001
Flour product (g/1000 kcal)	40.1	26.4	35.7	21.7	36.9	26.0	34.3	24.2	32.4	25.0	<0.001	<0.001
Nuts (g/1000 kcal)	0.3	1.2	0.5	1.5	0.7	2.0	0.7	1.5	1.1	2.4	<0.001	<0.001
Potatoes (g/1000 kcal)	19.7	12.1	24.7	14.4	28.0	14.7	34.3	18.2	41.3	23.2	<0.001	<0.001
Sugar & sweetener (g/1000 kcal)	4.8	3.7	5.3	3.5	5.3	3.9	5.3	3.8	5.6	3.9	0.007	0.025
Sweet & snacks (g/1000 kcal)	5.0	6.4	5.8	7.0	5.9	7.8	6.4	8.0	5.7	8.2	0.014	0.001
Fats & Oils (g/1000 kcal)	8.5	4.6	7.7	3.7	7.6	3.8	7.2	3.8	6.4	3.6	<0.001	<0.001
Soy beans and product (g/1000 kcal)	28.6	18.1	34.6	20.9	36.5	20.6	41.0	20.7	47.2	24.1	<0.001	<0.001
Fruit (g/1000 kcal)	29.7	26.3	44.5	35.0	52.2	36.7	61.7	39.6	76.8	46.8	<0.001	<0.001
Green & yellow vegetable (g/1000 kcal)	21.6	12.0	29.3	14.4	36.5	17.1	43.1	19.6	58.7	30.3	<0.001	<0.001
Other vegetable (g/1000 kcal)	61.0	23.2	74.1	24.8	82.2	29.2	93.2	33.0	105.0	40.6	<0.001	<0.001
Mushrooms (g/1000 kcal)	3.7	4.5	4.5	5.2	5.4	5.6	6.0	6.4	7.4	8.6	<0.001	<0.001
Sea algae (g/1000 kcal)	2.1	4.0	2.4	2.6	3.0	3.7	3.6	3.7	5.4	5.8	<0.001	<0.001
Condiment & beverage (g/1000 kcal)	119.5	111.6	118.3	98.0	98.9	76.8	100.4	89.9	84.4	77.1	<0.001	<0.001
Fish & shellfish (g/1000 kcal)	47.0	23.3	52.0	22.9	54.5	23.1	58.6	25.1	62.8	26.0	<0.001	<0.001
Meat (g/1000 kcal)	31.7	16.5	32.2	16.1	31.4	15.1	29.4	16.5	27.3	15.8	<0.001	0.004
Egg (g/1000 kcal)	20.1	9.8	19.6	9.5	19.4	9.1	19.9	10.2	19.5	9.9	0.595	0.664
Milk & dairy (g/1000 kcal)	25.0	22.6	34.0	25.6	39.2	28.3	42.9	32.1	58.5	47.6	<0.001	<0.001
Other food (g/1000 kcal)	2.2	3.5	1.9	3.0	2.2	3.9	1.5	2.6	1.4	2.5	<0.001	0.003

P diff values obtained by ANOVA statistics. *P* trend obtained by contrast statement of analysis of variance.

Table 8. Nutrient intakes of different food group according to quintiles of dietary potassium intake for women: NIPPON DATA90

Range	Potassium intake quintiles (mg/1000 kcal)										*P* diff	*P* trend
	582.8–1232.4		1232.5–1380.5		1380.6–1526.4		1526.5–1713.5		1713.6–3406.6			
	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*	Mean	*SD*		
n	970		971		971		971		971			
Cereals (g/1000 kcal)	154.4	*28.2*	147.4	*29.1*	141.4	*24.6*	135.7	*25.0*	128.8	*28.5*	<0.001	<0.001
Rice (g/1000 kcal)	103.6	*30.8*	101.4	*30.9*	97.4	*27.9*	96.1	*28.1*	91.3	*29.6*	<0.001	<0.001
Flour product (g/1000 kcal)	48.3	*29.0*	44.2	*26.4*	42.6	*25.9*	37.7	*24.9*	36.4	*27.2*	<0.001	<0.001
Nuts (g/1000 kcal)	0.5	*1.5*	0.7	*2.0*	0.7	*1.9*	1.0	*2.4*	1.3	*2.8*	<0.001	<0.001
Potatoes (g/1000 kcal)	23.8	*14.8*	30.5	*17.4*	34.1	*18.6*	39.7	*22.1*	50.1	*28.1*	<0.001	<0.001
Sugar & sweetener (g/1000 kcal)	5.9	*4.2*	6.3	*4.5*	6.4	*4.4*	6.4	*4.8*	6.5	*4.6*	0.029	0.013
Sweet & snacks (g/1000 kcal)	11.8	*13.6*	12.2	*13.3*	12.2	*13.5*	11.6	*13.6*	10.6	*13.5*	0.057	0.793
Fats & Oils (g/1000 kcal)	9.8	*5.2*	8.8	*4.2*	8.5	*4.0*	7.9	*4.1*	7.3	*4.1*	<0.001	<0.001
Soy beans and product (g/1000 kcal)	31.2	*19.6*	35.1	*20.4*	38.9	*20.2*	43.9	*23.0*	49.1	*26.8*	<0.001	<0.001
Fruit (g/1000 kcal)	48.3	*35.6*	68.3	*45.7*	81.3	*50.2*	98.6	*58.5*	115.8	*66.3*	<0.001	<0.001
Green & yellow vegetable (g/1000 kcal)	28.0	*15.1*	36.6	*18.3*	44.6	*21.2*	54.0	*24.0*	73.4	*36.0*	<0.001	<0.001
Other vegetable (g/1000 kcal)	70.6	*27.2*	84.4	*29.6*	92.5	*32.3*	104.6	*37.6*	118.6	*46.2*	<0.001	<0.001
Mushrooms (g/1000 kcal)	4.4	*6.2*	5.2	*5.9*	6.1	*6.2*	6.7	*7.2*	8.4	*9.6*	<0.001	<0.001
Sea algae (g/1000 kcal)	2.3	*4.2*	3.0	*3.6*	3.6	*4.2*	4.2	*4.3*	6.6	*7.0*	<0.001	<0.001
Condiment & beverage (g/1000 kcal)	49.5	*51.2*	46.8	*36.5*	45.9	*40.0*	41.9	*37.3*	39.6	*34.2*	<0.001	<0.001
Fish & shellfish (g/1000 kcal)	44.3	*19.3*	48.5	*20.8*	54.1	*22.4*	56.2	*24.2*	61.5	*25.2*	<0.001	<0.001
Meat (g/1000 kcal)	31.2	*15.7*	30.4	*15.4*	29.9	*15.3*	28.2	*15.7*	26.7	*16.0*	<0.001	<0.001
Egg (g/1000 kcal)	21.7	*10.5*	21.2	*10.6*	21.1	*10.2*	20.8	*10.8*	20.6	*10.2*	<0.001	<0.001
Milk & dairy (g/1000 kcal)	41.9	*34.1*	52.9	*38.5*	59.1	*41.3*	65.3	*48.4*	78.1	*55.6*	0.219	0.071
Other food (g/1000 kcal)	2.6	*4.0*	2.5	*4.0*	2.1	*3.8*	2.0	*3.5*	1.7	*3.0*	<0.001	<0.001

P diff values obtained by ANOVA statistics. *P* trend obtained by contrast statement of analysis of variance.

Table 9. Potassium and other major nutrient intakes by age group in men and women: NIPPON DATA80

Age	30–39		40–49		50–59		60–69		70–		Trend *P*	*P* diff
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Men (*n*)	1220		1196		1019		679		471			
Potassium (mg/1000 kcal)	1185.0	*202.1*	1239.3	*205.3*	1305.6	*243.6*	1365.4	*254.1*	1397.0	*269.8*	<0.001	<0.001
Potassium (mg/day)	2930.0	*761.3*	3064.9	*742.8*	3237.8	*840.9*	3107.6	*805.8*	2759.8	*738.6*	<0.001	<0.001
Carbohydrate (%kcal)	57.8	*5.8*	58.6	*5.8*	59.7	*6.2*	62.0	*6.5*	64.5	*6.7*	<0.001	<0.001
Protein (%kcal)	14.7	*2.1*	15.0	*2.0*	15.3	*2.2*	15.3	*2.1*	15.1	*2.2*	<0.001	<0.001
Total fat (%kcal)	22.1	*5.1*	20.4	*4.7*	19.4	*5.0*	18.3	*5.0*	17.2	*4.9*	<0.001	<0.001
Total energy (kcal)	2475.2	*486.0*	2476.2	*450.0*	2487.7	*484.2*	2297.8	*541.4*	1981.5	*406.4*	<0.001	<0.001
Women (*n*)	1583		1469		1319		900		566			
Potassium (mg/1000 kcal)	1302.5	*204.3*	1412.2	*249.1*	1521.1	*279.6*	1558.8	*293.2*	1547.6	*314.0*	<0.001	<0.001
Potassium (mg/day)	2546.3	*591.6*	2851.9	*729.9*	3001.9	*772.9*	2830.3	*783.6*	2530.6	*718.7*	<0.001	<0.001
Carbohydrate (%kcal)	59.2	*5.8*	60.9	*6.2*	62.6	*6.5*	65.5	*6.8*	66.4	*7.0*	<0.001	<0.001
Protein (%kcal)	15.1	*1.9*	15.3	*2.1*	15.7	*2.3*	15.7	*2.2*	15.7	*2.3*	<0.001	<0.001
Total fat (%kcal)	23.9	*5.4*	22.8	*5.6*	21.2	*5.4*	18.8	*5.4*	18.5	*5.2*	<0.001	<0.001
Total energy (kcal)	1957.0	*338.5*	2025.5	*400.6*	1984.9	*420.4*	1825.4	*412.8*	1639.2	*341.7*	<0.001	<0.001

Values are in mean and *standard deviation*. Trend *P* obtained by contrast statement of analysis of variance. *P* diff values obtained by ANOVA statistics.

intake with blood pressure.[1] Higher potassium intake exerts a blood pressure lowering effect. Potassium is present in most food groups, however good sources of potassium include fruits, vegetables, dairy products, whole grains, nuts, seeds and dried beans.[16]

A high potassium intake can be achieved through diet. Because potassium derived from foods is also accompanied by a variety of other nutrients, the preferred strategy to increase potassium intake is to consume foods that are rich in potassium, rather than supplements.[1] In studies, including the Dietary Approach Against Hypertension (DASH) trial, it was observed that increased fruit and vegetable consumption lowered BP.[18–20] DASH has also demonstrated that the addition of low-fat dairy products to a diet high in fruits and vegetables significantly reduced BP.[21] The effects of potassium on BP depend on the concurrent intake of salt and vice versa. Specifically, an increased intake of potassium has a greater BP-lowering effect in the context of a higher salt intake and lesser BP reduction in the setting of a lower salt intake. Conversely, the BP reduction from a reduced salt intake is greatest when potassium intake is low.[1] This emphasizes the feasibility of increasing the consumption of

Table 10. Potassium and other major nutrient intakes by age group in men and women: NIPPON DATA90

Age	30–39		40–49		50–59		60–69		70–		Trend *P*	*P* diff
Variable	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Men (*n*)	660		836		793		708		491			
Potassium (mg/1000 kcal)	1189.7	*196.7*	1245.7	*216.6*	1341.1	*259.6*	1393.9	*218.8*	1455.9	*281.2*	<0.001	<0.001
Potassium (mg/day)	2827.7	*692.9*	2987.8	*714.5*	3269.6	*877.3*	3118.1	*840.9*	2884.7	*800.4*	<0.001	<0.001
Carbohydrate (%kcal)	55.2	*5.1*	54.9	*4.9*	56.2	*5.5*	58.3	*5.8*	60.5	*6.2*	<0.001	<0.001
Protein (%kcal)	15.0	*1.7*	15.6	*1.9*	15.9	*2.0*	15.6	*1.9*	15.7	*2.1*	<0.001	<0.001
Total fat (%kcal)	24.6	*4.2*	23.2	*3.9*	21.9	*4.2*	21.1	*4.6*	20.3	*4.5*	<0.001	<0.001
Total energy (kcal)	2376.7	*436.1*	2405.1	*427.2*	2446.2	*475.3*	2237.8	*414.0*	1984.7	*413.5*	<0.001	<0.001
Women (*n*)	1031		1171		1035		915		702			
Potassium (mg/1000 kcal)	1303.6	*211.5*	1428.6	*258.9*	1566.5	*307.0*	1603.9	*311.2*	1577.5	*318.5*	<0.001	<0.001
Potassium (mg/day)	2446.4	*550.6*	2800.5	*694.9*	3014.2	*825.5*	2896.3	*795.7*	2544.1	*716.1*	<0.001	<0.001
Carbohydrate (%kcal)	55.8	*4.9*	56.9	*5.1*	59.4	*5.8*	61.3	*6.3*	62.7	*6.0*	<0.001	<0.001
Protein (%kcal)	15.3	*1.7*	16.0	*1.9*	16.3	*2.0*	16.1	*2.1*	16.0	*2.1*	<0.001	<0.001
Total fat (%kcal)	27.3	*4.4*	25.8	*4.2*	23.9	*4.7*	22.4	*4.8*	21.2	*4.7*	<0.001	<0.001
Total energy (kcal)	1880.2	*313.9*	1964.7	*350.4*	1926.5	*371.1*	1808.9	*374.7*	1615.5	*325.8*	<0.001	<0.001

Values are in mean and *standard deviation*. Trend *P* obtained by contrast statement of analysis of variance. *P* diff values obtained by ANOVA statistics.

potassium-rich foods while reducing that of sodium-rich foods at the individual level. In the generally healthy population with normal kidney function, a high potassium intake from foods poses no risk because excess potassium is readily excreted in the urine. However, in individuals whose urinary potassium excretion is impaired, a higher potassium intake may cause adverse cardiac effects from hyperkalemia.[1,22]

We observed that the participants with higher intake of dietary potassium tended to be from older age categories. These findings are comparable to the National Nutrition Survey in 2003 findings,[23] which demonstrated that potassium intake of people aged 50 and over was higher than younger people. The National Nutrition Survey in 2003 was based on the individual nutrition intake data.[23] Regarding the association between age and dietary potassium intake, similar to our findings, Iso et al[24] also reported lower intake of potassium among younger age group people using FFQ.

Dietary potassium intake is likely to be associated with the subject level covariates as well as the other components of the dietary patterns of a person. Information about the potassium intake in Japanese population in relation to other nutrient intake and overall dietary habit needs to be further investigated using longitudinal research. While, with the use of the pooled NIPPON DATA and NNS data set it would be possible for us to investigate the interactions in detail between nutritional factors, cardiovascular risk factors and mortality; on the other hand we also should be careful about the mutual correlations between potassium intake, other nutrient and food intake.

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日本人における食品群摂取量と血清総コレステロールとの関連：NIPPON DATA 80/90

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【背景】食習慣は健康を決定づける重要な要因のひとつである。食事と血中脂質との関連を食品レベルで研究することは、栄養素レベルで行うよりも疾病予防のための食習慣改善により直接的に応用できるという利点がある。

【方法】分析には、1980年と1990年のNIPPON DATAと国民栄養調査の結合データを用いた。血清総コレステロール値と食品群の摂取量との関連を年齢、BMI、総エネルギー摂取量を調整して性別、調査年別に重回帰分析を用いて分析した。

【結果】食品群の摂取量は、1980年に比べ1990年では、米類、砂糖類、菓子類、果物類、その他の野菜が少なく、緑黄色野菜、きのこ類、海藻類、卵類、乳類が多かった。血清総コレステロール値との関連では、男女共に肉類、乳類、卵類は正の、一方、男性のみに豆類で負の関連が1980年、1990年のいずれにもみられた。

【結論】日本人を代表するサンプルにおいて、1980年および1990年における性や年齢による食品群摂取の特徴が明らかとなり、血清総コレステロール値と食品群摂取量との正あるいは負の関連も示された。これらの結果は日本における疾病予防のための食習慣改善に有用となる。

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Association between Food Group Intake and Serum Total Cholesterol in the Japanese Population: NIPPON DATA 80/90

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ABSTRACT

Background: Dietary habit is one of the important determinants of health. Investigation of the association between diet and blood lipids at the food product level is more advantageous than that at the nutrient level because the results can be applied more directly to improving dietary habits for disease prevention.

Methods: The integrated datasets of the NIPPON DATA and National Nutrition Surveys in Japan conducted in 1980 and 1990 were used for analysis. The association between serum total cholesterol concentration and food group intake was examined by multiple linear regression analysis separately for sex and survey year with data adjusted for age, body mass index and total energy intake.

Results: Intakes of rice, sugar, sweets and snacks, fruit and vegetables other than green and yellow ones were lower and intakes of green and yellow vegetables, mushrooms, seaweed, eggs and milk were higher in the 1990 survey than in the 1980 survey. Intakes of meat, milk and eggs showed a positive association with serum total cholesterol concentration in both sexes while intake of legumes showed a negative association only in men in both the 1980 and 1990 surveys.

Conclusions: Sex- and age-specific food group intakes for 1980 and 1990 were identified, and positive and negative associations between serum total cholesterol concentration and food group intake were revealed in a representative sample of the Japanese population. The results provide some insights into the improvements in dietary habits that can be made for disease prevention in Japan.

Key words: serum cholesterol; Japan; nutrition; food; diet; survey

INTRODUCTION

The prevention of arteriosclerotic disease has become increasingly important in Japan in recent times. The onset of arteriosclerotic disease is closely associated with risk factors such as blood lipids, blood pressure and several lifestyle factors, and prevention of the disease through lifestyle modification has been reported mainly in Western countries.[1,2] Improving lifestyle through, for example, eating and exercise, has been recommended for the proper control of blood cholesterol concentration. Reducing intakes of meat, milk, dairy products and egg yolk while increasing intakes of vegetables and fruit has been shown to be effective for the prevention of coronary disease.[1] Furthermore, the recommended amount of intake has been specified for each food group, nutrients such as fat and dietary fiber, and even detailed nutrients such as fatty acids.[2] Studies at the nutrient or fatty acid level are important to clarify the effects of nutrient intake on blood lipid level, while studies at the food or food group level are of value in that the results can be applied more directly to the improvement of daily dietary habits. The present study aimed to reveal food group intake by sex and age group from data collected in 1980 and 1990, and to determine any association between serum total cholesterol concentration and food group intake in the Japanese general population.

METHODS

The integrated datasets of NIPPON DATA80/90 (National Integrated Project for Prospective Observation of Non-communicable Disease And its Trends in the Aged) were used for data analysis. These datasets contained the results of the third (1980)[3] and fourth (1990)[4] National Surveys on

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Circulatory Disorders as baseline data, with additional data on nutritional intake per individual estimated from the results of the National Nutrition Surveys in Japan[5,6]; hereinafter referred to as the 1980 survey and the 1990 survey. The details of the datasets have been reported elsewhere.[7] In the present study, data from subjects who consumed 500–5000 kcal/day of total energy were included for analysis; seven subjects from the 1980 survey and one subject from the 1990 survey whose total energy intake was less than 500 kcal/day, and eight subjects from the 1980 survey and one subject from the 1990 survey whose total energy intake was more than 5000 kcal/day were excluded.

For data analysis, we used 17 food groups from among the 18 food groups and 2 subgroups (rice and wheat from cereals) defined in the National Nutrition Survey in Japan: rice, wheat, nuts and seeds, potatoes, sugar and preserves (hereafter sugar), sweets and snacks, fat and oil, legumes, fruit, green and yellow vegetables, other vegetables (ie, vegetables other than green and yellow ones), mushrooms, seaweed, fish and shellfish (hereafter fish), meat and poultry (hereafter meat), eggs, and milk and dairy products (hereafter milk). Cereals were not used for the analysis because they are mainly composed of rice and wheat, and intake of cereals other than rice and wheat (eg, *soba* and cornflakes) were heterogeneous and rather small. Moreover, we did not use the food groups "seasonings and beverages" and "other food" because both of these food groups were heterogeneous and their nutritional significance was thus considered difficult to interpret.

Statistical analysis involved the following. The means and standard deviations of intake of each food group by sex and age group for each survey year were calculated. Multiple linear regression analysis was then performed separately for sex and survey year with serum total cholesterol concentration (mg/dl) as the objective variable and age (years), body mass index (kg/m^2), total energy intake (kcal/day) and intake of food groups (g/day) as the explanatory variables (covariates). Data for the 17 food group intakes were entered into the model first separately (model 1) and then collectively (model 2). The intake of legumes, which was significantly negatively correlated with serum total cholesterol concentration only in men, was also analyzed in a population of women aged 55 years or older. Differences were considered significant at $P < 0.05$. All statistical analysis was performed using SPSS® 17.0J.

RESULTS

Mean food group intakes were analyzed for 4578 men and 5829 women in the 1980 survey and 3487 men and 4853 women in the 1990 survey (Tables 1 and 2). Intakes of rice, sugar, sweets and snacks, fruit and other vegetables were lower and intakes of green and yellow vegetables, mushrooms, seaweed, eggs and milk were higher in the 1990 survey than in the 1980 survey, in both men and women. Because the classification of green and yellow vegetables was somewhat different between the two surveys,[5,6] the combined intakes of green and yellow vegetables and other vegetables (ie, total vegetables) was examined and found to be similar in both surveys.

The association between serum total cholesterol concentration and food group intake was analyzed for those with available data (4569 men and 5818 women in the 1980 survey, 3220 men and 4494 women in the 1990 survey) (Table 3). The means and standard deviations of serum total cholesterol concentration and body mass index were 186.4 ± 32.8 mg/dl and 22.5 ± 2.9 kg/m^2 in men and 191.2 ± 34.0 mg/dl and 22.8 ± 3.4 kg/m^2 in women in the 1980 survey, and 198.6 ± 36.8 mg/dl and 22.9 ± 3.0 kg/m^2 in men and 206.9 ± 38.8 mg/dl and 22.8 ± 3.3 kg/m^2 in women in the 1990 survey, respectively.

Firstly, the associations with serum total cholesterol concentration were examined when each food group intake was separately entered into multiple linear regression analysis (model 1). In the 1980 survey, a significant negative association was found for intakes of rice, potatoes and other vegetables in both sexes, for legumes and seaweed only in men and for fish only in women. A significant positive association was found for wheat, fat and oil, meat, eggs and milk in both sexes and for sugar, fruit and green and yellow vegetables only in women. In the 1990 survey, a significant negative association was found for rice in both sexes and for potatoes, sweets and snacks, legumes and other vegetables only in men. A significant positive association was found for wheat, meat and milk in both sexes, for nuts and seeds only in men and for fruit, green and yellow vegetables and eggs only in women.

Secondly, the associations with serum total cholesterol concentration were examined when all food groups intake was collectively entered into multiple linear regression analysis (model 2). In the 1980 survey, a significant negative association was found for rice and potatoes in both sexes and for legumes and other vegetables only in men. A significant positive association was found for meat, eggs and milk in both sexes and for sugar only in women. In the 1990 survey, a significant negative association was observed for potatoes, sweets and snacks and other vegetables in men and for rice only in women. A significant positive association was found for meat and milk in both sexes and for nuts and seeds and fish only in men.

Intake of legumes, which was shown to be negatively correlated to serum total cholesterol concentration only in men, was also analyzed to determine the association with serum total cholesterol concentration among women aged 55 years or older (2098 in the 1980 survey and 1950 in the 1990 survey). Intake of legumes was not significantly associated with serum total cholesterol concentration, with a small negative standardized regression coefficient in each survey (standardized regression coefficient (β) = −0.031, $P = 0.170$ in the 1980 survey; $\beta = -0.006$, $P = 0.786$ in the 1990 survey).

Table 1. Mean food group intake in men by survey year (g/day)

Survey year	Food group	Age (year) 30–39 Mean	(SD)	40–49 Mean	(SD)	50–59 Mean	(SD)	60–69 Mean	(SD)	70+ Mean	(SD)	Total Mean	(SD)
		n = 1217		*n* = 1196		*n* = 1018		*n* = 676		*n* = 471		*n* = 4578	
1980	Rice	285.2	(94.1)	307.8	(99.3)	331.6	(102.6)	305.3	(109.5)	264.0	(88.7)	302.2	(101.4)
	Wheat	110.8	(62.3)	90.8	(52.6)	68.3	(48.9)	73.6	(53.6)	63.2	(53.4)	85.7	(57.6)
	Nuts and Seeds	1.2	(3.9)	1.4	(5.0)	1.7	(6.0)	1.1	(3.2)	1.6	(4.6)	1.4	(4.7)
	Potatoes	62.0	(43.4)	63.4	(40.8)	70.4	(49.9)	71.4	(54.8)	67.4	(50.6)	66.2	(47.0)
	Sugar and Preserves	13.5	(9.4)	12.9	(9.5)	15.2	(12.2)	14.0	(10.7)	13.0	(10.0)	13.7	(10.4)
	Sweets and Snacks	15.2	(15.2)	14.0	(14.9)	11.7	(14.1)	18.4	(19.8)	23.9	(28.7)	15.5	(17.8)
	Fat and Oil	22.1	(13.3)	18.5	(11.4)	16.9	(10.8)	13.1	(9.8)	9.3	(8.5)	17.4	(12.0)
	Legumes	70.6	(39.8)	77.7	(45.3)	93.1	(54.3)	94.0	(54.8)	82.6	(51.9)	82.2	(49.2)
	Fruit	106.9	(72.3)	142.4	(89.3)	150.6	(103.2)	168.0	(105.7)	169.0	(122.6)	141.3	(97.7)
	Green and Yellow Vegetables	51.9	(35.3)	57.6	(37.6)	62.0	(41.8)	58.2	(44.0)	52.1	(40.2)	56.6	(39.4)
	Other Vegetables	217.8	(87.2)	229.7	(92.9)	245.6	(111.4)	247.5	(108.4)	202.6	(93.8)	229.9	(99.4)
	[Total Vegetables]	269.8	(101.0)	287.2	(106.4)	307.6	(124.1)	305.6	(122.4)	254.6	(107.4)	286.5	(113.2)
	Mushrooms	9.3	(11.8)	9.9	(13.6)	11.6	(14.5)	10.5	(13.8)	7.8	(11.5)	10.0	(13.2)
	Seaweed	5.5	(7.6)	6.5	(8.2)	7.3	(8.7)	6.8	(9.1)	6.1	(7.6)	6.4	(8.3)
	Fish and Shellfish	113.7	(58.4)	128.3	(65.5)	142.4	(69.8)	125.4	(60.2)	101.1	(53.3)	124.3	(64.0)
	Meat and Poultry	87.4	(43.2)	78.7	(41.0)	68.2	(38.9)	52.8	(31.8)	41.3	(29.7)	71.0	(41.7)
	Eggs	44.5	(22.6)	42.2	(21.9)	42.2	(22.4)	35.3	(21.8)	31.5	(19.9)	40.7	(22.4)
	Milk and Dairy Products	74.4	(52.0)	68.1	(49.4)	69.4	(63.7)	76.3	(68.8)	73.6	(70.6)	71.8	(58.9)
		n = 659		*n* = 836		*n* = 793		*n* = 708		*n* = 491		*n* = 3487	
1990	Rice	250.0	(72.9)	261.8	(79.2)	282.6	(88.6)	255.9	(85.6)	224.7	(76.0)	257.9	(83.0)
	Wheat	100.3	(53.9)	86.3	(49.9)	72.1	(51.9)	76.2	(55.0)	68.8	(50.6)	81.2	(53.4)
	Nuts and Seeds	1.1	(3.1)	1.3	(3.7)	2.0	(5.6)	1.8	(4.5)	1.8	(4.6)	1.6	(4.4)
	Potatoes	62.4	(40.6)	62.3	(36.7)	72.8	(48.2)	72.7	(47.3)	71.2	(47.8)	68.1	(44.3)
	Sugar and Preserves	11.1	(9.5)	12.2	(8.9)	13.0	(10.8)	12.6	(9.0)	12.2	(10.0)	12.2	(9.6)
	Sweets and Snacks	13.0	(14.8)	12.7	(14.3)	9.9	(14.2)	15.9	(22.1)	19.3	(24.1)	13.7	(18.0)
	Fat and Oil	22.9	(11.1)	19.5	(10.3)	17.8	(9.8)	15.1	(9.6)	10.6	(7.6)	17.6	(10.6)
	Legumes	71.0	(42.4)	78.5	(46.1)	96.7	(53.3)	95.5	(53.4)	88.1	(53.7)	86.0	(50.8)
	Fruit	76.8	(58.5)	107.6	(75.8)	131.0	(93.2)	146.1	(103.7)	161.9	(110.6)	122.6	(93.2)
	Green and Yellow Vegetables	76.6	(42.1)	79.2	(44.1)	95.7	(56.4)	95.5	(60.7)	84.2	(52.0)	86.5	(52.1)
	Other Vegetables	180.4	(79.3)	189.2	(78.2)	204.8	(88.8)	201.4	(87.3)	172.8	(83.5)	191.2	(84.3)
	[Total Vegetables]	257.0	(99.3)	268.4	(98.2)	300.5	(115.0)	296.8	(114.1)	257.0	(105.1)	277.7	(108.3)
	Mushrooms	10.1	(12.0)	12.1	(12.8)	15.6	(18.9)	12.9	(15.5)	10.8	(13.6)	12.5	(15.0)
	Seaweed	6.0	(6.7)	7.2	(8.2)	8.8	(10.3)	8.3	(12.3)	7.2	(8.8)	7.6	(9.5)
	Fish and Shellfish	107.6	(50.5)	127.7	(56.0)	148.9	(69.1)	128.3	(56.6)	109.4	(53.4)	126.3	(59.9)
	Meat and Poultry	88.4	(41.4)	86.1	(37.8)	70.5	(39.1)	55.8	(32.5)	43.5	(28.4)	70.8	(40.1)
	Eggs	47.2	(23.5)	47.1	(22.1)	47.8	(23.9)	42.4	(22.8)	39.7	(23.5)	45.3	(23.3)
	Milk and Dairy Products	85.8	(58.6)	79.5	(61.7)	90.9	(79.0)	99.0	(83.9)	109.9	(90.8)	91.5	(75.3)

DISCUSSION

Food products known to contribute substantially to higher serum total cholesterol concentration include meat, eggs, milk, other dairy products and butter.[8] Similarly, in the present study, meat, milk and eggs were also significantly positively associated with serum total cholesterol concentration in the representative sample of the Japanese population for the years 1980 and 1990. When the results of the 1980 and 1990 surveys were compared, intakes of eggs and milk and serum total cholesterol concentration were higher in the 1990 survey than in the 1980 survey, but the standardized regression coefficients of these food products in the 1990 survey were smaller than those in the 1980 survey. On the other hand, habitual intake of fish is known to be a negative predictor of serum total cholesterol.[9] However, in the present study, statistically significant negative association between fish intake and serum total cholesterol concentration was found only in women in the 1980 survey, and positive association was observed in men in the 1990 survey.

In Japan, several national health promotion measures have become active for decades. Opportunities for medical check-ups was increased under the Law of Health and Medical Services for the Aged enacted in 1983 and people have more conscious of serum total cholesterol concentration which was add to the test items of the medical check-ups. The

Table 2. Mean food group intake in women by survey year (g/day)

Survey year	Food group	Age (year) 30–39 Mean	(SD)	40–49 Mean	(SD)	50–59 Mean	(SD)	60–69 Mean	(SD)	70+ Mean	(SD)	Total Mean	(SD)
		n = 1583		*n* = 1467		*n* = 1316		*n* = 897		*n* = 566		*n* = 5829	
1980	Rice	185.1	(62.2)	212.7	(71.3)	216.9	(75.0)	225.8	(74.6)	223.4	(76.1)	209.2	(72.5)
	Wheat	113.2	(52.9)	83.3	(51.9)	73.6	(52.0)	64.6	(45.2)	49.6	(37.9)	83.1	(54.1)
	Nuts and Seeds	1.4	(5.1)	1.4	(4.7)	2.3	(7.2)	1.8	(5.7)	1.7	(4.8)	1.7	(5.6)
	Potatoes	57.6	(35.7)	62.9	(42.7)	67.2	(50.2)	71.7	(51.9)	67.5	(54.0)	64.2	(45.8)
	Sugar and Preserves	13.4	(8.9)	13.3	(10.1)	14.0	(10.9)	12.2	(9.8)	11.8	(9.1)	13.2	(9.9)
	Sweets and Snacks	28.6	(27.0)	29.3	(32.1)	28.3	(32.7)	21.7	(24.8)	19.8	(24.6)	26.8	(29.4)
	Fat and Oil	19.0	(11.0)	17.8	(10.7)	14.6	(9.7)	11.5	(8.9)	9.5	(7.1)	15.6	(10.5)
	Legumes	57.6	(32.4)	70.4	(40.1)	82.9	(48.0)	77.5	(46.9)	72.7	(43.7)	71.1	(42.7)
	Fruit	147.1	(88.2)	195.1	(121.9)	219.7	(143.1)	205.0	(139.7)	168.4	(120.7)	186.5	(125.2)
	Green and Yellow Vegetables	51.4	(32.3)	60.0	(39.8)	63.8	(45.4)	60.4	(45.0)	58.8	(46.1)	58.5	(41.1)
	Other Vegetables	191.9	(76.7)	218.7	(92.4)	227.9	(98.3)	213.4	(95.1)	187.7	(91.4)	209.7	(91.4)
	[Total Vegetables]	243.3	(88.0)	278.7	(108.2)	291.4	(113.7)	273.7	(110.2)	246.4	(108.4)	268.1	(106.5)
	Mushrooms	7.9	(9.8)	9.6	(12.0)	10.3	(13.2)	9.0	(12.6)	7.5	(10.7)	9.0	(11.7)
	Seaweed	4.3	(6.0)	6.4	(7.9)	7.2	(9.4)	6.9	(8.8)	6.4	(7.0)	6.1	(7.9)
	Fish and Shellfish	86.6	(42.1)	98.2	(50.6)	106.0	(50.6)	98.2	(49.4)	89.7	(47.1)	96.0	(48.4)
	Meat and Poultry	64.1	(34.3)	64.0	(33.5)	51.1	(33.8)	39.3	(27.1)	32.3	(25.5)	54.2	(34.2)
	Eggs	38.5	(19.2)	36.9	(18.9)	34.7	(19.9)	31.7	(21.1)	26.6	(16.4)	35.0	(19.7)
	Milk and Dairy Products	102.7	(61.9)	90.7	(72.0)	92.7	(83.4)	82.9	(73.1)	68.9	(62.0)	91.1	(72.1)
		n = 1031		*n* = 1171		*n* = 1034		*n* = 915		*n* = 702		*n* = 4853	
1990	Rice	163.1	(48.9)	178.9	(52.5)	185.7	(60.6)	188.6	(66.4)	187.2	(62.4)	180.0	(58.6)
	Wheat	96.0	(46.6)	82.7	(45.2)	72.5	(49.2)	66.0	(46.6)	55.3	(42.8)	76.2	(48.2)
	Nuts and Seeds	1.2	(3.0)	1.6	(4.5)	1.9	(5.4)	1.8	(4.2)	1.6	(4.5)	1.6	(4.4)
	Potatoes	58.1	(33.3)	63.0	(41.1)	68.2	(44.9)	75.2	(50.0)	67.0	(45.6)	65.9	(43.3)
	Sugar and Preserves	10.9	(7.2)	12.3	(9.7)	11.9	(9.0)	11.8	(10.5)	11.5	(9.2)	11.7	(9.2)
	Sweets and Snacks	23.7	(23.2)	26.2	(30.2)	23.3	(32.3)	20.1	(26.3)	18.5	(24.2)	22.8	(27.9)
	Fat and Oil	20.0	(9.5)	18.9	(9.6)	15.2	(8.8)	13.1	(8.6)	10.1	(6.7)	16.0	(9.5)
	Legumes	58.0	(30.8)	69.5	(40.7)	82.1	(45.0)	82.9	(48.9)	73.2	(42.3)	72.8	(42.7)
	Fruit	105.8	(76.6)	152.3	(104.1)	187.6	(130.4)	184.3	(120.3)	149.4	(114.5)	155.6	(114.0)
	Green and Yellow Vegetables	73.0	(40.3)	84.8	(50.5)	98.6	(60.8)	95.2	(58.7)	83.4	(53.6)	87.0	(53.8)
	Other Vegetables	159.3	(61.6)	180.2	(74.4)	190.0	(85.9)	179.0	(84.5)	154.7	(73.3)	174.0	(77.5)
	[Total Vegetables]	232.3	(80.1)	264.9	(99.6)	288.6	(115.0)	274.3	(109.1)	238.2	(97.6)	260.9	(103.2)
	Mushrooms	9.5	(10.5)	12.6	(13.5)	14.1	(16.5)	11.6	(14.1)	8.6	(10.9)	11.5	(13.6)
	Seaweed	4.9	(5.4)	7.2	(8.3)	8.5	(10.4)	8.1	(10.8)	7.5	(9.4)	7.2	(9.1)
	Fish and Shellfish	82.6	(36.8)	102.4	(43.2)	110.7	(49.4)	98.0	(44.1)	90.3	(43.1)	97.4	(44.6)
	Meat and Poultry	66.0	(31.0)	68.0	(30.9)	53.0	(30.1)	43.1	(26.1)	34.6	(23.8)	54.8	(31.5)
	Eggs	42.8	(20.0)	41.1	(19.5)	39.8	(20.2)	35.5	(20.2)	33.1	(19.1)	39.0	(20.1)
	Milk and Dairy Products	114.4	(71.8)	110.2	(84.7)	113.8	(96.9)	111.9	(90.3)	99.1	(89.2)	110.6	(86.8)

government established "Dietary Guidelines for Health Promotion" in 1985,[10] and recommends, for example, taking various types of food for balanced nutrition and not consuming excessive fat, considering the quantity and type of fat consumed. Also, nutritional education recommending, for example, those with high serum total cholesterol concentration to reduce egg intake has become more common. Annual report of National Nutrition Survey in Japan conducted in 1988[11] alerted an increase of osteoporosis in the elderly in context of low intake of calcium and new government established dietary guideline[12] recommends taking calcium-rich foods, such as milk, small fish and seaweeds, for preventing osteoporosis. It is unsure that these health promotion measures influence the effect of food intake on serum total cholesterol concentration, however, several lifestyle and socioeconomic factors might have contributed to the effect of food intake on serum total cholesterol, and even make a reverse causality in some situations.

In the present study, the intake of legumes was inversely associated with serum total cholesterol concentration in men, but not in women of any age group or in women aged 55 years or older. Rosell et al found a significant negative association between the intake of soybeans and serum total cholesterol concentration in women, with a particularly strong association observed in postmenopausal women.[13] Although we performed analysis among women aged 55 years or older,