Introduction

Cardiovascular risk factors such as hypertension and hypercholesterolaemia can be reduced by introducing appropriate dietary changes that include reducing the intake of salt and saturated fat, and increasing the intake of fruit and vegetables (*1*, *2*). Dietary interventions have been reported to be more effective if they are based on theories of changing health-related behavior, and several intervention trials have been conducted using conceptual models of dietary behavior (*3*). The stages of change construct in the transtheoretical model (*4*) and the Precede/Proceed model (*5*) have been investigated in some cross-sectional studies. The psychosocial factors used in these models, such as skills, knowledge, intentions, and stages of change, have been recognized as relating to dietary behavior and its changes (*6*, *7*). An examination of the longitudinal associations with stages of change showed an association between movement through the stages and dietary change (*8*).

Stroke is a major cause of death in Japan (*9*). Hypertension due to excess salt intake has been the most attributable risk factor for stroke (*10*, *11*), though several risk factors for hypertension exist (*12–14*). The average salt intake of the Japanese is still higher than that of people in Western populations (*15*). It should also be mentioned that differences in blood pressure by ethnicity are related to a variety of dietary behaviors linked to ethnic and environmental backgrounds (*16*). So it is important to clarify the relation between dietary behaviors and blood pressure in the Japanese population. Although studies in various fields have used urinary salt excretion to estimate the dietary salt intake in Japan (*17*, *18*), the relationship between urinary salt excretion, which is nearly equal to the dietary salt intake, and the stage of change to a decreased salt intake in the Japanese diet has not yet been studied.

We conducted a population-based dietary intervention program for a worksite and examined the association between stage of change for salt intake and urinary salt. This study used baseline data from the High-Risk and Population Strategy for Occupational Health (HIPOP-OHP) study.

Methods

HIPOP-OHP Study

The data reported here are taken from the baseline survey of the HIPOP-OHP study, a 5-year trial to prevent cardiovascular disease at the worksite funded by the Japanese Ministry of Health and Welfare and later by the Ministry of Health, Labour, and Welfare. The project has developed a number of strategies that include population-based worksite health promotion interventions and prevention of high-risk conditions such as cardiovascular disease, and tests their effectiveness. The study has been comprehensively described elsewhere

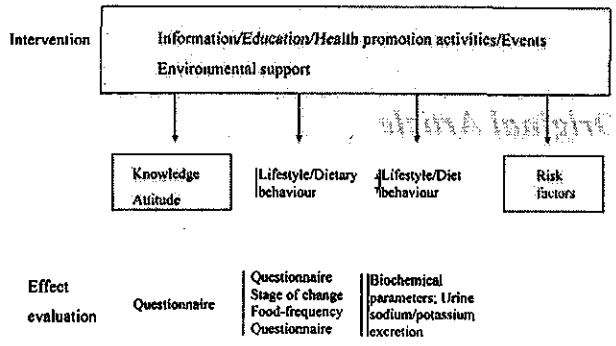

Fig. 1. *Elements, pathways, and outcomes of dietary intervention in the HIPOP-OHP study. Dietary intervention in the HIPOP-OHP study was designed to influence several phases—from knowledge and attitudes, to risk factor. For each phase, effects were measured to evaluate the intervention. Note: Adapted from Oxford Textbook of Public Health Fourth Edition (42).*

(*19*). The HIPOP-OHP study was a non-randomized control trial at 12 worksites (six intervention worksites and six control worksites) with 7,226 study participants, all of whom were employees at the 12 worksites and received general worksite health check-ups. Health promotion areas included smoking, physical activity, and diet. The population-based dietary intervention program aims at decreasing the salt and fat intake, increasing fruits and vegetables, and eating a well-balanced diet. A questionnaire on the diet and stages of change, the biochemical parameters such as urine salt and potassium, and blood pressure was used for the evaluation. A basic dietary intervention will affect health-related dietary knowledge, provide practical skills with which to change the diet, and facilitate or maintain behavioral change through an environmental program (Fig. 1). A standard quality of intervention was maintained across the six intervention worksites by using a standardized plan and process (Fig. 2).

The researchers responsible for each of the companies approached the health promotion office at each worksite. Each worksite was offered a program appropriate to its dietary environment. The plan for offices with a cafeteria was to provide leaflets, to leave advertising menus at point of purchase and on tables in the cafeteria, and to put up posters on the walls of worksites. These were regularly changed. Food labelling in the cafeteria also reinforced the intake of a balanced diet. Worksites with or without a cafeteria were offered recipes for workers in order to promote healthier eating at home, and events were offered to motivate workers to eat a healthier diet.

The HIPOP-OHP study baseline survey was conducted between 1999 and 2000. A total of 7,226 workers were included in the baseline survey, which consisted of a questionnaire. The responses of 6,816 workers (5,410 male and 1,406 female), or 94.3%, were valid and were used for the analyses. According to the aim of this study, subjects for the

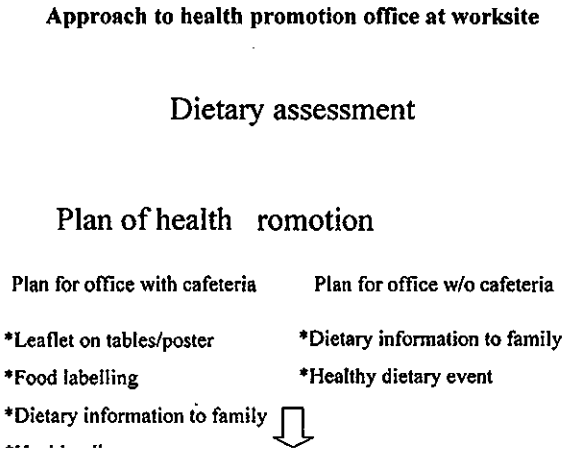

Fig. 2. *Process of dietary intervention in the HIPOP-OHP study. It is starting from the approach to the health promotion office at the worksite. After dietary assessment, the health promotion program is planned according to the dietary environment at each worksite and is adjusted to office activity. Evaluation of the program is expected to lead to suitable refinements.*

analyses were aged between 19 and 69 years.

Study Variables and Standardization

The method of baseline data measurement has been described in detail elsewhere (*19*). In brief, the recording of data from physical examinations, including data for blood pressure, height, and weight, was standardized for each regular worksite health check-up. The mean of twice-measured blood pressure (measured before and after a 5-min rest) was used as input data. The same automatic sphygmomanometer was used at each company site. Spot urine was collected and the values of estimated urinary salt and potassium excretion per day were calculated by the equation developed by Tanaka *et al.* (*20*). A standardized self-administered questionnaire was used to evaluate lifestyle parameters, including diet, stage of change for diet, medications, drinking habits, and usual volume of alcohol intake. Hypertension was defined as systolic blood pressure (SBP) of 140 mmHg or greater or diastolic blood pressure (DBP) of 90 mmHg or greater. Subjects taking antihypertensive agents were also defined as hypertensive subjects. A body mass index of 25 kg/m^2 was used as the cut-off point based on obesity criteria for Japanese (*21*). Average ethanol intake was calculated only for subjects consuming 1 g/day or more.

Stages of Change in Salt Intake

Stages of readiness to decrease salt intake were measured using a series of three questions developed for the 5 A Day research projects (*22*). The answers were categorized with an algorithm based on the Prochaska, *et al* transtheoretical model (*23*) (see Appendix for questions and algorithms). The five stages were as follows: precontemplation—not planning to begin the healthy behavior in the next 6 months; contemplation—intending to begin the behavior in the next 6 months; preparation—intending to begin within the next month; action—currently observing the healthy behavior, but having done so for less than 6 months; and maintenance—having observed the healthy behavior for 6 months or longer (*24*).

Statistical Analysis

For the analyses, we collapsed the five stages into three: the precontemplation or contemplation (P/C) stage, the preparation (P) stage, and the action or maintenance (A/M) stage. The stages were collapsed because precontemplation and contemplation were defined as preaction, and action and maintenance were defined as actual activity. Moreover, using a multivariate model with categorical dependent variables would show a clearer presentation. Results are presented separately for males and females, and obese and non-obese subjects. An analysis of variance was used to compare blood pressure across the stages. To compare distribution of age, body mass index, urinary salt and potassium excretion across stages, an analysis of variance was used when normality and equal variance were verified. The Tukey test was used as a multiple comparison analysis when the result of an analysis of variance was statistically significant. The Kruskal-Wallis test was used when either normality or equal variance was not verified. A χ^2 test was used to make a comparison by sex. Multiple linear regression models were used to examine relations between stages and urinary salt and blood pressure. Variables of stages were defined as follows: Precontemplation/contemplation (Precont/Cont) variable $=1$ for P/C stage, $=0$ for others; Preparation variable $=1$ for P stage, $=0$ for others. The association between stages and blood pressure was examined among subjects not taking antihypertensive agents. Age, body mass index, and urinary potassium, which may account for the association between stage of salt change and urinary salt, were used as covariates in multiple regression models. All probability values were two-tailed. Analyses were performed using the software package SPSS 10.0J for Windows (SPSS Version 10.0J; SPSS Japan, Tokyo, Japan).

The intervention plan was carried out following ethics approval by the Safety Hygiene Committee of each company. The Ethics Committee of Shiga University of Medical Science consented to the research protocol of the present study (No. 10–16).

Table 1. Age and Blood Pressure of the Participants by Stages of Change for Salt Intake, HIPOP-OHP Study Japan in 1999–2000 (n=6,816)

	Total	P/C	P	A/M	p*	p value†		
						P/C *vs.* P	P/C *vs.* A/M	P *vs.* A/M
Subjects	6,816 (100.0%)	4,846 (71.1%)	936 (13.7%)	1,034 (15.2%)				
Age	38.6 (9.6)	37.5 (9.5)	39.6 (9.6)	42.7 (9.4)	<0.05	<0.05	<0.05	<0.05
Male <40 years old								
SBP (mmHg)	117.7 (14.1)	117.2 (13.8)	119.7 (14.7)	119.2 (15.4)	<0.05	<0.05	ns	ns
DBP (mmHg)	69.8 (9.6)	69.4 (9.3)	71.0 (10.2)	71.9 (10.9)	<0.05	<0.05	<0.05	ns
40 years old≦								
SBP (mmHg)	120.3 (17.5)	118.6 (16.9)	123.3 (18.3)	124.1 (18.3)	<0.05	<0.05	<0.05	ns
DBP (mmHg)	76.3 (12.0)	75.2 (11.7)	78.2 (12.6)	78.7 (12.4)	<0.05	<0.05	<0.05	ns
Female <40 years old								
SBP (mmHg)	105.0 (12.8)	104.5 (12.3)	106.3 (13.6)	106.0 (13.9)	ns	—	—	—
DBP (mmHg)	62.5 (8.8)	61.9 (8.5)	64.0 (9.6)	63.3 (8.7)	<0.05	<0.05	ns	ns
40 years old≦								
SBP (mmHg)	114.1 (18.1)	111.7 (16.1)	118.1 (20.9)	115.8 (19.0)	<0.05	<0.05	ns	ns
DBP (mmHg)	69.4 (11.8)	68.2 (10.1)	71.4 (13.6)	70.3 (13.1)	<0.05	<0.05	ns	ns

*ANOVA was performed to make comparison among three stages groups. †Tukey test was performed to make comparison between stages after AVOVA. ns, not significant; P/C, Precontemplation or Contemplation; P, Preparation; A/M, Action or Maintenance. SBP, systolic blood pressure; DBP, diastolic blood pressure. Values are expressed as mean and SD in parenthesis.

Results

Of the 6,816 subjects, 79.4% were male, and the average age of participants was 38.6±9.6 years (mean±SD). Of all subjects, 12.8% (14.4% male and 6.7% female) were hypertensive, and 212 subjects (3.1%) were taking antihypertensive agents. Obese subjects (23.5% male and 13.2% female) constituted 21.3% of all subjects. The percentages of subjects classified into each of the stages of salt intake regulation were as follows: 65.2% were in the precontemplation, 5.9% in the contemplation, 13.7% in the preparation, 1.3% in the action, and 13.9% in the maintenance stage. The vast majority of workers were classified as being in the motivational stages of precontemplation, contemplation, or preparation (84.8% in total).

Table 1 provides the age and blood pressure of the participants by stages of change for salt intake. Older subjects were significantly more likely to be in a more healthy stage. With the exception of the SBP among females aged less than 40 years, the mean blood pressure values for subjects in the different stages were significantly different (p<0.05). Additionally, the mean blood pressure of males grouped by age in the P stage was higher than for those in P/C stages. The mean value of DBP for females aged less than 40 in the P stage was higher, though not significantly so, than that for those in the P/C stages, and the mean value of blood pressure among females aged 40 or more in the P stage was significantly higher than that for those in P/C stages (p<0.05).

Table 2 shows the mean values of age, body mass index, urinary salt and potassium excretion, and prevalence of risk characteristics by salt stages. Distribution of stages was significantly different by sex (p<0.05). Females tended to be in the healthier stages. A multiple comparison analysis showed that mean urinary salt in the A/M stages was significantly lower than that in the P (p<0.05) and P/C stages (p<0.05) for males. For females, the difference in urinary salt excretion across the three stages was not significant.

Table 3 shows the relationships between stages and urinary salt using multiple regression models for 5,410 males and 1,222 non-obese females. A 0.3 g/day increase in the P/C stage compared with the A/M stage was noted in males (p<0.05). For all of the 1,406 females, including those judged obese (not shown in Table 3), the coefficient of the P/C stage was 0.4 (p=0.11) when the A/M stage was used as a reference. Salt stage was not associated with urinary salt in multiple regression analyses of 176 obese women. Obesity was excluded from multivariate analyses conducted among subjects because their answers may have been affected by health consciousness, especially among females. Urinary salt among non-obese females was higher in the P/C stage (0.6 g/day) than in the A/M stages (p<0.05). The average age (±SD) was 37.1 (±9.8) years for non-obese females, and 40.2 (±9.1) years for obese females. Hypertension was recorded for 4.6% of non-obese females, and 20.7% of obese females. Average urinary salt was 8.9 (±2.0) g/day in non-obese females and 9.4 (±2.0) g/day in obese females. Each of these means or prevalences for non-obese females was significantly lower than those for obese females, with the p-value being less than 0.01. Among non-obese males (not shown in Table 2), the coefficients of P/C stage and P stage, with A/M stage as a reference, were 0.3 (p<0.05) and 0.2

Table 2. Mean of Age Body Mass Index, Urinary Salt and Potassium Excretion, and Prevalence of Risk Characteristics by Salt Stages HIPOP-OHP Study, Japan in 1999–2000 (n=6,816)

	Total	P/C	P	A/M	p	p value[d]		
						P/C *vs.* P	P/C *vs.* A/M	P *vs.* A/M
Male								
n	5,410 (100.0%)	3,997 (73.9%)	686 (12.7%)	727 (13.4%)				
Age[a]	38.9 (9.6)	37.9 (9.4)	40.2 (9.5)	43.1 (9.4)	<0.05	<0.05	<0.05	<0.05
Body mass index[a] (kg/m^2)	23.0 (3.0)	22.9 (3.0)	23.5 (3.2)	23.3 (2.9)	<0.05	<0.05	<0.05	ns
Urinary salt excretion[a] (g/day)	9.2 (2.2)	9.2 (2.2)	9.3 (2.1)	9.0 (2.1)	<0.05	ns	<0.05	<0.05
Urinary potassium excretion[a] (mmol/day)	42.7 (8.9)	42.4 (8.9)	43.5 (9.0)	43.8 (8.8)	<0.05	<0.05	<0.05	ns
Current smoker[c] (%)	54.1	56.7	49.7	43.6	<0.05			
User of antihypertensive agents[c] (%)	3.4	1.9	4.0	11.3	<0.05			
Female								
n	1,406 (100.0%)	849 (60.4%)	250 (17.8%)	307.0 (21.8%)				
Age[a]	37.4 (9.7)	35.8 (9.4)	37.8 (9.5)	41.6 (9.6)	<0.05	<0.05	<0.05	<0.05
Body mass index[b] (kg/m^2)	21.5 (3.4)	21.2 (3.3)	21.7 (3.5)	22.1 (3.5)	<0.05	ns	<0.05	ns
Urinary salt excretion[a] (g/day)	9.0 (2.0)	9.0 (2.1)	9.0 (2.0)	8.9 (2.0)	ns	—		
Urinary potassium excretion[a] (mmol/day)	40.8 (9.0)	40.5 (8.8)	40.4 (8.9)	41.9 (9.6)	ns	—		
Current smoker[c] (%)	9.5	10.2	4.8	11.4	<0.05			
User of antihypertensiveagents[c] (%)	2.0	0.4	1.8	6.9	<0.05			

[a]ANOVA was performed to make comparison among three stages groups. [b]Kruskal-Wallis test was performed to make comparison among three stages groups. [c]χ^2 test was performed to make comparison among three stage groups. [d]Tukey test was performed to make comparison between stages after AVOVA, and Games-Howell test after Kruskal-Wallis test. ns, not significant; P/C, Precontemplation or Contemplation; P, Preparation; A/M, Action or Maintenance. Values are expressed as mean and SD in parenthesis or percent.

Table 3. Multiple Regression Models Predicting Urinary Sodium Excretion by Stage of Salt Change and Covariates for Male, and Female without Obesity HIPOP-OHP Study, Japan in 1999–2000 (n=6,632)

Covariates[a]	β[b]	Standarized β[b]	p value
Male (n=5,410)			
Age	0.01	0.03	0.06
Precont/Cont variable[c,d]	0.30	0.06	0.00
Preparation variable[c,e]	0.22	0.03	0.11
Urinary potassium excretion (mmol/day)	0.13	0.56	0.00
Body mass index (kg/m^2)	0.04	0.05	0.01
			(R^2=0.37)
Female without obesity (n=1,222)			
Age	0.01	0.04	0.57
Precont/Cont variable[c,d]	0.61	0.15	0.04
Preparation variable[c,e]	0.61	0.12	0.09
Urinary potassium excretion (mmol/day)	0.11	0.47	0.00
Body mass index (kg/m^2)	0.08	0.08	0.18
			(R^2=0.33)

[a]Multiple regression analyses were performed with covariates including serum creatinin. [b]Regression coefficient. [c]Action or Maintenance is reference stage. [d]Precont/Cont=1, for precontemplation or contemplation stage; =0, for others. [e]Preparation=1, for preparation stage; =0, for others.

Table 4. Characteristics of Subjects without Antihypertensive Agents among Male, HIPOP-OHP Study, Japan in 1999–2000 (n=5,197)

	Total	P/C	P	A/M	p	p value[d]		
						P/C *vs.* P	P/C *vs.* A/M	P *vs.* A/M
Subjects	5,197 (100.0%)	3,904 (75.1%)	652 (12.5%)	641 (12.3%)				
Age[c] (years)	38.4 (9.4)	37.7 (9.4)	39.7 (9.3)	42.0 (9.1)	<0.05	<0.05	<0.05	<0.05
Body mass index[c] (kg/m^2)	22.9 (3.0)	22.8 (3.0)	23.4 (3.2)	23.1 (3.0)	<0.05	<0.05	<0.05	ns
<40 years old								
SBP[c] (mmHg)	117.5 (13.9)	117.0 (13.6)	119.5 (14.7)	118.8 (15.1)	<0.05	<0.05	ns	ns
DBP[c] (mmHg)	69.7 (9.5)	69.4 (9.3)	70.9 (10.1)	71.7 (10.7)	<0.05	<0.05	<0.05	ns
40 years old≦								
SBP[c] (mmHg)	118.9 (16.8)	117.8 (16.4)	121.7 (17.7)	120.9 (17.2)	<0.05	<0.05	<0.05	ns
DBP[c] (mmHg)	75.3 (11.6)	74.6 (11.3)	77.2 (12.3)	76.5 (11.8)	<0.05	<0.05	<0.05	ns
Urinary salt excretion[c] (g/day)	9.2 (2.2)	9.2 (2.2)	9.3 (2.1)	9.0 (2.1)	ns	—	—	—
Urinary potassium excretion[c] (mmol/day)	42.7 (8.9)	42.4 (8.9)	43.4 (9.0)	43.8 (8.9)	<0.05	<0.05	<0.05	ns
Drinker[a,e] (%)	58.7	58.9	58.6	57.7	ns	—	—	—
Ethanol intake[b,f] (average g/day)	28.9 (26.4)	29.2 (26.8)	28.2 (25.4)	27.6 (25.2)	ns	—	—	—
Walking time/day[e] (%)								
<30 min	16.6	16.6	16.3	17.0				
30 min–1 h	33.4	33.2	32.1	35.8	ns	—		
1 h–2 h	21.6	20.9	24.5	22.5				
2 h≦	28.4	29.3	27.0	24.7				

[a]Drinker was recognized as subjects with average ethanol intake per day≧1g/day. [b]Average ethanol intake per day was calculated among subjects consuming ≧1g/day. [c]ANOVA was peformed to make comparison among three stage groups. [d]Tukey test was performed to make comparison between stages after ANOVA. [e]χ^2 test was performed to make comparison among three stage groups. [f]Kruskal-Wallis test was performed to make comparison among three stages groups. ns, not significant; P/C, Precontemplation or Contemplation; P, Preparation; A/M, Action or Maintenance; SBP, systolic blood pressure; DBP, diastolic blood pressure. Values are expressed as mean and SD in parenthesis or percent.

(p=0.16), respectively.

To examine the possibility of an association between stage of change for salt intake and blood pressure, the characteristics of male and non-obese female subjects not taking antihypertensive agents are shown in Tables 4 and 5. Hypertension in the absence of antihypertensive agents was prevalent in 11.4% of males, and in 3.1% of non-obese females (not shown in tables). SBP in the P/C stage was 1.7 mmHg lower than in the A/M stage for males (p=0.06) (not shown in tables).

Neither SBP nor DBP was associated with salt stages in hypertensive men or women not taking antihypertensive agents. Table 6 presents the relationships between stage of salt intake and DBP for subjects not using antihypertensive agents. DBP for males in the P/C stage was 1.3 mmHg lower than that in the A/M stage (p<0.05) by multivariate analysis. The difference of DBP between the A/M stage and P/C stage was not statistically significant. Adding a covariate of urinary salt excretion to the analysis did not alter the statistically significant difference to the coefficient of stage variables. Stage variables were not statistically significant in multiple regression models, with or without urinary salt excretion, to predict either SBP or DBP among non-obese females. Stage variables were not statistically significant in multiple regression models predicting blood pressure for normotensive males or females. Results did not differ when analyses were performed by adding a covariate of usage of antihypertensive agent to the covariates shown in Table 6 among males or females (data not shown). Among the 176 obese women, blood pressure was not associated with salt stage in multiple regression analyses.

Discussion

The baseline data of the HIPOP-OHP study showed that stages of change for salt intake were associated with urinary salt excretion for males and non-obese females. Urinary salt was higher in the P/C stage than in the A/M stage for males and non-obese females.

It is reasonable in this cross-sectional analysis that blood pressure in the A/M stage was higher than that in the P/C stage. Subjects with hypertension might be more likely to try

Table 5. Characteristics of Subjects without Antihypertensive Agents among Female without Obesity, HIPOP-OHP Study, Japan in 1999–2000 (n=1,198)

	Total	P/C	P	A/M	p	p value[d]		
						P/C *vs.* P	P/C *vs.* A/M	P *vs.* A/M
Subjects	1,198 (100.0%)	755 (63.0%)	210 (17.5%)	233 (19.4%)				
Age[c] (years)	36.8 (9.7)	35.7 (9.5)	36.9 (9.4)	40.4 (9.6)	<0.05	ns	<0.05	<0.05
Body mass index[c] (kg/m^2)	20.5 (2.0)	20.5 (2.1)	20.6 (1.9)	20.7 (2.0)	ns			
<40 years old								
SBP[c] (mmHg)	103.6 (10.9)	103.5 (10.9)	104.5 (11.4)	102.8 (9.9)	ns	—		
DBP[c] (mmHg)	61.5 (7.8)	61.2 (8.0)	62.6 (8.0)	61.6 (6.8)	ns	—		
40 years old≦								
SBP[c] (mmHg)	111.2 (16.3)	110.4 (14.8)	114.2 (19.9)	110.9 (16.8)	ns	—		
DBP[c] (mmHg)	67.4 (10.7)	67.5 (9.8)	68.8 (12.7)	66.3 (11.0)	ns	—		
Urinary salt excretion[c] (g/day)	8.9 (2.0)	8.9 (2.1)	9.0 (2.0)	8.8 (1.9)	ns	—		
Urinary potassium excretion[c] (mmol/day)	40.3 (8.9)	40.1 (8.7)	39.8 (8.6)	41.3 (9.8)	ns	—		
Drinker[a,e] (%)	23.1	23.7	19.6	24.4	ns	—		
Ethanol intake[b,f] (average g/day)	14.2 (15.6)	14.4 (15.3)	9.9 (9.8)	16.6 (19.5)	ns	—		
Walking time/day[e] (%)								
<30 min	14.8	15.9	13.4	12.5				
30 min–1 h	27.9	29.1	27.3	24.6				
1 h–2 h	26.9	24.9	33.5	27.2				
2 h≦	30.5	30.1	25.8	35.8				

[a]Drinker was recognized as subjects with average ethanol intake per day ≧1 g/day. [b]Averege ethanol intake per day was calculated among subjects consuming ≧1 g/day. [c]ANOVA was performed to make comparison among three stage groups. [d]Tukey test was performed to make comparison between stages after AVOVA. [e]χ^2 test was performed to make comparison among three stage groups. [f]Kruskal-Wallis test was performed to make comparison among three stages groups. ns, not significant; P/C, Precontemplation or Contemplation; P, Preparation; A/M, Action or Maintenance; SBP, systolic blood pressure; DBP, diastolic blood pressure. Values are expressed as mean and SD in parenthesis or percent.

Table 6. Multiple Regression Models Predicting Diastoric Blood Pressure by Stage of Salt Change and Covariates among Subjects without Antihypertensive Agents, HIPOP-OHP Study, Japan in 1999–2000 (n=6,395)

Covariates[a]	β[b]	Standarized β[b]	p value
Male (n=5,197)			
Age	0.30	0.25	0.000
Precont/Cont variable[c,d]	−1.27	−0.05	0.048
Preparation variable[c,e]	0.45	0.01	0.599
Urinary potassium excretion (mmol/day)	−0.03	−0.02	0.283
Body mass index (kg/m^2)	1.22	0.31	0.000
			(R^2=0.22)
Female without obesity (n=1,198)			
Age	0.27	0.29	0.000
Precont/Cont variable[c,d]	−0.08	0.00	0.962
Preparation variable[c,e]	2.08	0.08	0.327
Urinary potassium excretion (mmol/day)	−0.05	−0.04	0.584
Body mass index (kg/m^2)	0.60	0.13	0.073
			(R^2=0.12)

[a]Multiple regression analyses were performed with covariates including serum creatinin, average walking time per day, and ethanol intake per day. [b]Regression coefficient. [c]Action or Maintenance is reference stage. [d]Precont/Cont=1, for precontemplation or contemplation stage; =0, for others. [e]Preparation=1, for preparation stage; =0, for others.

reducing their salt intake to a healthier level. However, the expected difference of urinary salt excretion between the A/C and A/M stages was 0.3 g/day for males, and 0.6 g/day for non-obese females. Further, as reported by Sacks *et al.* (*2*), a reduction of salt intake is effective, but other dietary factors also affect blood pressure level. No significant association of stages with blood pressure was recognized for non-obese females. This might have been due to the relatively lower rate of hypertension among non-obese females in our analysis.

In this study, a reduction in blood pressure at the A/M stage was not observed relative to the other stages, although salt intake at the A/M stage decreased. However, the results from this study of the relationship between salt stage and blood pressure cannot be considered to disprove the effectiveness of the stage model, or the effect on blood pressure of reduced dietary salt. First, the prior blood pressure of subjects at the A/M stage might have been higher than blood pressure from the baseline survey. Secondly, the DASH diet (*2*) and the INTERSALT study (*25*) have certainly shown that reduced salt intake reduces blood pressure in the general population. Therefore, a reduction of dietary salt intake resulting from behavioral change is beneficial for a reduction in blood pressure.

To our knowledge, this is the first study on the association between salt-intake stage and urinary salt. Many studies of the relationships between stages of diet and actual dietary intake have been performed in relation to low-fat diets (*24*, *26*) or fruit and vegetable intake (*27–29*). Additionally, in this paper, salt intake was not measured by dietary questionnaire, but by a biological measurement of urinary salt. Relationships between the stage-change model and dietary intake have been analyzed with dietary assessment tools such as 24-h recall (*28*) and various food frequency questionnaires (*25*, *30*). As mentioned by Ni Mhurchu (*31*), problems due to the potential mismatch between a person's perceived and actual dietary behaviour cannot be avoided in such studies. In our study, although the values of urinary excretion per day were estimated, they should be sufficiently valid because the equation established from data from 24-h urine samples is the gold standard in international collaborative studies (*20*). Additionally, the difficulties of obtaining accurate data for salt intake by self-reported dietary questionnaire are well known.

An investigation of urinary salt excretion and stage of change among non-obese women significantly found that the observed decrease in blood pressure was related to changes in salt intake, whereas a decrease in blood pressure among obese women would be more likely to be related to their body weight loss than their salt intake (*32*). One other thing should be explained. The self-reported salt intake and urinary salt excretion values might be less reliable among obese females, who may have heightened intentions of achieving a healthier diet that are not consistent with their actual dietary behavior, since the assessment of stage of change depends on respondents' intentions to change their diet and knowledge (*29*). This phenomenon might be more apparent in females than in males, since females appear to have a higher level of health-consciousness, as mentioned by other researchers of dietary behaviour (*7*, *24*). Finally, the intervention program in the present study used a population strategy—in other words, normotensive and non-obese subjects were the targeted population as well as hypertensive or obese subjects.

One potential weakness of this paper could be that although the original model consisted of five stages, the analyses were conducted using only three categorized stages. However, the rationale for integrating the five stages for examination of association between stages for salt intake and excretion is that the stage of change model describes the individual's readiness to change, and the difference between precontemplation and contemplation is the period of intention prior to behavioral change. Previous studies have reported little real difference between the proportion of calories from fat intake between the precontemplation and contemplation stages (*5*, *7*, *24*, *30*). Although there are some differences in fat intake between action and maintenance, in this study the two stages were combined for analysis, because of the relatively small proportion (1.3%) of subjects in the action stage of salt intake.

One further potential weakness is that the association between stage of change and salt excretion per day estimated by spot urine sample was analyzed from cross-sectional data. Stage of dietary salt intake might predict a change of salt intake more precisely than the initial salt intake, which might show no difference between the P/C and P stages. Intention to decrease dietary salt might not be represented by salt excretion in one day. Future HIPOP-OHP studies could examine the association between change of stage for salt intake and change of urinary salt excretion.

Another issue might be that the stages of change were measured by self-reported intention and behavior. However, because a population-based intervention usually involves limited contact between the intervention agent and subjects, a simple self-report questionnaire is a reasonable means for understanding the distribution of stages in the population.

Povey *et al.* have criticized the application of stages of change to studies of dietary behavior, because the model was originally developed for studying addictive behaviour (*33*). One of the reasons cited in that paper is that there are some misclassifications of perceived and actual dietary behaviors. For dietary-behavior questions that are less specific than, for example, whether or not a respondent intends to quit smoking, the responses might depend on subjectivities, which may be affected by health knowledge, social norms, and other factors. Greene *et al.* (*5*) reclassified subjects according to actual dietary behavior after categorization by stages of change, as mentioned in a critical paper (*33*). However, in the present study, significant differences between the A/M and P/C stages for males and non-obese females were shown by biological measurement.

We should explain the reason for the difference between mean salt intake in Japan and urinary salt excretion in this study. Mean salt intake in Japan is 11.5 g/day according to Japan's National Nutrition Survey 2001 (*34*), while in the present study the mean of urinary salt excretion was 9 g/day. One explanation for this difference is that the data obtained using the spot urine method are 1.5 g lower on average than those derived by the 24-h method. The 24-h urine collection method estimates dietary salt intake most precisely, and, accordingly, several epidemiological studies on hypertension have used this method (*12*, *15*, *25*, *35*). Another explanation might be the healthy worker effect, because subjects from the worksites may have been healthier than the general population. However, salt excretion estimated by spot urine is significantly effective for measurement of dietary salt intake for each stage population and for making comparisons between stages in a population.

The stage of change model for dietary behavior could be usefully applied; the stages at baseline of intervention can predict healthy behavioral change (*36*) or participation in a dietary intervention (*37*). Several studies have applied the model to dietary change (*7*, *8*, *29*, *38*), despite the fact that the model was initially designed for studying addictive behavior. The stages of change model was originally developed to examine individuals' readiness for behavioral change with regard to smoking cessation (*39*). It has shown that the stage of change in smoking behavior can significantly predict smoking cessation (*36*). Also, the distribution of stages for smoking has been studied, and interventions matching subjects' stages have been effective in randomized trials (*40*, *41*). Future studies will examine the association between stage of change at baseline and process of change for salt intake, and factors influencing the stage of change.

The findings of this study as part of a baseline survey from the HIPOP-OHP study show an association between stages of change and reduction of salt intake and urinary salt. The applicability of the stage of change model to an analysis of population-based dietary intervention was also shown.

Appendix

Staging questions for dietary salt reduction and response options.

I. Are you currently trying to reduce the amount of salt in your diet?

1 to 4; 1="definitely no" to 4="definitely yes"

Ia. If you answered from 1 to 3, when will you start to make a change to lower the salt in your diet?

I am not trying	1
During the next 1 month	2
During the next 6 months	3
During the next 12 or more months	4

Ib. If you answered 4 (currently trying to reduce the amount of salt), how long have you been trying to do so?

Less than 1 month	1
1–3 months	
4–6 months	
More than 6 months	

Staging algorithm are seen in the table.

Staging Algorithm

Stage	Question	Answer
Precontemplation	Ia	
Contemplation	Ia	
Preparation	Ia	
Action	Ib	
Maintenance	Ib	

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Original Article

Applicability of the Stages of Change Model for Analyzing Fruit and Vegetable Intake in Relation to Urinary Potassium Excretion: Baseline Results from the High-Risk and Population Strategy for Occupational Health Promotion (HIPOP-OHP) Study

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The Stages of Change model evaluates and conceptualizes attempts to alter particular behavior patterns. To investigate the validity of this model for assessing fruit and vegetable intake, we examined the association between the stage of change in fruit and vegetable intake and urinary potassium excretion. The data were from baseline surveys taken in 1999 and 2000 from the High-Risk and Population Strategy for Occupational Health Promotion (HIPOP-OHP) study in Japan. This was a non-randomized control trial at 12 worksites in Japan and aimed to decrease cardiovascular risk factors. Cross-sectional analysis was performed using data from 6,774 participants (5,364 men and 1,410 women). We used three categories of the model: precontemplation or contemplation (P/C), indicating no commitment to change; preparation (P), indicating readiness to change behavior but not actually doing so; and action or maintenance (A/M), indicating an actual change in behavior. Urinary potassium excretion was estimated from the potassium and creatinine concentrations in spot urine samples. Multivariate analysis indicated that urinary potassium excretion in the A/M stage was 1.65 mmol/day more than in the P stage, and 1.44 mmol/day more than in the P/C stage for men ($p<0.05$, respectively). For women, urinary potassium excretion in the A/M stage was 1.26 mmol/day more than in the P/C stage ($p<0.05$) and 1.04 mmol/day more than in the P stage, although the latter result lacked statistical significance ($p=0.08$). This study supports the potential value of the Stages of Change model for increasing fruit and vegetable intake in the design of dietary intervention programs.

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Introduction

A diet rich in fruits and vegetables is known to be effective in reducing hypertension and cardiovascular risks (*1–3*), and increased intake of potassium, which is prevalent in fruits and vegetables, has been reported to decrease blood pressure (*4*). Because hypertension, a known risk factor for stroke, is highly prevalent in Japan, increasing dietary potassium intake in this country is desirable (*5, 6*). Dietary potassium intake in Japanese is lower than in Western populations (*7*), although it exceeds the minimum recommended value of 2,000 mg/day (51 mmol/day) according to the National Nutrition Survey in Japan (*8*).

The Stage of Change model evaluates an individual's intention for behavioral change (*9*). Using this model, DiClemente *et al.* have demonstrated that smoking cessation programs are more effective if they concur with each subject's degree of intent to quit (*10*). Cross-sectional studies on dietary behavior have demonstrated that the stage for dietary intake, such as fruit and vegetable intake, and dietary fiber intake, is associated with actual dietary intake (*11–13*).

Conventional studies have investigated the association between potassium intake or urinary potassium excretion and blood pressure in Japan (*14–16*). Thus, to examine whether or not the Stages of Change model can be applied to fruit and vegetable intake in Japan, we will investigate the relationship between the stage of fruit and vegetable intake and urinary potassium excretion.

We previously conducted the High-Risk and Population Strategy for Occupational Health (HIPOP-OHP) study, a population-based dietary intervention program for a work site (*17, 18*). In another report (*19*), we showed that there were associations between subjects' expressed intention to reduce salt intake and their actual urinary salt excretion. In this study, using baseline data from the HIPOP-OHP study, we examined the associations between the expressed intention to increase fruit and vegetable intake, and actual urinary potassium excretion.

Methods

Study Design

The HIPOP-OHP study has been comprehensively described elsewhere (*17–19*). Briefly, this 5-year worksite trial was begun in Japan in 1999 with the aim of preventing cardiovascular disease. Health promotion consisted of two kinds of approaches for intervention: population-based health promotion intervention, and prevention of high-risk conditions associated with cardiovascular diseases. The intervention areas were diet, physical activity, and smoking cessation. Twelve worksites, with a total of 7,226 participants, were assigned to two intervention and control groups of six worksites each.

The data reported here are taken from the baseline survey conducted between 1999 and 2000. Among the 7,226 participants, the responses of 6,774 workers (93.7%) aged between 19 and 69 years (5,364 men and 1,410 women) were valid and were used for the analyses.

Study Variables and Standardization

Data from physical examinations, such as blood pressure, height, and weight, were measured in standardized ways for each regular worksite health check-up. The methods have been described in detail elsewhere (*17*). Blood pressure was measured in a standardized manner as follows. Subjects were informed in advance to abstain from smoking, from eating or drinking beverages except water, and from heavy physical activity for 30 min before measurement. After emptying their bladders, they sat quietly for 5 min, and their blood pressure was measured twice using an automated sphygmomanometer. The mean of the two values was used for analysis. Urinary potassium and salt excretion per day were estimated from spot urine samples using the equation developed by Tanaka *et al.* (*20*). Stage of change parameters for eating fruits and vegetables, and other lifestyle parameters such as daily alcohol intake, smoking habits, use of medications, and walking time per day were assessed using a self-administered questionnaire (*17–19*). Average ethanol intake was calculated only for subjects consuming 1 g/day or more. Hypertension was defined as the presence of a systolic blood pressure (SBP) of 140 mmHg or greater or a diastolic blood pressure (DBP) of 90 mmHg or greater, or the current use of antihypertensive agents. Obesity was defined as a body mass index (BMI) of 25 kg/m^2 or greater, as recommended by the Examination Committee of Criteria for 'Obesity Disease' in Japan (*21*).

Stages of Change in the Intent to Eat Fruits and Vegetables

Readiness to increase fruit and vegetable intake was determined using the Stages of Change model questions shown in Fig. 1. Each subject was first asked to state their frequency of intake of fruits and vegetables per week. Those who responded with a frequency of between 0 and 6 were asked when they would increase their intake of fruits and vegetables. Those who responded with a frequency of 7 or greater were asked about the duration of their behavior. Based on these responses, each subject was categorized into one of the 5 stages of change. The stages were as follows: 1) precon-

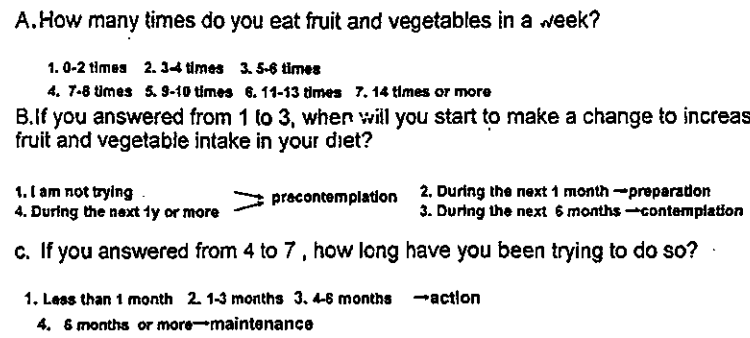

Fig. 1. *Stage of Change questions for fruits and vegetables intake used in the HIPOP-OHP Study.*

templation: no plan to begin healthy changes in the next 6 months; 2) contemplation: intent to begin behavior changes in the next 6 months; 3) preparation: intent to begin behavior changes in the next month; 4) action: currently observing healthy behavior, but having done so for less than 6 months; and 5) maintenance: having observed the healthy behavior for 6 months or longer (*10*, *22*).

Statistical Analysis

For purpose of analysis, the five stages were collapsed into three components, as described previously (*19*): the precontemplation and contemplation (P/C) stage, the preparation (P) stage, and the action or maintenance (A/M) stage. Each of the three is presented separately for men and women. Analysis of variance (ANOVA) or χ^2 tests were used to compare the distribution or prevalence of demographic and risk characteristics between stages. The Tukey test was performed to compare stages after ANOVA. The Kruskal-Wallis test was used when either normality or equal variance was not verified. Wilcoxon rank sum test with a Bonferroni procedure was used when the result of the Kruskal-Wallis test was statistically significant. Multiple linear regression models were used with stages as independent variables, and urinary potassium or blood pressure as dependent variables. Variables of stages were defined as follows: precontemplation and contemplation variable=1 for the P/C stage, 0 for the others; and preparation variable=1 for the P stage, 0 for the others. All probability values were two-tailed. Analyses were performed using the software package SPSS 10.0J for Windows (SPSS Version 10.0J; SPSS Japan, Tokyo, Japan).

Results

The mean age of the 6,774 subjects was 38.6±9.7 years, and 79.4% were men. Hypertension was found in 13.0% (14.6% of men and 7.0% of women), which included 213 subjects (3.1%) taking antihypertensive agents; 20.5% (22.6% of men and 12.8% of women) were obese. Subjects who reported being in the healthiest stage—*i.e.*, the maintenance stage—formed the largest group, making up 49.2% of the total population studied. Of the other subjects, 3.3% were in the action, 14.9% in the preparation, 4.3% in the contemplation, and 28.3% in the precontemplation stage.

Distributions of age, BMI, blood pressure, urinary potassium, and salt excretion, and prevalence of other risk characteristics among the 5,364 men are shown in Table 1. Among subjects aged 40 years or more, the SBP and DBP values were higher in those in the P stage than those in the A/M stage. Urinary potassium excretion in the A/M stage was higher than that in the other stages. The proportions of current smokers in the A/M stages were lower than those in the other stages.

For the 1,410 women, there was a significant difference among stages in urinary potassium excretion, but no significant differences were found in the mean values of age, BMI, blood pressure, or urinary salt excretion (Table 2). The proportion of current smokers was different among stages.

Table 3 shows the relationships between stages and urinary potassium using multiple regression analysis. A 1.44 mmol/day increase in the A/M stage, and a 1.65 mmol/day increase in the P stage compared with the P/C stage were noted among men ($p<0.05$). A 1.26 mmol/day increase in the A/M stage compared with the P/C stage was noted among women ($p<0.05$). There were no associations between stages and blood pressure in either sex (data not shown).

Discussion

This study indicated that the stage of change for fruit and vegetable intake was significantly associated with urinary potassium excretion, based on the baseline data of the HIPOP-OHP study. Urinary potassium excretion in the A/M stage was significantly higher than that in the P/C stage for both men and women.

This is the first study to investigate the association between the stage of change for fruit and vegetable intake and urinary potassium excretion in Japan. Our results concur with previous studies reporting that the stage of change relates to dietary intake among the general adult population (*11*, *22*, *23*). Two of those studies used a seven-item food

Table 1. Mean Age, Body Mass Index, Blood Pressure, Urinary Potassium and Salt Excretion, Prevalence of Risk Characteristics, and Walking Time per Day by Stages for Fruit and Vegetable Intake among Men, HIPOP-OHP Study, Japan in 1999–2000 (N=5,364)

	Total	P/C[d]	P[e]	A/M[f]	p	p value P/C *vs.* P	P/C *vs.* A/M	P *vs.* A/M
Subjects (number (%))	5,364 (100.0)	1,907 (35.6)	780 (14.5)	2,677 (49.9)				
Age[a]	38.9±9.6	38.1±9.7	38.6±9.9	39.6±9.4	<0.05	ns[c]	<0.05	<0.05
Body mass index (kg/m^2)[a]	23.0±3.0	22.8±3.0	23.3±3.2	23.1±3.0	<0.05	<0.05	<0.05	ns
<40 years old								
SBP[a] (mmHg)	117.7±14.2	117.5±13.9	118.8±14.6	117.6±14.2	ns	—	—	—
DBP[a] (mmHg)	69.9±9.6	69.5±9.4	70.6±10.1	69.9±9.7	ns	—	—	—
≧40 years old								
SBP[a] (mmHg)	120.4±17.5	120.2±17.8	122.9±17.8	119.8±17.3	<0.05	ns	ns	<0.05
DBP[a] (mmHg)	76.3±12.1	76.0±12.1	78.0±12.2	76.1±12.1	<0.05	<0.05	ns	<0.05
Urinary potassium excretion[a] (mmol/day)	42.7±9.0	41.8±8.8	41.6±9.1	43.7±8.9	<0.05	ns	<0.05	<0.05
Urinary salt excretion[a] (g/day)	9.2±2.2	9.1±2.2	9.1±2.2	9.2±2.2	ns	—	—	—
User of antihypertensive agents[b] (%)	3.4	2.6	3.9	3.9	<0.05			
Current smoker[b] (%)	53.8	61.9	60.3	46.1	<0.05			
Drinker[b,g] (%)	58.5	56.5	56.8	60.4	<0.05	—	—	—
Ethanol intake[h] (average g/day)	29.0±26.0	31.3±28.6	31.3±27.2	26.8±23.7	<0.05	ns	<0.05	<0.05
Walking time/day[b] (%)								
<30 min	16.7	18.5	19.7	14.5	<0.05			
30 min–1 h	33.3	30.1	29.0	36.8				
1–2 h	22.0	19.4	20.9	24.1				
>2 h	28.1	31.9	30.3	24.6				

Data are mean or mean±SD. [a] ANOVA was performed to compare the three stage groups. Tukey tests were performed after AVOVA. [b] χ^2 test was performed to compare the three stage groups. [c] Not significant. [d] Precontemplation or Contemplation. [e] Preparation. [f] Action or Maintenance. [g] Drinkers were recognized as subjects with an average ethanol intake >1 g per day. [h] Average ethanol intake per day was calculated among subjects consuming >1 g per day. Kruskal-Wallis test was performed to make comparison among three stages groups. Wilcoxson rank sum test with Bonferonni correction was performed after Kruskal-Wallis test. SBP, systolic blood pressure; DBP, diastolic blood pressure.

frequency questionnaire, which was developed for 5-A-Day Projects, to assess fruit and vegetable intake (*22*, *23*). Although this food frequency questionnaire was reported to underestimate fruit and vegetable intake (*24*, *25*), it was used subsequently by Campbell *et al.* (*22*) and Van Duyn (*23*). This was because the objective of these studies was to investigate the relative intake of fruits and vegetables among stages. The objective of our study was similar. Also, as pointed out by Kristal *et al.* (*26*), there is no truly valid measure of fruit and vegetable intake, including urinary potassium measurement. Thus the current measurement using urinary potassium is not less valid than the measurements used previously (*22*, *23*).

In our study, the association between the self-reported stages and urinary potassium excretion was not linear, although urinary potassium in the A/M stage was significantly greater than those in the P or P/C stages. Similar trends have been reported in previous studies (*11*, *22*). The non-linear trend between stages and urinary potassium or dietary intake was attributable to the method of categorizing subjects into each stage. Subjects who reported to be changing their behavior, or who had maintained a behavioral change for over 6 months were categorized into the A/M stage. Subjects who reported not changing their behavior and who were thus not consuming enough fruits and vegetables were categorized into the P or P/C stages. Although the association between the stages and urinary potassium excretion or dietary intake was not linear, the Stages of Change model would be expected to be applicable for effective population-based intervention programs. This is because the main purpose of these programs is to reduce the risk of cardiovascular disease (CVD) by increasing potassium intake, which can be achieved by eating more fruits and vegetables during the A/C stage.

The lack of any association between blood pressure and stage of change in our study does not mean that the Stages of Change model is useless for health intervention programs. Epidemiological studies show that an increased intake of potassium decreases blood pressure (*2*, *14*, *27*). The INTERSALT study has shown that a 15-mmol increase in potassium intake is associated with a 1 mmHg drop in SBP (*27*).

Table 2. Mean Age, Body Mass Index, Blood Pressure, Urinary Potassium and Salt Excretion, and Prevalence of Risk Characteristics, and Walking Time per Day by Stages for Fruit and Vegetable Intakes among Women, HI-POP OHP Study, Japan, for 1999–2000 (N=1,410)

	Total	P/C[d]	P[e]	A/M[f]	p	p value P/C *vs.* P	P/C *vs.* A/M	P *vs.* A/M
Subjects (number (%))	1,410 (100.0)	301 (21.3)	226 (16.0)	883 (62.6)				
Age[a]	37.5±9.8	37.0±10.3	36.9±10.0	37.9±9.6	ns	—	—	—
Body mass index (kg/m^2)[a]	21.5±3.4	21.5±3.7	21.7±3.3	21.5±3.3	ns	—	—	—
<40 years old								
SBP[a] (mmHg)	105.2±12.8	106.4±14.0	104.4±11.3	104.9±12.7	ns	—		
DBP[a] (mmHg)	62.5±8.8	62.5±10.0	62.0±8.0	62.6±8.6	ns	—	—	—
≧40 years old								
SBP[a] (mmHg)	114.3±18.0	115.4±16.6	114.4±19.4	114.0±18.1	ns	—	—	—
DBP[a] (mmHg)	69.6±11.7	70.7±10.5	69.6±12.7	69.3±11.9	ns	—	—	—
Urinary potassium excretion[a] (mmol/day)	40.9±9.0	40.0±8.8	40.3±8.6	41.3±9.2	<0.05	ns	ns	ns
Urinary salt excretion[a] (g/day)	9.0±2.0	8.9±2.1	9.0±2.0	9.0±2.0	ns	—	—	—
User of antihypertensive agents[b] (%)	2.1	1.3	1.3	2.5	ns			
Current smoker[b] (%)	9.5	14.6	9.3	7.7	<0.05			
Drinker[b,g] (%)	22.4	20.8	18.8	23.8	ns	—	—	—
Ethanol intake[h] (average g/day)	13.9±15.0	19.6±19.3	11.7±10.1	12.7±14.0	<0.05	ns	ns	ns
Walking time/day[b] (%)								
<30 min	14.0	20.5	13.5	11.9				
30 min–1 h	28.1	23.2	27.9	29.9	<0.05			
1–2 h	26.8	23.2	26.1	28.2				
>2h	31.1	33.2	32.4	30.0				

Data are mean or mean±SD. [a] ANOVA was performed to make comparison among three stages groups. Tukey test was performed after AVOVA. [b] χ^2 tess were used to compare three stage groups. [c] Not significant. [d] Precontemplation or Contemplation. [e] Preparation. [f] Action or Maintenance. [g] Drinker was recognized as subjects with average ethanol intake per day >1 g per day. [h] Average ethanol intake per day was calculated among subjects consuming >1 g per day. Kruskal-Wallis test was performed to make comparison among three stages groups. Wilcoxson rank sum test with Bonferonni correction was performed after Kruskal-Wallis test. SBP, systolic blood pressure; DBP, diastolic blood pressure.

Whelton *et al.* performed a meta-analysis of randomized controlled trials concerning oral potassium intake and blood pressure (*28*). They found that changes in blood pressure and changes in urinary potassium excretion were similar to estimates predicted from the INTERSALT study. In our study, the differences in urinary potassium excretion between the groups categorized as P/C and those classed as A/M were estimated to be 1.44 mmol/day for men and 1.26 mmol/day for women. Thus, the relatively moderate impact of potassium on blood pressure led to a lack of association between blood pressure and stage in this study. Additionally, several elements other than potassium, such as calcium, magnesium, and dietary fiber, are known to affect blood pressure (*2*, *29*). However, effective intervention to increase fruit and vegetable intake enough to provide sufficient dietary potassium may be expected to decrease blood pressure levels, since we observed a significant difference of urinary potassium excretion between the P stage and the A/M stage even in the baseline survey before intervention.

Whether the urinary potassium excretion of the subjects in this study was different from that in the Japanese population reported previously (*16*, *30*) should be considered. We found a mean urinary potassium excretion of 42.7 mmol/day for men and 40.9 mmol/day for women. These values are lower than the means of 54 mmol/day for men and 50 mmol/day for women estimated by the method by Kawasaki *et al.* in a cohort study in Okinawa (*16*). They are also lower than the figures of 49.2 mmol/day (range 45.0–50.3) for men and 48.5 mmol/day (range 44.9–55.2) for women from four areas in Japan in the INTERMAP study, in which 24 h urine collection was used for measuring potassium excretion (*30*). The method used in our study thus gives results about 4 mmol/day lower than when 24 h urine collection is used for measuring potassium excretion (*20*), and the outputs here would be equivalent to the lowest value found in the INTERMAP study. However, our measurements are still applicable to the Stages of Change model for potassium intake. The objective of this study was to examine the relative excretion of urinary potassium among stages. The results are internally consistent and reflect a constant proportion of

Table 3. Multiple Regression Models Predicting Urinary Potassium Excretion by Stage of Change for Fruit and Vegetable Intake and Covariates, HIPOP-OHP Study, Japan in 1999–2000 (N=6,774)

Covariates	β[a]	Standarized β[a]	p value
Men (n=5,364)			
Age	0.16	0.17	0.00
Precont/Cont variable[b,c]	−1.44	−0.08	0.00
Preparation variable[b,d]	−1.65	−0.06	0.00
Urinary salt excretion (g/day)	2.07	0.50	0.00
Body mass index (kg/m^2)	0.21	0.07	0.00
			(R^2=0.31)
Women (n=1,410)			
Age	0.15	0.16	0.00
Precont/Cont variable[b,c]	−1.26	−0.06	0.02
Preparation variable[b,d]	−1.04	−0.04	0.08
Urinary salt excretion (g/day)	1.99	0.45	0.00
Body mass index (kg/m^2)	0.25	0.09	0.00
			(R^2=0.27)

[a] Regression coefficient. [b] Action or Maintenance is reference stage. [c] Precont/Cont=1 for precontemplation or contemplation stage, =0 for others. [d] Preparation=1 for preparation stage, =0 for others.

"real" potassium excretion at each stage.

The mean urinary salt excretion in this study was 9 g/day, which is lower than the mean salt intake in Japan of 11.5 g/day according to Japan's National Nutrition Survey 2001 (*8*). In this survey, the dietary intake of subjects was obtained by asking the subjects to weigh and record the amounts of each food eaten at each meal. Thus, the method used by the National Nutrition Survey is different from that used here (the spot urine method), and the data cannot be directly compared. However, the difference might be partly attributable to the use of the spot urine method, which has been shown to estimate a mean urinary salt excretion value 1.5 g/day lower than that derived by the 24 h method reported previously (*19*). It is also possible that this difference is related to the "healthy worker" effect, because the subjects from the worksites surveyed might have been healthier than the general population. The high proportion of subjects in the healthiest stage (the A/M stage) of fruit and vegetable intake in our study would seem to suggest that such an effect was operative.

There are limitations to this study. First, the questions concerning fruit and vegetable intake might not have revealed the actual amounts of fruits and vegetables eaten, since we focused on the subjects' will to change their dietary lifestyle, rather than on the actual intake. Second, to test the applicability of the stage model, we examined the association between the stages and estimated potassium excretion values from urine spots on a single day. A single day's excretion might not represent an individual's intention to increase fruit and vegetable intake and, clearly, the spot urine method is less accurate than the 24 h urine collection method. In future studies, we will examine whether the expressed stages of intention to change fruit and vegetable intake at baseline in intervention studies predict dietary changes as measured by changes in urinary potassium after intervention. We also plan to study whether changes in dietary stage at baseline are associated with increases in fruit and vegetable intakes as reported in the Working Well Trial (*31*) and in the Next Step Trial (*32*). In addition, as dietary behavior might be affected by ethnicity (*33*), the factors influencing the stage of change (*23*) should be investigated in the HIPOP-OHP study.

In conclusion, this study supports the applicability of the Stages of Change model for evaluating fruit and vegetable intake intentions in population-based dietary intervention studies.

Appendix

HIPOP-OHP Research Group

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ORIGINAL ARTICLE

Specific alcoholic beverage and blood pressure in a middle-aged Japanese population: the High-risk and Population Strategy for Occupational Health Promotion (HIPOP-OHP) Study

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The purpose of this study was to clarify the effects of popular Japanese alcoholic beverages on blood pressure. We performed a cross-sectional study on 4335 Japanese male workers using baseline data from an intervention study. We defined six groups according to the type of alcoholic beverage that provided two-thirds of the subject's total alcohol consumption: *beer, sake* (rice wine), *shochu* (traditional Japanese spirits), *whiskey, wine* and others. The partial regression coefficients of daily alcohol intake (1 drink = 11.5 g of ethanol) to systolic blood pressure (SBP) and diastolic blood pressure (DBP) were 0.87($P<0.001$, standard error (s.e.) = 0.09) and 0.77($P<0.001$, s.e. = 0.06), respectively. A comparison among the types of alcoholic beverages mainly consumed revealed significant differences in SBP and DBP. Both SBP and DBP were highest in the shochu group. However, an analysis of covariance adjusting for total alcohol consumption resulted in the disappearance of these differences. Although after adjustment for total alcohol consumption, the shochu group exhibited a significant positive association with 'high-normal blood pressure or greater' (odds ratio 1.43, 95% confidence interval 1.06–1.95) compared with the beer group, this significant relation disappeared after adjusting for the body mass index (BMI), urinary sodium and potassium excretion. The pressor effect, *per se*, of popular Japanese alcoholic beverages on blood pressure may not be different among the types of alcoholic beverages after adjusting for other lifestyle factors.
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Keywords: alcoholic beverages; blood pressure; urinary sodium excretion; urinary potassium excretion; high-normal blood pressure

Introduction

Consumption of alcohol in Japan has been increasing during the post-Second World War period.[1] Alcohol consumption is known to be a risk factor for hypertension,[2–8] although inverse associations of moderate alcohol consumption with coronary heart disease,[9,10] diabetes[11] and ischemic stroke[12,13] have been reported. Recently, epidemiologic researchers have been exploring the differing effects of various

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types of alcoholic beverages on cardiovascular disease or risk factors.[14–18] However, there are few studies that examine the association of the Japanese traditional alcoholic beverage with hypertension. *Sake* (Japanese rice wine) and *shochu* (spirits made from barley, sweet potato or rice or any combination of these) are traditional alcoholic beverages in Japan.[8] Previous studies have demonstrated that in subjects who consume mainly (or exclusively) sake, there is a higher prevalence of hypertension than in those who consume other alcoholic beverages.[5,8] The purpose of this study was to clarify the effects of specific alcoholic beverages on blood pressure, so that this information may be taken into consideration when planning a populational prevention programme for hypertension. Towards this end, we performed a cross-sectional study in a large Japanese worksite population.

Materials and methods

Study population

We used the baseline data from a large intervention study named the High-risk and Population Strategy for Occupational Health Promotion Study (HIPOP-OHP study). The details of this study have been described elsewhere.[19] Briefly, 12 participating companies were divided into an intervention group (Companies A–F), in which the health-related environment was improved based on a population strategy and a control group (Companies H–L). Company A was the head office of a life insurance company, Companies D and H were factories of chemical companies and the other nine companies were factories of electrical appliance manufacturers. The population strategy for health promotion consists of three fields, that is, nutrition, physical activity, and smoking. In each field, a researcher's working team was organized and has been supporting the intervention. This study was carried out as a health promotion activity to increase work efficiency at each company, and approval for the study was obtained from the Institutional Review Board of Shiga University of Medical Science for ethical issues (No. 10–16).

Data collection and standardization

In 1999 or 2000, a baseline exam was performed on 7226 participants (5346 males and 1880 females). After a 5-min rest, blood pressure was measured twice on each participant, using the same automatic sphygmomanometer (Nihon Colin, BP-103iII) at each company, and the mean value was recorded. Hypertension was defined as a systolic blood pressure (SBP) of 140 mmHg or higher, or a diastolic blood pressure (DBP) of 90 mmHg or higher, or any combination of these. As the population of the study was composed of young and substantially healthy workers, the prevalence of hypertension was presumed to be relatively low and without sufficient statistical power. Additionally, recent studies have suggested that high-normal blood pressure is a causal risk factor for cardiovascular disease.[20,21] Therefore, we also defined a 'high-normal or greater' blood pressure for use in this analysis. 'High-normal blood pressure or greater' was defined as a SBP of 130 mmHg or higher, or a DBP of 85 mmHg or higher, or any combination of these. Serum gamma-glutamyl-transpeptidase activity (γ-GTP) was measured using a colorimetric method. The body mass index (BMI) was calculated as weight (kg) divided by the height squared (m^2).

Drinking habits for each subject were assessed by a questionnaire common to all companies.[9,22] The frequency of alcohol consumption during a typical week and the total alcohol intake on each occasion was determined and used to calculate the alcohol intake per week. This value was then divided by 7 to obtain the average alcohol intake per day. Subjects were asked to estimate their alcohol intake based on *gou*, a traditional Japanese drinking unit corresponding to 23 g of ethanol. One *gou* is equivalent to 180 ml of *sake*, and its ethanol content is roughly equivalent to that of a bottle of beer (663 ml), two single shots of whiskey (70 ml), a half glass of shochu (110 ml), or 240 ml of wine. *Hatupousyu*, which has a taste and ethanol concentration similar to that of beer but includes less malt as a raw material, was calculated as beer. In this study, we defined half a *gou* as one drink (11.5 g of ethanol), a value nearly equal to a 'standard' drink in most countries.[23] Drinkers were defined as those consuming more than 0.6 drinks per week (1 g of ethanol a day). As most drinkers consumed a variety of alcoholic beverages, we defined groups according to the type of beverage most often consumed. Individuals were classified into a specific alcoholic beverage group when the amount of ethanol from that particular beverage exceeded two-thirds of the total amount of ethanol intake, as in a previous study.[5] The groups were defined as *beer, sake, shochu, whisky* or *wine*. Drinkers who could not be classified into any of these five groups were defined as '*other*'.

Dietary salt intake was assessed as urinary sodium excretion. A formula was used to estimate the 24-h sodium excretion from the sodium and creatinine concentrations of a spot urine.[24] Potassium excretion per day was also calculated.

Statistical analysis

The participants who belonged to Company L ($n=526$) were excluded from the analysis, because we did not use the same automatic sphygmomanometer that was used in other companies. Additionally, only 21.1% of the female subjects were

classified as drinkers. This low prevalence did not allow an alcoholic beverage-specific analysis, so we used data only from the male subjects. Of 5346 males, a total of 1011 were excluded for the use of antihypertensive agents ($n=171$) or a lack of information on the questionnaire ($n=840$). Finally, we analysed 4335 subjects (1782 nondrinkers and 2553 drinkers), whose mean age was 38.2 years (range, 20–69; standard deviation, 9.4).

The Statistical Package for Social Science (SPSS ver.10.0J; SPSS Japan, Tokyo) software was used for statistical analysis. As the distribution of serum γ-GTP was positively skewed, a logarithmic transformation was used to normalize the distribution. The *t*-test or the Wilcoxon rank-sum test was used for comparison of the means of risk characteristics between nondrinkers and drinkers. For comparison of the means across the specific alcoholic beverage group, a one-way analysis of variance or Kruskal–Wallis test was used. A linear regression analysis was used to examine the contribution of alcohol consumption (one drink) to blood pressure level in each company by adjusting for age, BMI, urinary sodium and potassium excretion. The partial regression coefficient for total participants was calculated by weighing the partial regression coefficient of each company with the square reciprocal of each standard error.[25] For comparison of the means of blood pressures, analyses of covariance were performed three times adjusting for age, for age and alcohol consumption, and for age, alcohol consumption, BMI, and urinary sodium and potassium excretion. Logistic regression analysis was used to examine the contribution of each type of alcoholic beverage to 'high-normal blood pressure or greater' or to hypertension by adjusting for age (model 1), age and alcohol consumption (model 2) and for all confounding variables (model 3). The group who mainly consumed beer was defined as being a standard.

All probability values were two-tailed and all confidence intervals were estimated at the 95% level.

Results

Table 1 shows the risk characteristics according to drinking habits. Compared with those of nondrinkers, the mean age, urinary sodium excretion, urinary potassium excretion and γ-GTP of drinkers were all significantly greater. The mean alcohol consumption of drinkers was 30.8 g/day. A comparison of the groups classified by the type of alcoholic beverage consumed revealed significant differences in age, BMI, urinary potassium, γ-GTP and total alcohol consumption. Total alcohol consumption tended to decrease in the order of shochu > sake > other > whiskey > wine > beer.

Table 2 demonstrates the association between alcohol consumption and blood pressure in a linear regression analysis in each company. A partial regression coefficient of alcohol consumption to SBP and DBP showed significant positive associations in almost every company, except for Companies A, F and J in SBP, and Companies A and J in DBP. A partial regression coefficient of alcohol consumption for SBP and DBP in the whole population was 0.87 for SBP (standard error (s.e.); 0.09, $P<0.001$) and 0.77 for DBP (s.e.; 0.06, $P<0.001$).

A comparison among the groups according to the type of alcoholic beverage that was mainly consumed exposed significant differences in SBP and DBP (Table 3). Both SBP and DBP were highest in the shochu group. The wine group had the lowest SBP and the beer group had the lowest DBP. The difference in SBP between the shochu and wine groups was 6.9 mmHg, and the difference in DBP between the shochu and beer groups was 3.6 mmHg.

Table 1 Risk characteristics according to drinking habit including the stratification by the type of alcoholic beverage that was mainly cunsumed

Drinking habit	N	*Age (years)*	*BMI (Kg/m²)*	*Urinary sodium excretion (mmol/day)*	*Urinary potassium excretion (mmol/day)*	*γ-GTP[a] (IU)*	*Alcohol consumption (g/day)*
Comparison between nondrinkers and drinkers							
Nondrinkers	1782	36.6 (9.6)	23.0 (3.2)	154.5 (37.0)	41.0 (8.7)	22.6 (1.8)	
Drinkers	2553	39.3 (9.1)	22.9 (2.8)	160.3 (37.2)	43.9 (9.1)	32.5 (2.0)	
		$P<0.001$	$P=0.643$	$P<0.001$	$P<0.001$	$P<0.001$	
Comparison according to sources of ethanol in drinkers							
Beer	1293	37.4 (8.9)	22.7 (2.8)	159.2 (37.0)	43.1 (8.8)	28.8 (2.0)	
Sake	125	45.8 (7.6)	22.3 (2.7)	158.9 (33.4)	44.5 (8.4)	41.0 (2.3)	
Shochu	343	41.5 (9.0)	23.5 (2.9)	164.3 (38.4)	44.9 (10.0)	41.0 (2.1)	
Whisky	68	42.3 (7.3)	23.0 (2.4)	158.7 (39.6)	44.3 (8.2)	40.7 (2.1)	
Wine	50	37.7 (7.5)	22.9 (3.1)	153.7 (33.3)	45.4 (8.9)	25.8 (1.7)	
Other	674	40.5 (9.2)	23.0 (2.8)	161.1 (37.6)	44.9 (9.2)	32.9 (2.0)	
P-values		$P<0.001$	$P<0.001$	$P=0.207$	$P<0.001$	$P<0.001$	

Number in parentheses are standard deviations.
[a]Geometric means of 1322 nondrinkers and 2034 drinkers with blood collection.