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Original Article

Job stress and behavioral characteristics in relation to coronary heart disease risk among Japanese police officers

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Abstract: This study examined the association between job-related behavioral characteristics and the risk of coronary heart diseases (CHD) in Japanese male police officers. Compared to office clerks, police officers exhibited greater age-related increases of the prevalence of CHD risk factors, and a clustering number of CHD risk factors was significantly higher in the group of those over 45 yr of age. Among the police officers, coronary-prone behavior was more frequent than that seen in office clerks. The police officers with coronary-prone behavior tended to engage in shift work and to work overtime more; yet they were less likely to perceive job stress and to express the relevant physical and psychological symptoms than those without coronary-prone behavior. The subjects with such behavioral characteristics had a significantly greater number of CHD risk factors. In a multiple regression analysis, coronary-prone behavior together with age, social support, walking hours per day, and amount of alcohol consumption were selected as significant determinants of a cluster of CHD risk factors. These results suggest that coronary-prone behavior may contribute to the higher prevalence of CHD risk factors in police officers via leading the long working hours and the work-related unfavorable lifestyles, such as alcohol drinking and physical inactivity.

Key words: Police officers, Coronary heart diseases, Behavioral characteristics, Job stress, Working condition

Introduction

The work environment is known to exert both beneficial and negative health effects among the working population. Police work by nature is a particularly stressful occupation in which officers are exposed to a wide variety of stressors. These stressors include factors common to other occupations such as shift work, long working hours, lack of decision making power, lack of support from superiors[1–3], and other factors typically associated with the specific tasks of a professional police officer such as those resulting from violence or the use of weapons[4, 5].

A number of studies have demonstrated the higher prevalence of coronary heart disease (CHD) and CHD risk factors in police officers compared to general population[6–13]. According to the statistical report from the National Police Agency of Japan[14], police officers have a higher sickness absence rate due to CHD compared to those seen among the other public service employees; and, CHD is one of the most frequent causes for mortality in their occupational

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life. In this regards, several studies of occupational stress demonstrated that the psychosocial environmental factors (i.e., job as law enforcement[6–8], high effort-reward imbalance[15], and posttraumatic stress disorder[16] were associated with the risk for developing CHD among workers. In addition, shift work, a major stressor in police work, has been found to lead to disruption of circadian rhythms and adverse cardiovascular outcomes[17, 18]; and further, unhealthy habits have arisen from police work, such as irregular food habits, a lack of regular exercise and inadequate sleep, may contribute to the increase in the risk of metabolic disorders and CHD[6, 9, 10, 13]. However, studies investigating occupational stress among police officers in Japan are still limited; hence, the reasons for their higher risk of CHD have not been understood fully.

Furthermore, in most previous studies, stress was often investigated through the conceptual framework of environmental load, in which occupational conditions at work are held responsible for stress, and less attention was given to individual differences in work stress. However, personality factors are associated with perceived stress levels or reactivity to environmental stressors, and it could influence vulnerability or resilience to job stress[19–21]. In fact, a few recent studies have revealed that symptoms of anxiety, depression and hostility are not higher in police officers than other groups of workers, and suggested that stress levels and its related subjective symptoms of police officers are rather comparable or lower than those of different category employees[22–24]. Therefore, the personality factors should be taken into account when evaluating the effect of occupational stress on health problems among police officers. In addition, it is well recognized that certain behavioral characteristics, representatively known as the type A behavior pattern, increase the risk for developing CHD[25], and such behavioral characteristics were found to be more frequent among police officers compared to those among general population[20, 21]. On the basis of these findings, we hypothesized that peculiar personality profiles of police officers might mediate the association between work-related stress and risk of CHD observed in the previous studies. However, very few studies have considered the behavioral characteristics that may lead to an increased incidence of CHD among police officers.

Therefore, in the present study, we simultaneously assessed job stress and coronary disease-prone behavioral characteristics among police officers and examined whether the personality variables contributed to the high prevalence of risk factors for developing CHD.

Subjects and Methods

Study subjects

A cross-sectional sample of 1,196 middle-aged men (mean age, 44.8 ± 9.5 yr) was recruited for this study from a total of 2,177 police personnel who submitted to general medical examination in combination with a mental health check-up conducted annually at the police station in Japan. The inclusion criteria were subjects who (1) were ≥30 yr and <60 yr of age; (2) had been engaging in full time work for more than five yr; (3) were not restricted by their job for reasons such as chronic illness or mental disorder; and (4) did not have incomplete data on CHD risk factors, job stress, behavioral characteristics, and the other covariates. The subjects were composed of 1,081 police officers and 115 office clerks of all ranks, from officers to management.

The prefectural police examined in this study were composed of one headquarter and 14 police stations. The police headquarters had the departments of police administration, community safety, criminal investigation, traffic, and security. The job position among police officers in a prefectural police-unit consists of an officer, sergeant, inspector, chief inspector, superintendent, and commissioner. The number of police personnel who were belonged to the prefectural police was approximately 2,500 at the time of survey; and the ratio of police officers and office clerks was approximately 9 : 1.

Written informed consent to participate and clearance for the examination data to be used were obtained from the subjects after they received an explanation of the study aim and procedures. The study protocol and informed consent procedures were approved by the Ethics Committee of Wakayama Medical University.

General procedures

The subjects underwent general medical examinations, including anthropometric, physiological, and blood biochemical measurements. All measurements were carried out in a quiet, temperature-controlled room and conducted in the morning after an overnight fast and an abstinence from smoking and caffeine for at least three h before the examination. Any subjects using medications were advised to refrain from taking them for 24 h before the examination.

The anthropometric measurements were collected with each subject wearing light clothing without shoes. Body mass index (BMI) was calculated as the weight-to-squared-height ration (w/h^2). Waist circumference was measured at the end of normal expiration, at the midpoint between the

iliac crest and the lower edge of the ribs in the midaxillary line using a standard non-stretchable flexible measuring tape. When the subject was in a comfortable seated position, the blood pressure was measured in the left arm using digital sphygmomanometer. Means of two readings of systolic and diastolic blood pressure were used in the analysis. Venous blood samples were obtained from the antecubital vein for the measurement of serum concentrations of total cholesterol, high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, triglycerides, fasting blood glucose, and uric acid. The subjects completed a structured, self-reporting questionnaire about personal medical histories, medication used, working condition, and habits of daily living including smoking, alcohol consumption, physical activity, and sleep condition.

Job stress

The stressors and its relevant psychological and physical outcomes in the workplace were assessed by means of the Brief Job Stress Questionnaire (BJSQ)[26]. It is a multidimensional job stress questionnaire composed of questions related to (1) job stressors (nine factors with 17 items: e.g., quantitative job overload, qualitative job overload, and job control); (2) stress response (six factors with 29 items: e.g., psychological stress response and physical stress response); and (3) workplace social support (two factors with 6 items; e.g., supervisor support and coworker support), as shown in Table 3. Reliability and validity of the BJSQ among employees had already established[26], and the BJSQ has been proven to be a useful tool for investigating a psychosocial work environment[27].

In this study, the standardized scores were calculated respectively for a total of 17 factors of the questionnaire according to the BJSQ guidelines[26]. For example, the personal score for the factor of "quantitative job overload" was calculated based on the answers of the following three questions; "Q1: Do you have to work hard?" "Q2: Do you have to do a lot of work?", and "Q3: Do you have difficulty completing your tasks within your schedule?" The response to each question was based on a four-point Likert scale and scores ranged from "agree"=1 to "disagree"=4. The personal score was calculated initially by summing the score of the three questions; and then, this raw score was converted to the standardized score with a five-point scale based on the standard scoring system, in which the value decreases with increasing job-overload level; that is, a value of 1 indicates high job overload, and a value of 5 indicates low job overload. Subsequently, we arbitrary defined the subjects who had a standard score of 2 or less as the "high job-overload group" and those who had a score of greater than 3 as the "low job-overload group." By this procedure, the subjects were respectively grouped into one of two strata (lower score category or higher score category) for another 16 factors in the questionnaire. Furthermore, we calculated mean values for three subscales, namely job stressor, stress response, and social support, by summing the standard score of the relevant containing factors and then dividing the total score by the number of factors, in order to compare each other.

Coronary disease-prone behavior

The behavioral characteristics in relation to CHD were evaluated using the Japanese Coronary-prone Behavior Scale (JCBS), which was developed to investigate behavioral correlates with CHD among contemporary Japanese persons beyond the concept of the type A personality[28, 29]. The JCBS originally consists of 122 questions including behavior patterns specific to Japanese society and culture and are based on the 10 psycho-physiologic features (e.g., attitude to job, emotional hostility, and speed and impatience). From the original JCBS, a subscale was extracted consisting of nine items that were independently associated with the presence of CHD in patients undergoing coronary angiography[29, 30].

The Scale C subscale represents three behavioral characteristics: (1) job-centered lifestyle; (2) social dominance; and (3) suppression of overt type A behaviors. The response to each item of the scale is scored on a four-point scale ranging from "strongly agree"=4 to "strongly disagree"=1. The Scale C score was calculated from the result of the JCBS by applying the coefficient matrix for the canonical score. In order to determine the presence or absence of coronary-prone behavior, the subjects were dichotomized according to the Scale C score (≤ -0.3 and > -0.3). The cutoff value of Scale C is the value that best discriminated between patients with CHD and those without CHD[29, 30]. The external validity of the Scale C was confirmed by a separate study using different participants[31, 32].

CHD risk factors

The CHD risk profiles of the subjects were determined by the number of clustered metabolic risk factors, including hypertension, dyslipidemia, glucose intolerance, and hyperuricemia. The definitions for the four risk conditions used in this study were as follows[33]: (1) hypertension: systolic blood pressure $\geq$130 mmHg or diastolic blood pressure $\geq$85 mmHg or the use of antihypertensive

medications; (2) dyslipidemia: triglycerides ≥150 mg/dl or LDL-cholesterol >=140 mg/dl or HDL-cholesterol <40 mg/dl or on medication for dyslipidemia; (3) glucose intolerance: fasting blood glucose ≥110 mg/dl or on medication for diabetes mellitus; and (4) hyperuricemia: uric acid ≥7.0 mg/dl or on medication for hyperuricemia or gout.

Working conditions and lifestyle habits

Information on the working form (daytime work or shift work), average overtime work hours per month in the previous six months, and total days off from work per month in previous three months were obtained from a questionnaire. The sleep duration was investigated using the question, 'How many hours do you sleep per day on average during a work day?' Smoking pattern was classified as follows: current, former (past), or non-smoker. Former smokers are those who had stopped smoking for at least six months prior. Habitual drinking pattern was investigated with respect to alcohol consumption patterns (frequency, quantity) and the type of beverage (local alcohol, wine, beer, etc.). Mean quantity of pure alcohol (in grams per day) was computed based on the amount, frequency, and alcohol content of the beverages. Usual physical activity was evaluated as total duration of walking in hours per day for any of transportation, leisure, main occupation, and house work.

Data analysis

The descriptive statistics are means (standard deviation) for continuous variables and percentages for categorical variables, unless otherwise specified. Differences in the mean values and proportions between dichotomous variables were statistically analyzed by the unpaired *t* test (Welch test) or χ^2 test with Yate's correction. The number of clustered CHD risk factors was compared between police officers and office clerks after the stratification by age categories. The effect of the combination of age and job type (police officers or office clerks) on the clustering of CHD risk factors was tested with a two-way analysis of variance (ANOVA). Multiple regression analysis with stratified models and stepwise regression analysis were carried out to explore variables that were associated with a greater number of clustered CHD risk factors among police officers. The following variables (cut-off value) were included in the models as explanatory variables; age (≥45 yr), job position (lower position: officer, sergeant, or inspector), shift work, amount of overtime work (≥80 h/month), days off (≥3 d/mon), smoking habit (current smoking), alcohol consumption (≥300 g/wk), daily walking (≥1 h/d), sleep duration (<5 h/d), job stressors and its components (quantitative job overload, qualitative job overload, physical demand, interpersonal conflict, poor physical environment, job control, skill underutilization, suitable jobs, intrinsic rewards), stress response, social support, and coronary-prone behavior (Scale C score≥−0.3). The null hypothesis was rejected at a level of significance of $t<0.05$, and all statistical tests were two-tailed. Data analyses were performed using the SPSS statistical package version 21 (SPSS software, Inc., Chicago, IL, USA).

Table 1. Demographic and clinical characteristics in police officers and office clerks

	Police (*N*=1,081)	Office (*N*=115)	*p*
Age (yr)	44.8 ± 9.6	44.8 ± 8.7	0.909
Shift work	28.8	7.4	<0.001
Overtime work (≥80 h/mon)	14.2	6.2	0.005
Days off (<3 d/mon)	17.0	6.8	0.001
Smoking habit (current smoker)	38.5	33.3	0.199
Alcohol consumption (≥300 g/wk)	7.6	8.0	0.867
Daily walking (≥1 h/d)	27.1	29.6	0.540
Sleep duration (<5 h/d)	4.1	6.2	0.236
Body mass index (≥25 kg/m^2)	44.7	24.5	<0.001
Waist circumference (≥85 cm)	63.4	46.0	<0.001
Blood pressure (≥130/ 85 mmHg)[a]	36.6	31.9	0.299
Triglycerides (≥150 mg/dl)[a]	32.1	19.6	0.001
HDL cholesterol (<40 mg/dl)[a]	10.9	12.3	0.506
LDL cholesterol (≥140 mg/dl)[a]	11.9	10.4	0.596
Fasting blood glucose (≥110 mg/dl)[a]	14.3	12.3	0.636
Uric acid (≥7.0 mg/dl)[a]	26.6	22.7	0.313

Values are shown as mean ± s.d., or percent of population.
p values were calculated using Student *t* test or χ^2 test.
[a] Patients taking any of medication for the risk conditions were also included.

Results

The demographic features and CHD risk profiles of study subjects are shown in Table 1. No statistically significant difference in mean age was found between police officers and office clerks. Nearly one third of police officers engaged in shift work that was not a part of their regular daytime schedule. The percentages of subjects who worked more than 80 h of overtime per month, and who had fewer than three days off per month, were significantly higher in police officers than office clerks. An overweight (BMI≥25 kg/m^2) and abdominal obesity (waist circumference≥85 cm) were significantly more prevalent in police officers than office clerks. Among the four CHD risk conditions investigated in this study, the most prevalent was

Table2. Comparisons of the number of clustered CHD risk factors in police officers and office clerks according to age groups

	Age group		Job type effect		Age effect		Interaction	
	30–44 yr	45–59 yr	F-value	*p*	F-value	*p*	F-value	*p*
Police (*N*=1,081)	0.84 ± 0.92	1.50 ± 1.06	8.38	0.004	36.04	<0.001	4.27	0.039
Office (*N*=115)	0.78 ± 0.90	1.10 ± 0.96	—		—		—	

Values are shown as mean ± s.d. Number of clustered CHD risk factors indicate the sum of presence of hypertension, dyslipidemia, glucose intolerance and hyperuricemia. The criteria of each risk condition are as follows: hypertension, blood pressure ≥130/85 mmHg; dyslipidemia, triglycerides ≥150 mg/dl or HDL-cholesterol <40 mg/dl or LDL-cholesterol ≥140 mg/dl; glucose intolerance, fasting blood glucose ≥110 mg/dl; hyperuricemia, uric acid ≥7.0 mg/dl. The number of police officers and office clerks are 545 and 62 in the group of 30–44 yr, and are 536 and 53 in the group of 45–59 yr, respectively.

Table 3. Job stress and coronary-prone behavior in police officers and office clerks

	Police (*N*=1,081)	Office (*N*=115)	*p*
Job stress			
Job stressors	3.07 ± 0.45	2.97 ± 0.41	0.021
Quantitative job overload	18.8	22.6	0.209
Qualitative job overload	25.4	24.3	0.726
Physical demands	34.3	15.7	<0.001
Interpersonal conflict	24.4	31.3	0.086
Poor physical environment	24.9	34.8	0.041
Job control	18.2	21.7	0.206
Skill underutilization	26.9	33.9	0.056
Suitable jobs	18.3	27.0	0.011
Intrinsic rewards	15.5	27.8	0.001
Stress response	3.57 ± 0.77	3.22 ± 0.77	<0.001
Vigor	14.2	20.9	0.048
Anger-irritability	14.6	27.0	<0.001
Fatigue	14.4	21.7	0.020
Anxiety	8.8	22.6	<0.001
Depression	8.4	14.8	0.012
Somatic complaint	16.9	21.7	0.080
Social support	3.29 ± 0.99	2.29 ± 0.88	<0.001
Supervisor	25.6	29.6	0.453
Coworker	28.3	44.3	<0.001
Coronary-prone behavior			
Job centered lifestyle	1.93 ± 0.60	1.82 ± 0.49	0.025
Suppressed overt type A behaviors	2.14 ± 0.77	2.18 ± 0.71	0.467
Social dominance	2.21 ± 0.42	2.04 ± 0.39	<0.001
Scale C score	−0.33 ± 1.14	−1.01 ± 1.10	<0.001
Scale C score (≥−0.3)	45.9	15.9	<0.001

Values are shown as mean ± s.d., or percent of population.
p values were calculated using Student *t* test or χ^2 test.

hypertension in both groups of job type. The police officers exhibited significantly higher prevalence of hypertriglyceridemia than office clerks, whereas there was no significant difference in the other parameters.

The number of clustered CHD risk factors in individuals was compared between police officers and office clerks after the stratification of age categories (Table 2). In both groups of job type, the clustering of risk factors, including hypertension, dyslipidemia, glucose intolerance and hyperuricemia, was more common in the older age categories. However, the increase in risk factors with advancing age in police officers was significantly greater compared with office clerks, despite the difference being not clearly present in the younger age category. The job type effect, age

Table 4. Demographic and life style variables, job stress, and CHD risk factors in police officers according to coronary-prone behavior

	Subjects with coronary-prone behavior Scale C (≥−0.3) (*N*=486)	Subjects without coronary-prone behavior Scale C (<−0.3) (*N*=595)	*p*
Demographic and lifestyle variables			
Age (yr)	44.8 ± 9.8	44.3 ± 9.5	0.343
Job position (lowor level)[a]	83.1	81.8	0.583
Shift work	32.9	26.2	0.016
Overtime work (≥80 h/mon)	16.9	11.6	0.013
Days off (<3 d/mon)	19.8	13.6	0.007
Smoking habit (current smoker)	41.6	34.1	0.012
Alcohol consumption (≥300 g/wk)	7.9	5.8	0.169
Daily walking (≥1 h/d)	27.2	26.9	0.931
Sleep duration (<5 h/d)	5.8	3.4	0.058
Job stress			
Job stressors	3.10 ± 0.45	3.06 ± 0.45	0.042
Stress response	3.60 ± 0.77	3.55 ± 0.77	0.374
Social support	3.40 ± 0.98	3.21 ± 0.97	0.002
CHD risk factors			
Hypertension[b]	36.8	35.0	0.523
Dyslipidemia[b]	41.8	37.3	0.135
Glucose intolerance[b]	17.1	11.4	0.008
Hyperuricemia[b]	28.8	25.9	0.282
Number of clustered CHD risk factors[c]	1.24 ± 1.03	1.10 ± 1.05	0.019

Values are shown as mean ± s.d., or percent of population.

p values were calculated using by Student's *t*-test or χ^2 test.

[a] The job position of police officers was dichotomized as follows: officer, sergeant, inspector as the lower level; chief inspector, superintendent, and commissioner as the higher level.

[b] The criterion of each risk condition was as follows: hypertension, blood pressure ≥130/85 mmHg; dyslipidemia, triglycerides ≥150 mg/dl or HDL-cholesterol <40 mg/dl or LDL-cholesterol ≥140 mg/dl; glucose intolerance, fasting blood glucose ≥110 mg/dl; hyperuricemia, uric acid ≥7.0 mg/dl. Patients taking any of medication for the risk conditions were also included.

[c] Number of clustered risk factors indicates the sum of the presence of hypertension, dyslipidemia, glucose intolerance, and hyperuricemia.

effect, and the interaction between job type and age were significant by a two-way ANOVA.

The psychosocial factors in the workplace and the relevant stress responses of subjects are summarized in Table 3. The percentages of the subjects in the lower score category (≤2), which refers to the higher job stress condition, are compared between police officers and office clerks. As for job stressors, the police officers themselves recognized high physical demands, but simultaneously felt low workplace environmental stress, as well as high job suitability and job intrinsic rewards. Moreover, the police officers were less likely to perceive stress-related symptoms rather than office clerks. Significant differences were observed with respect to the symptoms of vigor, anger-irritability, fatigue, anxiety, and depression. In addition, the police officers were more satisfied with the support from coworkers. The mean values for the all subscales of BJSQ were significantly higher (i.e., lower stress condition) in police officers than in office clerks.

The scores for JCBS Scale C and its components of the three characteristics are compared between the police officers and office clerks (Table 3). The police officers showed a significantly higher score of the Scale C, together with the higher values of "job-centered lifestyle" and "social dominance". The prevalence of coronary-prone behavior (Scale C score of ≥−0.3) in police officers was around three times higher than in office clerks.

We dichotomized the police officers according to the presence or absence of a coronary-prone behavior, and compared these subgroups with respect to their demographic and lifestyle variables, job stress, and the CHD risk profiles (Table 4). In police officers, the percentages of subjects who engaged in shift work, who worked more than 80 h of overtime per month, and who had fewer than

Table 5. Multiple regression analysis to investigative variables independently associated with the number of clustered CHD risk factors in police officers

	Model 1[a] (Age-adjusted)		Model 2[b] (Multivariate adjusted)		Model 3[c] (Stepwise selection)	
	β	*p*	*β*	*p*	*β*	*p*
Demographic and life style variables						
Age (≥45 yr)	0.303	<0.001			0.292	<0.001
Job position (lower level)[d]	0.031	0.304				
Shift work	0.013	0.653				
Overtime work (≥80 h/mon)	0.048	0.101				
Days off (<3 d/mon)	0.016	0.569				
Smoking habit (current smoker)	−0.020	0.493				
Alcohol consumption (≥300 g/wk)	0.059	0.042			0.058	0.045
Daily walking (≥1 h/d)	−0.090	0.002			−0.085	0.003
Sleep duration (<5 h/d)	0.019	0.508				
Job stress[e]						
Job stressors	0.039	0.167	0.034	0.240		
Quantitative job overload	0.021	0.465	0.014	0.626		
Qualitative job overload	0.057	0.048	0.049	0.088		
Physical demands	−0.054	0.061	−0.029	0.338		
Interpersonal conflict	0.047	0.102	0.047	0.098		
Poor physical environment	0.048	0.093	0.041	0.150		
Job control	0.015	0.595	0.010	0.740		
Skill underutilization	0.033	0.254	0.034	0.232		
Suitable jobs	0.041	0.152	0.037	0.195		
Intrinsic rewards	0.061	0.033	0.058	0.046		
Stress response	0.022	0.433	0.017	0.605		
Social support	0.057	0.048	0.056	0.050	0.063	0.030
Coronary-prone behavior[f]						
Scale C score (≥−0.3)	0.065	0.025	0.066	0.023	0.075	0.009

β, standardized partial regression coefficient.

[a] Adjusted for age (only age was not adjusted)

[b] Adjusted for age, job position, shiftwork, overtime work, days off, smoking habit, alcohol consumption, daily walking, and sleep duration.

[c] All variables were entered simultaneously into the model by a stepwise selection (adjusted R^2=0.198, F-value=27.42, p<0.001)

[d] The job position of police officers was dichotomized as follows: officer, sergeant, inspector as the lower position; chief inspector, superintendent, and commissioner as the higher position.

[e] Job stress was assessed by means of the score of job stressors (including its each component), stress response, and social support, a subscale of Brief Job Stress Questionnaire.

[f] Coronary-prone behavior was evaluated by a Scale C score of Japanese Coronary-Prone Behavior Scale.

three days off per month were higher in those with coronary-prone behavior. The subjects with this behavioral type were more likely to be a current smoker and sleep shouter, and to show the higher scores for job stressors and social support, indicating that they perceived less stress and satisfied with support at their workplace. In addition, the group showed significantly higher prevalence of glucose intolerance, and had greater number of clustered CHD risk factors compared to their colleagues without coronary-prone behavior.

We performed multiple regression analysis with stratified models to explore independent variables related to greater number of clustered CHD risk factors among police officers (Table 5). In the age-adjusted model, alcohol consumption, daily walking, qualitative job overload (i.e. psychological demand), intrinsic rewards, social support, and coronary-prone behavior were found to be significantly associated with high prevalence of CHD risk factors. The overall stress response showed only a week association with clustered CHD risk factors. In the second model, further adjustments for the demographic and lifestyle variables attenuated the magnitude of the observed

association between job stressors and cluster of CHD risk factors. However, the contribution of coronary-prone behavior was essentially unchanged and still significant even after the correction for confounders. In the final model, in which all the variables were inserted simultaneously, age, alcohol consumption, daily walking, social support, and coronary-prone behavior were selected as the significant determinants of a cluster of CHD risk factors among police officers.

Discussion

In this cross-sectional study of male police personnel in a prefectural police in Japan, a clustering of CHD risk factors, including hypertension, dyslipidemia, glucose intolerance and hyperuricemia, was more frequent in police officers than in office clerks. Among the police officers, subjects with coronary-prone behavior tended to engage in shift work and to work longer hours; nevertheless, they were less likely to perceive job strain and to express the relevant physical and psychological symptoms. In a stepwise multiple regression analysis, coronary-prone behavior together with age, low workplace social support, and unhealthy habits such as alcohol drinking and lack of physical activity was selected as a significant determinant of the clustered CHD risk factors. These findings suggest that police officers likely have coronary-prone behavior, and these behavioral characteristics may be one of the important factors that contribute to greater prevalence of CHD and its risk factors, compared to that among other public service employees or general population.

In concordance with the previous studies[6–13], the prevalence of risk factors for CHD among police officers was greater in our study group; in particular, the overweight (BMI>=25 kg/m^2) and abdominal obesity (waist circumference>=85 cm) were found in around 44.7% and 63.4%, respectively. These proportions greatly exceeded the general prevalence within the same age strata of the Japanese population[34]. The much higher rate of obesity among the police officers was also highlighted by other studies[6, 10–13, 35] and might be regarded as one of the key reasons for more adverse CHD risk levels among them.

The metabolic abnormalities such as hypertension, dyslipidemia, glucose intolerance and hyperuricemia caused by the accumulation of abdominal fat tend to cluster together and are widely recognized as metabolic syndrome. A number of epidemiologic studies have reported that an increase in the number of risk factors leads to a higher incidence of cardiovascular events[36, 37]. It is well known that metabolic syndrome is one of the pivotal targets to prevent subsequent development of cardiovascular diseases. However, according to the criterion of Japan-specific metabolic syndrome[33], a person who does not have abdominal obesity is not diagnosed with metabolic syndrome even if he/she has all of the metabolic abnormalities. In this regards, some recent reports including our study have revealed that a clustering of the metabolic abnormalities is crucial irrespective of the presence or absence of abdominal obesity[38–40]. We, therefore, attempted to estimate the individual risk profile for CHD by assessing a clustering number of hypertension, dyslipidemia, glucose intolerance and hyperuricemia except for abdominal obesity.

After stratification of age range (i.e. age of 30 to 44 yr, and age of 45 to 59 yr), the police officers in the older age strata exhibited a greater number of clustered CHD risk factors than office clerks, despite the difference being not clearly present in the younger age strata. It is suggested that the police work accompanied with the exposure to various occupational stressors may have an adverse effect on the cardiovascular health condition among police officers. Moreover, the work-related factors may only raise CHD risk after a long latency, and therefore for the younger age group, the lag time may not have been long enough to allow any significant effects for the work-related factors to be observed.

Even though the actual mechanisms underlying the association remain unclear, there is increasing evidence of the potential role of stress in the pathogenesis of premature CHD[41, 42]. Stress at work may affect the body directly through the activation of the neuroendocrine stress pathways, and also indirectly through individual unhealthy behaviors. It has been consistently reported that police personnel have an irregular diet and a limited choice of food while on duty, suffer from disrupted sleep patterns, have a lack of regular exercise, and have high rates of cigarette smoking and alcohol consumption[6, 9, 10, 13]. In this regard, the multiple regression analysis revealed that the number of walking hours per day and the amount of alcohol consumption were selected to be the significant contributing factors for clustering CHD risk factors among police officers. Thus, although police officers are considered to be a presumably healthy occupational group, long-term exposure to the stressful work and its related unfavorable lifestyles would account for the greater number of clustered CHD risk factors than office clerks observed in this study.

The police officers themselves recognized the high physical demand but simultaneously felt lower occupational stress than office clerks working at same place. In

this regards, several studies have demonstrated that perceived stress levels and psychological health in police officers are comparable or better than those in other groups of workers[22–24]. The police officers are trained for police operational duties, whereas their ability to cope with the organizational stressors may be less adequate; and further, it has been indicated that attitudes and behavioral characteristics generated by police work itself can lead to rigidity, suspiciousness, cynicism, and authoritarianism[43]. These features may be one of the reasons for that they are not able to complain about the psychological demands at the work environment of police officers, unlike other types of workers.

The two most widely used general models to quantify exposure to stress in occupational field are the demand-control-support (DCS) model[44] and the effort-reward imbalance (ERI) model[45]. According to the models, high psychological demands in combination with low control and low social support, and further imbalance between the efforts spent and rewards received are considered to be the crucial components that have a great impact on the employee's health in the work site. In multiple regression analysis, high qualitative job overload (i.e. high psychological demand) related to increase in the number of clustered CHD risk factors. This findings is in concordance with a previous longitudinal study indicating that job demand is the most important in bringing about metabolic syndrome among police officers[46]. However, the associations of qualitative job overload and a cluster of CHD risk factors were disappeared after taking into account the demographic and lifestyle confounding factors in the model. This difference was probably linked firstly to the measurement of job demand that might influence the perception of job overload and strain, and also to the characteristics of the sample of our study that was composed of occupational group who relatively less complained about the psychological demands at their work environment.

In addition, high rewards and high social support were negatively associated with the clustering of CHD risk factors though the association somewhat lowered after correcting for confounding variables. The police officers in our study felt greater amount of intangible rewards for their work; and they were at the same time more satisfied with support from colleagues at workplace than office clerks. The high job rewards and high social support among police officers moderates their perceived stress levels and responsiveness to environmental work stressors; and further this may contribute to attenuate the risk for CHD that arisen from stressful working tasks. Moreover, other longitudinal study of police officers revealed that low physical environment and high interpersonal strain were one of the factors associated with the risk for developing type 2 diabetes[47]. Our study, by contrast, found only non-significant weak associations between these stressors and clustering of CHD risk factors.

There are very few studies that have examined the personality traits of police officers in relation to the risk for CHD[35]. It is well recognized that a certain behavioral characteristic, known as the type A behavior pattern, has been found to increase the risk for developing CHD in Western studies[25]. This pattern is characterized by such attributes as hard-driving effort, striving for achievement, competitiveness, aggressiveness, haste, impatience, restlessness, and alertness. On the other hand, in Japanese persons, the coronary-prone behavior has been thought to be characterized by less aggression and a greater tendency to display workaholic characteristics[28, 29]. In this study, we used the JCBS which was developed to investigate correlates with CHD among contemporary Japanese persons. The Scale C, the subscale of JCBS, consists of behavior patterns specific to Japanese society and culture[29, 30].

As compared to the office clerks, the police officers showed a significantly higher score of Scale C, together with the higher values of both "job-centered lifestyle" and "social dominance" as the aspects of workaholic characteristics. In addition, among police officers, subjects with coronary-prone behavior tended to engage in shift work and work longer hours; nevertheless, they were less likely to perceive job strain and to express the relevant physical and psychological symptoms. Also, these subjects showed higher prevalence of glucose intolerance, and had a greater number of clustered CHD risk factors compared to those without such behavioral features. Therefore, as indicated in previous studies[20, 21], police officers likely have coronary-prone behavior which are represented in a workaholic characteristics; and this peculiar personality profile may be one of the important factors which influence their ability to perceive and response to various stressors in the workplace, and further induce the greater prevalence of CHD risk factors. It is also suggested that the personality factors of police officers should be taken into account in investigating the association between the work-related stress condition and the risk of CHD among them.

The present study did not demonstrate a clear association between shift work and clustering number of CHD risk factors. There have been conflicting reports on the association of shift work with CHD mortality and morbidity[17, 18, 48, 49]. The previous studies have indicated that

a disturbed metabolic regulation due to altered lifestyles, mismatch of circadian rhythms and chronic job stress may explain the relation between shift work and adverse cardiovascular outcomes[9, 10, 17, 48]; and then, it is considered that these relevant factors rather than shift work itself are important as mediators of the association between shift work and increased risk of CHD. Furthermore, police work is a particularly stressful occupation in which officers are exposed to a wide variety of stressors including factors that are common to other occupations[1–3] or typically associated with the specific police tasks[4, 5]. It is therefore speculated that the exposure to high level of various stressors may attenuate the magnitude of the association between shift work and cluster of CHD risk factors in police officers. However, there was the potential for bias that arose from the healthy worker effect; while the healthy persons have been able to engage in shift work, the ill ones have been unable to stay on the work. Policing is an occupation that requires shift work.

Some limitations should be taken into account when interpreting the results obtained in this study. First, our study was based on observational data, as we analyzed the associations of job stress and personal behavioral characteristics with the prevalence of CHD risk factors, and therefore, no conclusions about cause-effect relationships or temporal precedence can be made. Second, because our sample belonged to a prefectural police which was located in non-urban area in an eastern part of Japan, our results may not be generalizable to the other police officers with different occupational exposures that are related to regional and cultural characteristics. In addition, police officers perform a lot of tasks, and the different police works may produce different levels of job-related stress. However, we evaluated only job position, working form (daytime work or shift work), overtime time work, and total days off from work, but did not take into account the type of task which is considered the important component of working conditions. Furthermore, office clerks in the prefectural police served as a referent group because they worked at same work place with the police officers. The ratio of police officers and office clerks accounted for around a 9 : 1 ratio; and accordingly, the size of the office clerks was naturally much smaller than police officers. This fact undoubtedly reduced the statistical power of the analyses with regard to the comparisons between police officers and office clerks. Third, in our study, the work-related stress and coronary-prone behavior of subjects were assessed simultaneously by means of self-reported questionnaire at one point in time; therefore, we cannot rule out a reporting bias leading to their underestimation or over-estimation. In relation to this, when interpreting the results of the association between work-related stress and coronary-prone behavior, we must pay attention to the possibility of the other bias, that is, common method variance; however, it has been argued that common method variance is not automatically a source of bias in research based on self-reports and that any eventual effect is often small[50].

The present study evaluated the CHD risk profiles in police officers who were considered to be particularly exposed to highly stressful conditions, and revealed a greater prevalence of CHD risk factors in police officers compared to office clerks. The findings are in concordance with previous studies; however, we have revealed that police officers are more likely to have coronary-prone behavioral characteristics, which are represented primarily in a job-centered lifestyle; therefore, this peculiar personality profile might play a role in the high prevalence of CHD risk factors, by influencing the perception or reactivity to environmental stressors at work. It is therefore suggested that a comprehensive health prevention plan must be focused on their personality profiles in combination with improving the stressful working environment and unfavorable lifestyle that arise from police work. However, further studies with larger sample sizes and a prospective study will be needed to confirm the role of job stressors and personal behavioral characteristics on the risk for developing CHD in a specific occupational group of police officers.

Conflict of Interest

The authors declare no conflict of interest.

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