

Impact of Anger Expression on Blood Pressure Levels in White-Color Workers with Low-Coping Behavior

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Abstract

To examine the relationships between anger expression and blood pressure (BP) levels and their effect modification by stress coping behaviors, the authors analyzed data from a cross-sectional study of 790 Japanese male workers aged 20-60 years. We used the Spielberger anger expression scales to measure anger-out, anger-in, and anger-control. Relationships between anger expression scales and mean systolic and diastolic BP levels were examined in the total sample and in two subgroups of high and low stress coping behaviors (low coping behavior group: having none, one, or two coping behaviors; and high coping behavior group: having three or more coping behaviors). Anger expression scales were not associated with BP levels in the total sample. Among men who reported only two or fewer coping behaviors, however, the anger-out score was significantly associated with systolic blood pressure (SBP) levels while no association was found among men who reported the larger number of coping behaviors. Anger-in and anger-control were not associated with BP levels in either low or high coping behavior groups. This study suggests that male workers who do not express their anger have a higher probability of developing high BP when they have no or few stress coping behaviors.

Key words: anger expression, blood pressure, coping behavior, cross-sectional study, Japanese.

Introduction

Hypertension is a consistent and strong risk factor for cardiovascular disease, particularly stroke, the most common cardiovascular disease in Japan.^{1, 2)} In addition to overweight, excessive sodium intake, and alcohol intake,³⁻⁶⁾ psychological factors may contribute to the development of hypertension. Recently, the contribution of psychological factors to hypertension may have increased in Japan because the proportion of persons with excessive sodium intake declined, but the proportion of employees who felt psychological stress concerning their work increased.⁷⁾

A broad range of epidemiological, clinical, and experimental studies have reported associations of psychological factors such as anger expression,⁸⁻¹⁵⁾ anxiety,^{16, 17)} defensiveness,^{18, 19)} and job stress²⁰⁻²³⁾ with BP levels and/or hypertensive status. We chose anger expression to evaluate psychological stress because anger is one of the most influential emotions which changes BP levels in daily

life.^{24, 25)} Previous studies showed that anger-in (suppressed hostility or anger) was positively associated, and anger-out (anger expressed outwardly) was inversely associated with BP levels and/or hypertension status.^{8-13, 15)} However, it is uncertain whether these findings are applicable to the Japanese because the style of anger expression may differ between Japanese and Caucasians.^{26, 27)}

The relationship between anger expression and BP levels varied according to socio-ecological status, race, and age.^{9, 14, 15)} However, behavioral factors which modify the relationship between anger expression and BP levels have not been well elucidated. The identification of effect modifier for psychological effects on increased BP levels is of public health importance in the prevention and control hypertension.

The aim of the present study is to examine the relationship between anger expression and BP levels and the effect modification by stress coping behaviors among Japanese male workers in a nuclear power plant. We assume that nuclear power plant workers have relatively higher psychological stress than other kinds of job workers because they need to pay strict attention to operate or manage a plant. We hypothesized that coping behaviors may be effect modifiers in the relationship between anger expression and BP levels because several experimental studies showed that increases in BP in response to

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psychological challenges were smaller with social support by friends than without it.^{28, 29)}

Methods

Subjects

The survey was conducted in a nuclear power plant (the total number of male workers was 849, including 260 shift workers) in November of 1995. In this plant, shift workers were engaged mainly in plant operations and day workers worked mainly for supporting or managing the plant maintenance done by out-plant workers. All workers had a high school or higher level education and most of them had lived in five communities located near the workplace. The subjects were 814 men aged 20-60 years (mean age, 34 years) who participated in a routine health check-up. The 814 workers were sent a self-administered questionnaire on anger expression and stress coping behavior a week before the routine health check-up. These subjects were instructed to bring the completed questionnaire to the health check-up and 805 subjects (95% of the total male workers) returned the questionnaire. Four subjects who took medication for cardiovascular diseases such as myocardial infarction and angina pectoris were excluded, although 16 subjects using antihypertensive medication were included in the analysis because the variance of this group matched the variance of the total sample. Eleven subjects who failed to complete the questionnaire were excluded. As a result, 790 subjects were included in the statistical analyses.

Measurement of anger expression and stress coping behaviors

Anger Expression Scale.

To measure anger expression, we used 24 items in the original Anger Expression Scale developed by Spielberger et al.^{30, 31)} The Anger Expression Scale is based on the frequency of reactions to anger provoking situations. Subclassification of anger expression was determined by the direction of anger expression; anger expressed behaviorally was regarded as "anger out" and anger held in or suppressed as "anger in" and the attempts to control anger expression as "anger control." We used 24 self-administered questionnaire items; i.e., eight anger-out items such as "express my anger", "do things like slam doors", and "argue with others", eight anger-in items such as "keep things in", "withdraw from people", and "secretly quite critical of others", and eight anger-control items such as "control my temper", "keep my cool", and "try to be tolerant and understanding." Participants indicated the extent to which each statement describes their general feelings or actions when angry or mad with a 4-point response: 1 ("almost never"), 2 ("sometimes"), 3 ("often") and 4 ("always"). Scores in the eight items for anger-out, anger-in, or anger-control were summed and used as anger expression scores. Therefore, each score range was 8-32 points. We modified the Japanese version of the Anger Expression Scale to apply it to population-based samples because the original Japanese version was validated using only samples of hospital patients and/or college student volunteers.³²⁾ We also evaluated the reliability and construct validity of the modified Japanese version of the Anger Expression Scale in the present sample. To examine a factor-based validity, all of the 24 items were subjected to an explanatory factor analysis using principal axis factor analysis. Three factors with eigenvalues of more than 1.0 were extracted. The factor structure of our Japanese version was similar to a previous psychometric evaluation of the original Anger Expression Scale except for the

item "boil inside, but don't show it."^{30, 31)} The item "boil inside, but don't show it" belonged to anger-control for our sample, whereas in the American samples, this item belonged to anger-in.^{30, 31)} Therefore, we also analyzed the relationship between anger expression and BP levels excluding the item "boil inside, but don't show it." However, the results were essentially the same. The internal consistency in our translated questionnaire, measured by Cronbach's alpha coefficients, were 0.91, 0.75, and 0.96 for anger-out, anger-in, and anger-control, respectively. The internal consistency of our version seemed to be better than that in the previously translated version (Cronbach's alpha coefficients were 0.78, 0.76, and 0.82 for anger-out, anger-in, and anger-control, respectively).³²⁾

Stress coping behaviors.

We presented the subjects with 12 stress coping behaviors, related to "seeking social support" and "self-distraction", against anger situations or stressful situations because previous surveys showed that "seeking social support" and "self-distraction" were major coping behaviors among Japanese subjects.^{7, 33)} The lead question was, "When you are angry or feeling stressed, do you use any of the following coping behaviors to divert your mind? If so, choose all those which apply to you". The stress coping behaviors listed were "talk with my friends or family members", "go shopping", "eat snacks", "have a drink", "smoke cigarettes", "play a game such as *pachinko* (pinball) or *mah-jong*", "listen to music", "do *karaoke* (sing a song along with music)", "do physical exercise such as walking and sports", "go on a trip", "work harder", and "sleep or rest". Subjects were also asked to list other coping behaviors they employed in an open question. These stress coping behaviors were cited as common stress coping behaviors among Japanese middle-aged men by previous epidemiological surveys in Japan.^{7, 33)} Mean value, standard deviation, median value, and range in the number of coping behaviors of the total subjects were 2.3, 1.5, 2, and 0-7, respectively. To do physical exercise, to have a drink, and to talk with close friends were three major coping behaviors. We calculated the Pearson correlation coefficients between the number of stress coping behaviors and 12 scales of the COPE inventory³⁴⁾ among 2,428 Japanese workers. These 12 scales include active coping, planning, seeking social support for instrumental reasons, seeking social support for emotional reasons, positive reinterpretation & growth, acceptance, turning to religion, focus on & venting of emotions, denial, behavioral disengagement, mental disengagement, and alcohol-drug disengagement. The number of stress coping behaviors significantly and positively related to some scales of the COPE inventory³⁴⁾ such as "seeking social support for emotional reasons" ($r = 0.18$), "mental disengagement" ($r = 0.17$), and "alcohol-drug disengagement" ($r = 0.14$).

Procedures

Two BP measurements were conducted between 9:00 and 16:00 during their working day. Systolic and diastolic blood pressures were obtained from the participants in the seated position, after a 5-minute rest under a room temperature between 21 and 24 degrees centigrade, by trained nurses using a standard mercury sphygmomanometer. Readings were made to the nearest 2 mmHg, and diastolic blood pressure (DBP) was taken as the phase V. Korotkoff sound. BP measurements were taken at least 30 seconds apart and the second of two measurements was used in the analyses. Height in stocking feet and weight in light

clothing were measured, and body mass index (BMI) was calculated as weight (kg)/height (meters)². To assess alcohol intake, an interviewer asked the subject to evaluate the usual weekly intake of alcohol in units of *go* (a Japanese traditional unit of volume corresponding to 23 grams ethanol intake), which was converted to grams of ethanol per day. One *go* is 180 ml of sake, and corresponds to one bottle (633 ml) of beer, two single shots (75 ml) of whisky, or two glasses (180 ml) of wine.

Statistical analysis

Participants were divided into two groups, split by the median number of stress coping behaviors. We defined them as the low coping behavior group when they reported two or less coping behaviors, and as the high coping behavior group when they did three or more coping behaviors. The proportions of shift workers and management staff members did not differ between the high and low coping behavior groups. Furthermore, mean values of age, BP levels, BMI, alcohol intake, and anger expression scores did not differ between them (Table 1). The

Table 1 Percentage of frequency of stress coping behaviors and cardiovascular risk variables among low and high coping behavior groups

	Low coping behavior n=436	High coping behavior n=354	p value
Percentage of frequency			
Stress coping behaviors (yes, %)			
Talk with close friends	18.1	53.4	<0.001
Go shopping	0.7	13.0	<0.001
Eat snacks	1.6	10.2	<0.001
Have a drink	18.6	60.7	<0.001
Smoke cigarettes	12.8	36.2	<0.001
Do <i>pachinko</i> or <i>mah-jong</i>	5.5	22.9	<0.001
Listen to music	11.2	40.7	<0.001
Do <i>karaoke</i>	3.0	17.5	<0.001
Do physical exercise	35.8	61.9	<0.001
Go on a trip	10.3	39.0	<0.001
Work harder	0.7	7.3	<0.001
Sleep or rest	4.1	7.6	0.04
Cardiovascular risk variables			
Shift workers (%)	33.8	37.9	0.29
Management staff members (%)	8.7	7.2	0.47
	Mean (SD)		
Age (year)	34.2 (9.8)	34.0 (9.9)	0.69
SBP (mmHg)	124.8 (9.5)	124.6 (9.7)	0.68
DBP (mmHg)	75.2 (7.4)	74.9 (7.4)	0.57
Body Mass Index(kg/m ²)	23.1 (2.8)	23.1 (2.8)	0.91
Alcohol intake (g/day)	20.4 (17.1)	22.3(17.4)	0.12
Anger-out	13.1 (3.2)	13.2 (3.3)	0.56
Anger-in	16.1 (3.5)	16.2 (3.2)	0.67
Anger-control	20.6 (4.9)	20.8 (4.7)	0.52

§ difference by chi-square test or student's t-test. SD = standard deviation.

Table 3 Age-adjusted Pearson partial correlation coefficients for anger-out, anger-in, and anger-control, stratified by the coping behavior group

Variables	Low coping behavior		High coping behavior		Total	
	SBP	DBP	SBP	DBP	SBP	DBP
n	436		354		790	
Anger-out	-0.11*	-0.07	0.09	0.07	-0.02	-0.01
Anger-in	0.01	0.04	-0.04	-0.09	-0.02	-0.02
Anger-control	-0.01	-0.01	-0.09	-0.10	-0.04	-0.05

* p<0.05.

Low coping behavior: to have none, one, or two coping behaviors.

High coping behavior: to have three or more coping behaviors.

Table 2 Mean and standard deviations for anger-out, anger-in, and anger-control

Age(year)	n	Anger-out	Anger-in	Anger-control
		Mean score (SD)	Mean score (SD)	Mean score (SD)
20-29	288	13.4(3.4)	16.8(3.4)	21.7(4.7)
30-39	303	12.9(3.2)	15.9(3.4)	20.3(5.0)
40-49	128	13.1(3.1)	15.5(2.8)	20.0(4.5)
50-60	71	13.1(2.9)	15.2(3.3)	19.7(4.7)
F value		0.90	7.69	7.47
p value §		0.439	<0.001	<0.001

§ difference among age groups. SD = standard deviation.

relationships between the anger expression scales and BP levels were examined, stratified by the two stress coping behavior groups. Intercorrelations among the three categories of anger expression scales were examined using the Pearson correlation coefficient. Differences in mean values of anger expression scales between age groups were tested by analysis of variance (ANOVA). Relationships between the anger expression subscales and BP levels were examined using the Pearson partial correlation coefficient adjusted for age. When p values for the Pearson partial correlation coefficient were less than 0.10, we conducted multiple linear regression analyses to estimate the independent effects of specific anger expression scores on systolic blood pressure (SBP) and DBP adjusted for age, BMI, and alcohol intake. Predicted changes in BP levels associated with three-point (1 standard deviation) change in anger expression scores were presented. Furthermore, mean SBP levels according to tertile of selected anger expression scores was calculated using the analysis of covariance controlling for age, BMI, and alcohol intake, and a linear trend was tested using median variables of the anger expression categories. The 0.05 level of probability was accepted as significant, and all statistical tests using probabilities were two-tailed.

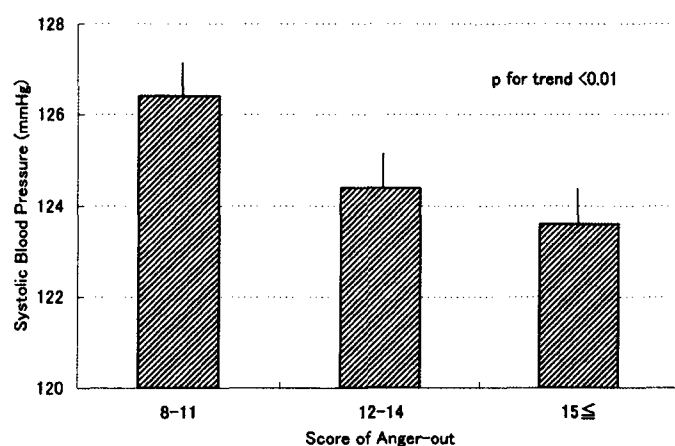
Results

Table 2 shows the mean and standard deviations of the anger expression scores for the 790 men. The mean score of anger-out did not vary among the age groups. The mean scores of anger-in and anger-control were lower with increased age. There was moderate intercorrelation between anger-out and anger-control (r= - 0.31), and between anger-control and anger-in (r= 0.30), but the correlation between anger-in and anger-out was weak (r= 0.14). There was no significant intercorrelation between stress coping behavior and subscales of anger expression.

None of these anger expression subscales correlated with BP levels in the total sample (Table 3). However, there was a significant inverse relation between anger-out and SBP among the low coping behavior group in analyses stratified by subgroup of stress coping behavior (Table 3). A similar trend was observed for DBP, but it did not reach statistical significance. Neither

anger-in nor anger-control was related to BP levels among the low coping behavior group. The anger expression subscales did not correlate with BP levels among the high coping behavior group.

In multiple linear regression analysis, the inverse association of anger-out with SBP among the low coping behavior group reached statistical significance ($p=0.006$, Table 4). A significant inverse relationship between anger-out and DBP was also observed among the low coping group ($p=0.027$). Fig.1 shows the mean SBP level after controlling for age, BMI, alcohol intake according to the tertile of anger-out among the low coping behavior group. Mean SBP levels were higher with a lower score of anger-out.



Bars on the top of the columns represent standard errors.

Fig. 1 Multivariate-adjusted systolic blood pressure levels according to the tertile of anger-out scores among the low coping group.

Moreover, these associations with BP levels were also seen when we further divided the low coping behavior group into two subgroups (no coping behavior, and one or two coping behaviors). The standard regression coefficients of anger-out on SBP/DBP were -1.20 ($p=0.17$)/ -0.72 ($p=0.19$) among 98 men who reported no coping behavior and -1.17 ($p=0.02$)/ -0.69 ($p=0.06$) among 338 men who reported one or two coping behaviors.

Discussion

The present study showed a significant inverse relationship between anger-out and SBP levels among Japanese male workers with two or less coping behaviors, whereas no association was seen among the workers with three or more coping behaviors. This study, to our knowledge, is the first to show an interaction of the number of stress coping behaviors with the relationship between anger-out and BP. This result suggests that stress coping behaviors may attenuate an effect of low anger-out on increased BP levels.

Kamarck et al. showed that raised BP or pulse rates in response to two standardized psychological challenge tests was more evident among students who were not accompanied to the test-site by their friends than among those who were accompanied by friends.²⁸⁾ Furthermore, Gerin et al. reported that persons who received assistance from a friend showed

Table 4 Multiple regression analyses between blood pressure levels and variables among the low coping behavior group

Variables	SBP	DBP
	β (SE)	β (SE)
Age (10years)	2.54 (0.50)**	2.83 (0.36)**
Body Mass Index (3kg/m ²)	1.53 (0.48)**	1.67 (0.35)**
Alcohol intake (23g/day)	0.59 (0.62)	0.66 (0.45)
Anger-out (3points)	-1.19 (0.43)**	-0.69 (0.31)*
Anger-in (3points)	0.51 (0.42)	0.59 (0.30)
Anger-control (5points)	-0.57 (0.50)	-0.46 (0.36)
R ²	0.144	0.264

* $p<0.05$; ** $p<0.01$. β = standard regression coefficient.

SE = standard error.

significantly smaller increases in BP and heart rate during a discussion than persons who did not receive assistance from a friend.²⁹⁾ These studies suggest a buffering effect of social support, such as the company of friends, on the individual's cardiovascular reactivity to psychological challenge. In our study, men who reported more stress coping behaviors were likely to have more social support than those men who reported fewer stress coping behaviors, because interaction with friends was one of the three major stress coping behaviors in our samples. This inference was also supported by the finding that the number of stress coping behaviors was correlated with the COPE score on seeking social support for emotional reasons.

We found no relationship between anger-in and BP levels among Japanese male workers, though previous studies have shown a positive relationship between anger-in and BP levels among black and white high school students.^{12, 13)} In these other studies, higher BP levels were found only among white students with very high scores of anger-in (i.e., 23 and over). In our study population, the proportion of very high anger-in was only 4 percent. Therefore, it is possible that finding no relationship between anger-in and BP in our sample was due to the low proportion of high anger-in scores. However, because the present study was performed among male Japanese workers in a company, further studies are needed in various populations to confirm the relationship between anger expression and blood pressure levels among Japanese.

It is well known that some persons in anger have an acute rise in BP levels through the activated sympathetic nervous system,^{24, 25)} but chronic effects of anger expression on BP levels are not well elucidated. Esler et al. showed that the proportion of men suppressing hostility was 63% among high-renin hypertensive men, compared with 10% among normotensive men.¹⁰⁾ These high-renin hypertensives exhibited a raised plasma norepinephrine concentration, and showed a reduction to normal BP by pharmacological alpha- and beta-adrenergic blockade.¹⁰⁾ That study suggested that suppressed anger expression was linked to higher activity of the sympathetic nervous system or renin-angiotensin system, which are major determinants of BP levels. In another study of 27 black college students, anger-out, estimated by the Spielberger anger expression scale, was inversely associated with SBP levels after psychological challenge tests (viewing video films involving a racist scene).³⁵⁾ Moreover, BP increases in response to standardized mental and physical challenges were associated with 6.5-year later DBP levels, adjusted for baseline BP levels among 206 middle-aged adults.³⁶⁾

Because we tested multiple relationships between anger expression and BP levels stratified by the coping behavior group, we need to be careful in inflating the risk of Type I errors.

However, a greater association between anger-out and BP levels among the low coping behavior group was hypothesized *a priori*. The significance level of the effect on SBP levels was 0.006 in the multivariate analysis. Another drawback of this study is that, although job characteristics of the subjects were not different between the high and low coping behavior groups, we did not have the data on other potential confounding factors such as job stress. Therefore, we cannot reject the possibility that other factors than stress coping behaviors may modify the relationship between anger-out and BP levels.

In conclusion, the present study suggests that Japanese male workers who do not express their anger have a higher probability of developing high BP in the case that they have no or few stress coping behaviors. If the causality is accepted, to have many coping behaviors may be one of the promising strategies in prevention of hypertension. However, because our study is a

cross-sectional study, the observed relationships with anger-out do not imply causal relationships. Prospective studies and intervention studies among various Japanese populations should be carried out to isolate causal factors and the mechanisms by which these factors affect BP levels.

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