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The Effects of Job-Related Factors and Lifestyle on the Five-Year Cumulative Incidence of Hypertension in Japanese Steelworkers

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Abstract: The Effects of Job-Related Factors and Lifestyle on the Five-Year Cumulative Incidence of Hypertension in Japanese Steelworkers: Yasushi OKUBO, *et al.* Department of Hygiene, School of Medicine, Chiba University—We conducted this epidemiological follow-up study from 1990 to 1995 to clarify the effects of job-related factors and/or lifestyle on the five-year cumulative incidence of hypertension in Japanese normotensive steelworkers. The subjects were normotensive 3,061 males aged 40–54 yr, and 2,249 subjects were followed-up completely. Job-related factors (job class, job type and promotion), lifestyle (salt intake, calorie intake, habitual exercise, alcohol consumption and smoking habit) and six subjective symptoms which were thought to be related to mental health were evaluated in relationship to the five-year cumulative incidence of hypertension. The results of the multiple logistic regression analysis indicated that age, mean blood pressure in 1990, and promotion during the five-year period were factors significantly related to hypertension. Odds ratios of age (per 1 year old), mean blood pressure (per 1 mmHg) were 1.08 and 1.19, respectively. Odds ratio of promoted workers to non-promoted workers was 0.56. Promotion was related independently to the five-year cumulative incidence of hypertension. No relationship between hypertension and other job-related factors, blood findings or subjective symptoms was noted. In conclusion, our study suggested that age and mean blood pressure strongly influence the five-year cumulative incidence of hypertension, and promotion reduced the risk of hypertension in male workers.
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Key words: Follow-up study, Incidence, Industrial worker, Office worker, Promotion, Blood pressure, Risk factor

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Cardiovascular diseases are the main cause of premature death and highly ranked among the leading causes of disability among males of working age. Many studies have reported that hypertension is the major risk factor of cardiovascular disease[1–3]. In addition, it was pointed out that illness-related absenteeism and total costs, including medical cost and loss of working time, were high in hypertensive workers[4, 5]. Thus, hypertension should be treated as one of the targets of health management for workers.

It is thought that factors such as obesity, lifestyle, blood findings, mental stress and job-related factors affect the blood pressure of workers. High normal blood pressure[6, 7], obesity[8–10] and lifestyle including lack of habitual exercise[11, 12], excess salt intake[13–15] and drinking habit[16–20], have been suggested as risk factors of hypertension. Some studies also indicated a relationship between hypertension and job-related factors, but the results of these studies are not always similar, especially the relationship between blood pressure or hypertension and job-related factors.

We performed a five-year follow-up study in steelworkers in Japan to clarify the effects of job-related factors and/or lifestyle on the five-year cumulative incidence of hypertension.

Materials and Methods

Subject

We conducted a five-year follow-up study from 1990 to 1995. The subjects were 3,061 male steelworkers in Chiba Pref. in Japan. They were aged 40–54 yr and had normal blood pressure in a periodical health examination in 1990. Workers who were diagnosed with hypertension or had started antihypertension therapy in 1990 were excluded. Furthermore, we excluded 812 subjects who had retired or transferred to other factories from the analysis. Consequently, we could follow-up 2,249 male workers (45.9 ± 3.7 yr of age) completely. All followed-up subjects underwent periodical health examinations in both 1990 and 1995. The subjects' profile is shown in Fig. 1.

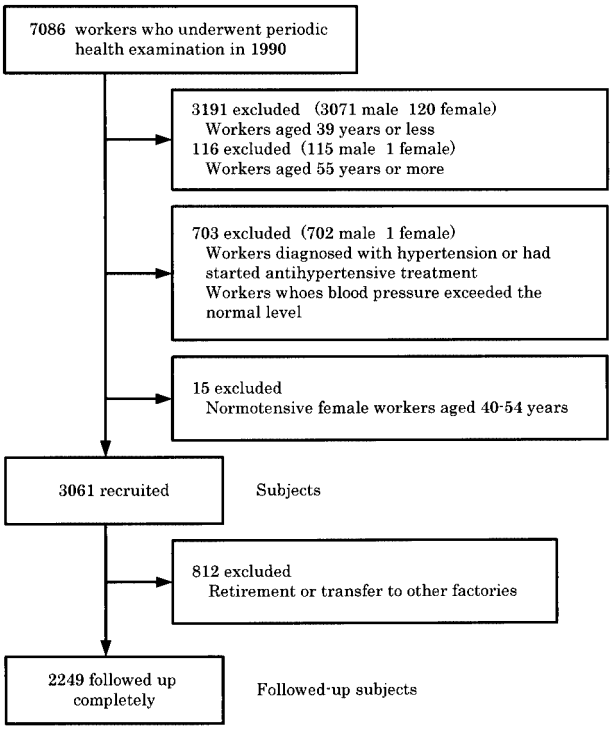

Fig. 1. Subjects' profiles

Blood pressure measurement

The blood pressure was measured in the sitting position by a nurse with an automatic sphygmomanometer (BP103 made by COLIN) at the periodical health examinations in both 1990 and 1995. When a blood pressure which exceeded normal was shown, we take it measure three or four times after from 5 to 30 min. Consequently, when the blood pressure was at a hypertensive level, we took it again on another day, and the lowest blood pressure was adopted.

In univariate analysis, we classified blood pressure in 1990 into high normal blood pressure (high normal: systolic blood pressure was 130–139 mmHg and/or diastolic blood pressure was 85–89 mmHg) and normotensive (systolic blood pressure of 129 mmHg or less and diastolic blood pressure of 84 mmHg or less). In multiple logistic regression analysis, mean blood pressure in 1990 (diastolic blood pressure plus one third of pulse pressure) was used as a dependent variable.

We classified blood pressure in 1995 into hypertensive (systolic blood pressure was 140 mmHg or more and/or diastolic blood pressure was 90mmHg or more) and non-hypertensive (systolic blood pressure of 139 mmHg or less and diastolic blood pressure of 89 mmHg or less). Subjects who started antihypertensive therapy during the observation period were classified as having hypertension. The reason why borderline cases (systolic blood pressure of 140–159 mmHg and/or diastolic blood pressure of 90–94 mmHg) were classified as having hypertension was that workers who were borderline needed following up from the viewpoint of preventive medicine.

Job-related factors

Job class, job type and promotion were used as variables of job-related factors. Job class in 1990 was classified into two categories: workers and managers. Similarly, job type in 1990 was classified into two categories: factory workers and office workers. Promotion was classified into two categories according to the presence/absence of promotion during the observation period. Promotion included not only promotion from worker to manager but also other types of promotion, for example promotion from worker to chief, which were in the same job class.

We confirmed that high blood pressure or the existence of hypertension had never affected the assessment of an employee's performance including the decision to promote in this company.

The number of subjects according to job class, job type and promotion are shown in Table 1.

Lifestyle and subjective symptoms

Salt intake, calorie intake, habitual exercise, alcohol consumption and smoking habit were used as variables related to lifestyle. Six items thought to be related to mental health among 50 subjective symptoms were used: "Insufficient sleep", "Anxiety", "Irritation", "Depressive mood", "Lack of self-confidence" and "Fatigue". A self-administered questionnaire was used to examine lifestyle and subjective symptoms at the periodical health examination in 1990, and the contents were confirmed in an individual interview by a public health nurse.

We investigated the average content of meals during a day, and calculated salt intake and calorie intake by using the 4th revision of the table of Japanese food standard components (Resources Council, Science and Technology Agency; Tokyo, 1992). The amount of habitual exercise was calculated based on the results of examination of the kinds of exercise, frequency and regular exercise time. The degree of alcohol consumption was calculated based on the results of the examinations of the kinds of drinking, the frequency of drinking and the average amount of alcohol consumption at one time. Gou, which is the unit expressing the volume of alcoholic beverages in Japan, was used to quantify the volume of alcohol consumed. One gou corresponds to 27 m*l* of ethanol. Smoking habit was evaluated according to the presence of a smoking habit and the amount smoked. Workers who had previously smoked but were non-smokers in 1990 were classified as non-smokers.

Each lifestyle was classified into two categories by the later values: salt intake=12 g/d, calorie intake=35 kcal/

Table 1. Numer of followed-up subjects and retired or transferred subjects

Number of subjects	Category (unit) (person)	Followed-up subjects			Retired or transferred subjects		
		40–44	45–49	50–54	40–44	45–49	50–54
		775	1163	311	66	255	491
Physical examination							
Blood pressure	normotension / high normal	520 / 255	815 / 348	189 / 122	47 / 19 n.s.	165 / 90 n.s.	320 / 171 n.s.
BMI	<25.0 / ≧25.0 (kg / m^2)	679 / 96	1046 / 119	268 / 43	50 / 16 n.s.	201 / 54 n.s.	371 / 120 n.s.
Job-related factor							
Job class	Workers / Managers	637 / 138	905 / 258	278 / 33	38 / 28 ***	82 / 173 ***	335 / 156 ***
Job type	Factory workers / Office workers	630 / 145	936 / 227	288 / 23	50 / 16 n.s.	202 / 53 n.s.	377 / 114 ***
Promotion	Non-promoted / Promoted	523 / 252	1055 / 108	309 / 2			
Blood examinations							
GTP	≦60 / >60 (IU)	693 / 82	1022 / 141	270 / 41	55 / 11 n.s.	216 / 39 n.s.	443 / 48 n.s.
Total serum cholesterol	<220 / ≧220 (mg / d*l*)	643 / 132	955 / 208	241 / 70	51 / 15 n.s.	204 / 51 n.s.	386 / 105 n.s.
Triglyceride	<150 / ≧150 (mg / d*l*)	544 / 231	873 / 290	240 / 71	48 / 18 n.s.	187 / 68 n.s.	379 / 112 n.s.
HDL cholesterol	≧40 / <40 (mg / d*l*)	674 / 101	1030 / 133	277 / 34	56 / 10 n.s.	223 / 32 n.s.	422 / 69 n.s.
Uric acid	≦7.8 / >7.8 (mg / d*l*)	752 / 23	1128 / 35	299 / 12	65 / 1 n.s.	245 / 10 n.s.	480 / 11 n.s.
Creatinine	≦1.00 / >1.00 (mg / d*l*)	758 / 17	1132 / 33	298 / 13	64 / 2 n.s.	244 / 11 n.s.	479 / 12 n.s.
IGT	non-IGT / IGT	741 / 34	1063 / 100	280 / 31	61 / 5 n.s.	235 / 20 n.s.	436 / 55 n.s.
Lifestyle							
Salt intake	≦12 / >12 (g / d)	319 / 456	502 / 661	129 / 182	37 / 29 *	130 / 125 *	231 / 260 n.s.
Calorie intake	<35.0 / ≧35.0 (kcal / kg / d)	545 / 230	816 / 347	218 / 93	52 / 14 n.s.	198 / 57 *	371 / 120 n.s.
Exercise	≧200 / <200 (kcal / d)	67 / 708	140 / 1023	34 / 277	5 / 61 n.s.	28 / 227 n.s.	65 / 426 n.s.
Alcohol consumption	<10.0 / ≧10.0 (gou / wk)	540 / 235	818 / 345	217 / 94	54 / 12 *	181 / 74 n.s.	376 / 115 *
Smoking habit	≦20 / ≧21 (cigarette / d)	582 / 193	900 / 263	252 / 59	51 / 15 n.s.	189 / 66 n.s.	378 / 113 n.s.
Subjective symptoms							
Insufficient sleep	absence / presence	700 / 75	1048 / 115	274 / 37	60 / 6 n.s.	210 / 45 ***	424 / 67 n.s.
Anxiety	absence / presence	750 / 25	1128 / 35	294 / 17	63 / 3 n.s.	239 / 16 *	470 / 21 n.s.
Irritation	absence / presence	759 / 16	1135 / 28	300 / 11	65 / 1 n.s.	247 / 8 n.s.	466 / 25 n.s.
Depressive mood	absence / presence	768 / 7	1146 / 19	308 / 3	66 / 0 n.s.	248 / 7 n.s.	485 / 6 n.s.
Lack of self-confidence	absence / presence	766 / 9	1134 / 29	301 / 10	65 / 1 n.s.	240 / 15 **	475 / 16 n.s.
Fatigue	absence / presence	730 / 45	1093 / 70	292 / 19	59 / 7 n.s.	220 / 35 ***	452 / 39 n.s.

Chi-square test was performed to compare each veriable for analyzed subjects and retired or transferred subjects according to age group. n.s.: not significant, *: p<0.05, **: p<0.01, ***: p<0.001. BMI: body mass index, IGT: ignored glucose tolerance.

kg/d, habitual exercise=200 kcal/d, alcohol consumption=10 gou/wk, smoking habit=20 cigarettes/d. In univariate analysis, they were used as the categorical variables. Our adoption the level of 10 gou/wk in the classification of drinking habit was based on the reports which suggested that less than 2–3 drinks/d (1drink: 10–12 m*l* of ethanol) did not increase blood pressure[19–21].

The check list of six answers regarding subjective symptoms of answers consisted of "not at all", "occasionally", and "almost always". For each question, a "presence" was defined as a respondent who answered "occasionally" or "almost always". Each subjective symptom was classified into two categories by the presence/absence of each symptom.

The number of subjects according to lifestyle and subjective symptoms are shown in Table 1.

Physical measurements and blood examinations

In addition to blood pressure, we used nine items which were measured at the periodical health examination in 1990: age, body mass index (BMI) and blood findings such as gamma-glutamyl transpeptidase (GTP), total serum cholesterol, triglyceride, HDL cholesterol, uric acid, creatinine and plasma glucose.

Workers whose plasma glucose exceeded 160 mg/d*l* were classified as having impaired glucose tolerance (IGT). The presence of IGT was used as a variable. Workers who had been diagnosed with diabetes mellitus or had started receiving treatment in a hospital were classified as having IGT.

Age was classified into three categories: 40–44 yr, 45–49 yr and 50–54 yr. Other items were classified into two

categories by the reference values: BMI=25 kg/m^2, GTP=60 IU, total serum cholesterol=220 mg/d*l*, triglyceride=150 mg/d*l*, HDL cholesterol=40 mg/d*l*, uric acid=7.8 mg/d*l* and Creatinine=1.0 mg/d*l*. BMI was classified according to the WHO criteria for obesity[22]. These variables were used as categorical variables in univariate analysis. Blood was taken while fasting.

Our laboratory participated in the external quality control programs which were administered by the Japan Medical Association and National Federation of Industrial Health Organization. Furthermore, four kinds of standard samples were measured among every 100 samples in the internal quality control program. In addition, we confirmed that there was no change in the analytical method during the observation period.

The number of subjects according to physical measurements and results of blood examination are shown in Table 1.

Statistical analysis

In univariate analysis, the relationships between the five-year cumulative incidence of hypertension and each variable were examined by Chi-squared test. When the expectation frequency became less than five, Fisher's exact test was used.

In multivariate analysis, it was considered that variables were related to each other, and multiple logistic regression analysis was therefore done to clarify the independent relationship between the five-year cumulative incidence of hypertension and all independent variables including age, mean blood pressure, job-related factors, lifestyle, physical findings, blood findings and subjective symptoms in 1990. In multiple logistic regression analysis, the variables of blood findings and lifestyle were used as continuous variables except for IGT and alcohol consumption. The variables were selected by using the backward elimination method (Likelihood ratio method, out: $p>0.10$). All statistical analysis was conducted with SPSS version 7.5.1.

Results

The five-year cumulative incidence of hypertension according to age group, job-related factors, the results of the health examination, lifestyle and subjective symptoms is shown in Table 2.

Age group, blood pressure and BMI in univariate analysis

The five-year cumulative incidence of hypertension was 6.8%, 10.9% and 16.1% in the workers aged 40–44, 45–49 and 50–54 yr, respectively. The five-year cumulative incidence rose with age. As for blood pressure, the five-year cumulative incidence was 4.5% in normotension and 22.3% in high normal, this difference being significant. The five-year cumulative incidence of hypertension was 9.3% in the group in which BMI was less than 25 kg/m^2 and 13.6% in the group in which BMI was 25 kg/m^2 or more, this difference also being significant.

Job-related factors in univariate analysis

In job-related factors, significant relationships were observed in job type and promotion. The five-year cumulative incidence of hypertension was 10.8% in factory workers and 7.3% in office workers, a significant difference. The five-year cumulative incidence of hypertension in promoted workers was 5.2% and 11.2% in non-promoted workers. The five-year cumulative incidence in promoted workers was significantly lower than that in non-promoted workers.

Blood examinations, lifestyle and subjective symptoms in univariate analysis

GTP and creatinine were closely related to hypertension. The five-year cumulative incidence of hypertension in the groups that exceeded the reference values was higher than in the groups within the reference values.

Significant relationships were observed between the five-year cumulative incidence of hypertension and habitual exercise, alcohol consumption or smoking habit. The five-year cumulative incidence of hypertension in the group consuming 200 kcal/d or more in habitual exercise and in the group consuming less than 200 kcal/d was 14.1% and 9.8%, respectively. The five-year cumulative incidence of hypertension in the group consuming of alcohol 10 gou/wk or more and in the group consuming less than 10 gou/wk was 12.9% and 9.1%, respectively. The five-year cumulative incidence of hypertension in the group smoking 20 cigarettes/d or less and in the group smoking 21 cigarettes/d or more was 11.1% and 7.2%, respectively.

No significant relationships between the five-year cumulative incidence of hypertension and subjective symptoms were observed.

Multiple logistic regression analysis

The results of multiple logistic regression analysis are shown in Table 3.

In the results, age, mean blood pressure in 1990 and promotion during five years were selected as significant ($p<0.05$) independent variables by the backward elimination method.

The odds ratios for age (per 1 year old) and mean blood pressure (per 1 mmHg) were 1.08 and 1.19, respectively. The odds ratio for promoted workers to non-promoted workers was 0.56, and it showed that promotion reduced the risk of hypertension.

In addition, we conducted multiple logistic regression analysis excluding mean blood pressure in 1990 from independent variables. In the results of this analysis, age, BMI, smoking habit, alcohol consumption and promotion

Table 2. The five-year cumulative incidence of hypertension according to age group, job-related factors, the results of health examinations, lifestyle and subjective symptoms in 1990

Variables	Unit	Category	N	Followed-up subjects		
				Normotension	Hypertension[#]	
Age group	year old	40~44	775	93.2% (722)	6.8% (53)	
		45~49	1163	89.1% (1036)	10.9% (127)	
		50~54	311	83.9% (261)	16.1% (50)	***
Blood pressure		normotension	1524	95.5% (1456)	4.5% (68)	
		high normal	725	77.7% (563)	22.3% (162)	***
BMI	kg/m^2	<25.0	1740	90.7% (1579)	9.3% (161)	
		≧25.0	509	86.4% (440)	13.6% (69)	***
Job-related factors						
Job class		Workers	1820	89.5% (1629)	10.5% (191)	
		Managers	429	90.9% (390)	9.1% (39)	n.s.
Job type		Factory workers	1854	89.2% (1653)	10.8% (201)	
		Office workers	395	92.7% (366)	7.3% (29)	*
Promotion		Non-promoted	1887	88.8% (1676)	11.2% (211)	
		Promoted	362	94.8% (343)	5.2% (19)	**
Results of the health examination						
GTP	IU	≦60	1985	90.3% (1792)	9.7% (193)	
		>60	264	86.0% (227)	14.0% (37)	*
Total serum cholesterol	mg/d*l*	<220	1839	90.1% (1657)	9.9% (182)	
		≧220	410	88.3% (362)	11.7% (48)	n.s.
Triglyceride	mg/d*l*	<150	1657	90.3% (1497)	9.7% (160)	
		≧150	592	88.2% (522)	11.8% (70)	n.s.
HDL cholesterol	mg/d*l*	≧40	1981	89.6% (1775)	10.4% (206)	
		<40	268	91.0% (244)	9.0% (24)	n.s.
Uric acid	mg/d*l*	≦7.8	2179	89.8% (1956)	10.2% (223)	
		>7.8	70	90.0% (63)	10.0% (7)	n.s.
Creatinine	mg/d*l*	≦1.00	2187	90.0% (1968)	10.0% (219)	
		>1.00	62	82.3% (51)	17.7% (11)	*
IGT		non-IGT	2084	89.6% (1867)	10.4% (217)	
		IGT	165	92.1% (152)	7.9% (13)	n.s.
Lifestyle						
Salt intake	g/d	≦12	950	90.9% (864)	9.1% (86)	
		>12	1299	88.9% (1155)	11.1% (144)	n.s.
Calorie intake	kcal/kg/d	<35.0	1579	90.4% (1427)	9.6% (152)	
		≧35.0	670	88.4% (592)	11.6% (78)	n.s.
Exercise	kcal/d	≧200	241	85.9% (207)	14.1% (34)	
		<200	2008	90.2% (1812)	9.8% (196)	*
Alcohol consumption	gou/wk	<10.0	1575	90.9% (1432)	9.1% (143)	
		≧10.0	674	87.1% (587)	12.9% (87)	**
Smoking habit	cigarette/d	≦20	1734	88.9% (1541)	11.1% (193)	
		>21	515	92.8% (478)	7.2% (37)	*
Subjective symptoms						
Insufficient sleep		absence	2022	90.1% (1821)	9.9% (201)	
		presence	227	87.2% (198)	12.8% (29)	n.s.
Anxiety		absence	2172	89.8% (1951)	10.2% (221)	
		presence	77	88.3% (68)	11.7% (9)	n.s.
Irritation		absence	2194	89.9% (1973)	10.1% (221)	
		presence	55	83.6% (46)	16.4% (9)	n.s.
Depressive mood		absence	2221	89.8% (1995)	10.2% (226)	
		presence	28	85.7% (24)	14.3% (4)	n.s.
Lack of self-confidence		absence	2201	89.9% (1978)	10.1% (223)	
		presence	48	85.4% (41)	14.6% (7)	n.s.
Fatigue		absence	2115	89.7% (1897)	10.3% (218)	
		presence	134	91.0% (122)	9.0% (12)	n.s.

n.s.: not significant, *: p<0.05, **: p<0.01, ***: p<0.001 (Chi-squared test). BMI: body mass index, IGT: impaired glucose tolerance. [#]Hypertension includes borderline.

Table 3. Results of the multiple logistic regression analysis

Variables		Model including mean blood pressure			Model excluding mean blood pressure		
		OR	(95% C.I.)	P value	OR	(95% C.I.)	P value
Results of physical measurements in 1990							
Age	per 1 year old	1.08	(1.03, 1.12)	0.001	1.09	(1.05, 1.14)	<0.001
Mean blood pressure	per 1 mmHg	1.19	(1.16, 1.22)	<0.001	#		
BMI	per 1 kg/m^2	–			1.14	(1.08, 1.21)	<0.001
Job-related factors							
Job class	Workers / Managers	–			–		
Job type	Factory workers / Office work	–			–		
Promotion	Non-promoted / Promoted	0.56	(0.33, 0.95)	0.031	0.59	(0.35, 0.98)	0.044
Results of blood tests in 1990							
GTP	per 1 IU	–			–		
Total serum cholesterol	per 1 mg/d*l*	–			–		
Triglyceride	per 1 mg/d*l*	–			–		
HDL cholesterol	per 1 mg/d*l*	–			–		
Uric acid	per 1 mg/d*l*	–			–		
Creatinine	per 1 mg/d*l*	–			–		
IGT	non-IGT / IGT	–			–		
Lifestyle in 1990							
Salt intake	per 1 g/d	–			–		
Calorie intake	per 1 kcal/kg/d	–			–		
Exercise	per 1 kcal/d	–			–		
Alcohol consumption	Light drinker / heavy drinker	–			1.61	(1.21, 2.16)	0.001
Smoking habit	per 1 cigarette/d	–			0.99	(0.98, 0.99)	0.011
Subjective symptoms in 1990							
Insufficient sleep	absence / presence	–			–		
Anxiety	absence / presence	–			–		
Irritation	absence / presence	–			–		
Depressive mood	absence / presence	–			–		
Lack of self-confidence	absence / presence	–			–		
Fatigue	absence / presence	–			–		

Odds ratio (OR): The ratio of the latter to the former. Method of the selection of variables: backward elimination. Light drinker: Subjects who drink less than 10 gou/wk and include non-drinkers. Heavy drinker: Subjects who drink 10 gou/wk or more. –: not selected. #: not include.

were selected as significant independent variables.

We divided the subjects into categories by age group, blood pressure, BMI, alcohol consumption, smoking habit and promotion, and obtained the five-year cumulative incidence of hypertension in each category. Consequently, we adjusted the five-year cumulative incidence of hypertension by blood pressure, age group, BMI, alcohol consumption and smoking habit by means of ANOVA, and compared the five-year cumulative incidence for promoted workers and non-promoted workers. The results were shown in Fig. 2–5. The promoted workers showed a significantly lower five-year cumulative incidence of hypertension than the non-promoted ones.

Discussion

Julius *et al.*[23] estimated that the frequency of change from normotension to borderline hypertension was about 1% per year in middle age. Itsuno *et al.*[7] reported that 145 (13.2%) hypertensive subjects including borderline cases were observed in 1,099 normotensive workers aged 40–60 yr during a five-year observation period. In our study, the incidence of hypertension including borderline was 6.8% in 40–44 yr, 10.9% in 45–49 yr, 16.1% in 50–54 yr and 10.2% in all age groups after five years. Although Izuno did not report the incidence according to age, it was considered that the five-year cumulative incidence of hypertension in our study was lower than

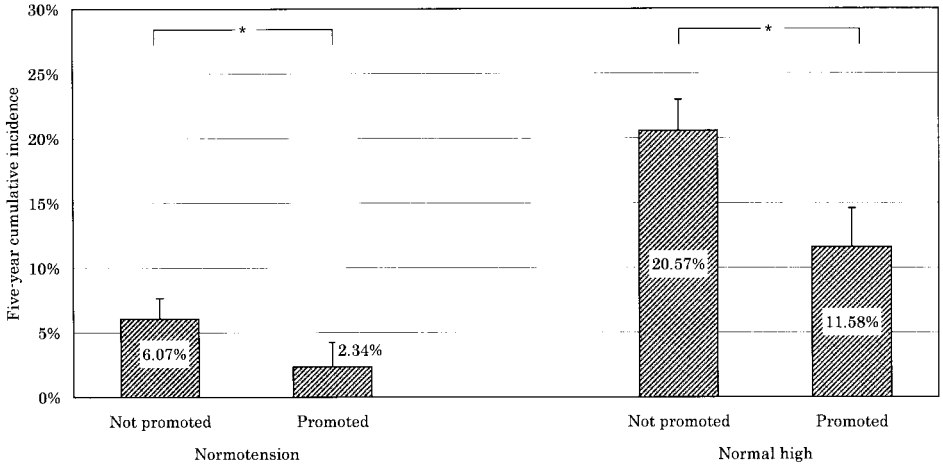

Fig. 2. Comparison of the five-year cumulative incidence of hypertension in not promoted and promoted subjects (Mean ± S.E.) (Age, BMI, alcohol consumption and smoking habit were adjusted). *: $p<0.05$.

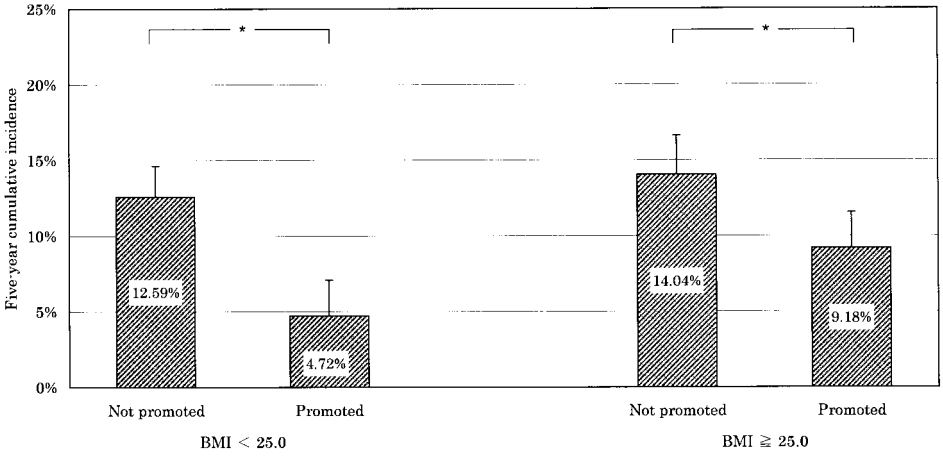

Fig. 3. Comparison of the five-year cumulative incidence of hypertension in not promoted and promoted subjects (Mean ± S.E.) (Age, blood pressure, alcohol consumption and smoking habit were adjusted). *: $p<0.05$.

that reported by Itsuno.

Various studies have investigated the effects of job-related factors on disease such as cardiovascular disease and pointed out differences in the incidence and mortality rate according to job-related factors[24, 25]. Fukuda *et al.*[26] pointed out that blood pressure differed according to the occupation category in workers in a Japanese railway company. On the other hand, some studies did not confirm a significant relationship between blood pressure and occupation category[27, 28]. Konishi *et al.*[29] performed a follow-up study from 1963 to 1985 in male workers. They concluded that the difference between clerical and manual workers in blood pressure had become smaller 20 yr later.

Some studies which investigated the relationship between hypertension and job-related factors are available. Cobb *et al.*[30] performed a cross-sectional study on air traffic controllers (4,325 persons, average age 35.1 yr), and concluded that the prevalence of hypertension in the high workload group was significantly higher than that in the low workload group. Komachi *et al.*[31] compared the prevalence of hypertension in 1,086 male workers aged 40–69 yr in a cross-sectional study, and pointed out that the prevalence of hypertension in managers was significantly higher than that in manual and clerical workers. Morikawa *et al.*[32] conducted a nine-year follow-up study of 538 male workers aged 35–44 yr. They noted that the proportion of hypertension in "managerial officers" was significantly higher than that in "light or medium physical intensity laborers" and

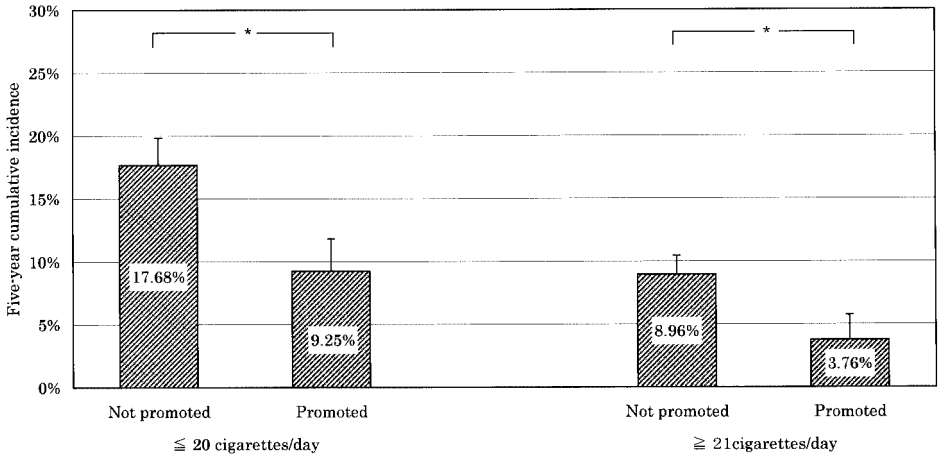

Fig. 4. Comparison of the five-year cumulative incidence of hypertension in not promoted and promoted subjects (Mean ± S.E.) (Age, blood pressure, alcohol consumption and BMI were adjusted). *: $p<0.05$.

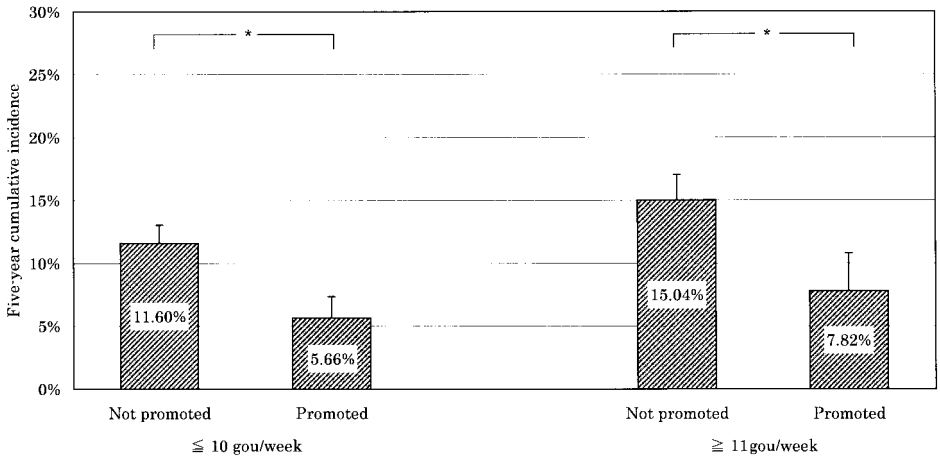

Fig. 5. Comparison of the five-year cumulative incidence of hypertension in not promoted and promoted subjects (Mean ± S.E.) (Age, blood pressure, BMI and smoking habit were adjusted). *: $p<0.05$.

"heavy physical intensity laborers". On the other hand, there was a report which did not show a significant relationship between hypertension and job-related factors. Sugimori *et al.*[33] conducted a 15-yr cohort study of 2,257 male workers. They used a Cox proportion hazard model and investigated the relationship between the incidence of hypertension and job type in managers, office workers, salespersons, blue-collar workers and engineers. They found that each type of occupation had a different pattern of risk factors for hypertension, but they could not confirm any significant relationship between the incidence of hypertension and job type.

We could not confirm a relationship between the five-year cumulative incidence of hypertension and job class. We confirmed the relationship between the five-year cumulative incidence of hypertension and job type in a Chi-square test, but not in a multiple logistic regression analysis. At the time of the investigation, the participants' work consisted mainly of operating machines, driving and superintending. In addition, deskwork for factory workers had increased. Consequently, we thought that the difference between managers and workers or factory workers and office workers in work content might have become smaller than before.

We found that promotion has a characteristic effect; promotion reduces the risk of the five-year cumulative incidence of hypertension. As far as we know there are no reports revealing the effect of promotion on the incidence of hypertension. Promotion is thought to be a life event and a stressor. Although the job stress model

proposed by Karasek[34] suggested that job demands was a risk factor, this effect of promotion may be explained partly by an effort reward imbalance model, which was proposed by Siegrit *et al.*[35, 36] According to this model, a situation which involved high effort and low reward was most stressful and was related to hypertension. It is considered that promotion is one type of high reward.

The effect of job stress on blood pressure or hypertension has been reported. Matthews *et al.*[37] reported that job dissatisfaction is a risk factor for hypertension in blue-collar workers. Curtis *et al.*[38] investigated 726 African-Americans and suggested that decision latitude might be important for hypertension risk. In contrast, Aro *et al.*[39] performed a five-year follow-up study on 388 workers and concluded that obesity was related to blood pressure, but occupational stress was not. In our study, we used subjective symptoms which were thought to be related to mental health to evaluate the job stress of the subjects examined, but none of these subjective symptoms was significantly related to the five-year cumulative incidence of hypertension determined by the Chi-square test or multiple logistic model.

In this study, the proportions of the retired or transferred subjects in the group of office workers aged 50–54 yr or managers were higher than those in the group of workers or factory workers, but we confirmed that retirement was never compelled, and in office workers transference to other factories was scheduled without consideration of their health status. In addition, in the subjects we could not find either a critical event or a retirement which was related to blood pressure. Furthermore, 97% or more of workers had a health examination every year. We are therefore confident that the results of this study were not influenced by the retired or transferred subjects.

Obesity is considered to be a progressive factor of hypertension[9]. Stamler *et al.*[10] reported that body weight was related to blood pressure even in the absence of obesity. In addition, there are many reports stating that reducing weight reduces the risk of hypertension by 40% to 60%[40–42]. In our study, we found that the odds ratio of a 1 kg/m^2 increase in BMI was 1.14 in a multiple logistic model excluding blood pressure in 1990 as an independent variable. This suggests that weight control is important in preventing hypertension.

It is reported that exercise 3 times per week is effective in reducing blood pressure[11, 12], but in our study we found no relationship between hypertension and habitual exercise in the multiple logistic regression analysis. In addition, a relationship between hypertension and salt intake was reported[13–15], but we could not confirm the effect of salt intake on the five-year cumulative incidence of hypertension either.

Many longitudinal studies evaluating the effect of alcohol consumption on hypertension have been carried out[17–20]. In these studies it was reported that increased alcohol consumption affects both systolic and diastolic blood pressure. Dyer *et al.*[19] and Klatsky *et al.*[20] reported that small doses of alcohol are not a high risk factor for hypertension. We could confirm a significant relationship between the five-year cumulative incidence of hypertension and alcohol consumption in a multiple logistic model excluding blood pressure in 1990 as an independent variable.

Yamada *et al.*[43] reported that GTP is independently related to high blood pressure, but GTP was not significant in our investigation.

It was reported that the blood pressure of smokers was lower than that of non-smokers[44]. Our study found a similar relationship between the five-year cumulative incidence of hypertension and smoking habit in a multiple logistic model excluding blood pressure in 1990 as an independent variable. On the other hand, it was reported that smoking is a risk factor for malignant hypertension in hypertensive patients and resists antihypertensive drugs[45]. In this case, education against smoking may be valuable in the prevention of hypertension.

The relationship between IGT (including DM) and the incidence of hypertension has been reported. In these reports it was also pointed out that hyperinsulinemia was related to hypertension[46–48]. In contrast, a number of other epidemiological studies failed to confirm these relationships[49–51]. In our investigation, although the existence of hyperinsulinemia was not examined, we failed to find a significant relationship between the five-year cumulative incidence of hypertension and IGT in a multiple logistic regression analysis including blood pressure as an independent variable. So that we could not confirm the effect of IGT on the incidence of hypertension.

In this study, we could not evaluate the subjects who had had abnormal blood pressure or recovered normal blood pressure during five years. We have to consider the possibility that the repetitive measurement of blood pressure of subjects who had abnormal blood pressure in 1990 affected the results. In addition, because job stress was not investigated by an established method and the mechanism of the effect of promotion was unclear, a further study to elucidate these concerns is needed.

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