〈原　著〉

Smoking and its relation to blood pressure in drinkers and nondrinkers

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The relationship between cigarette consumption and blood pressure in drinkers (drink alcohol daily or most days) and nondrinkers (not in the habit of drinking) was studied in 991 healthy males, aged 30～39 years. Significant dose-response relationships between smoking and systolic and diastolic blood pressure were observed among nondrinkers, in which, smokers who smoked relatively large amounts of cigarette had lower average systolic and diastolic blood pressure. Among drinkers, definite linear relationships were not necessarily observed; that is, heavy smokers had higher diastolic blood pressure compared with moderate smokers. Systolic blood pressure tended to be lower at increasing levels of cigarette consumption as observed among nondrinkers. The rising trend of diastolic blood pressure among drinkers was not explained by a high alcohol consumption according to higher levels of cigarette use. Mean values of body mass index increased with the increase in the amount smoked per day both in drinkers and nondrinkers. This result indicates that the reduction in blood pressure seen in smokers was not the result of differences in body mass index. The mechanism of smoking-related blood pressure reduction was discussed.

Key words　smoking, blood pressure, alcohol drinking, body mass index.

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INTRODUCTION

Cigarette smoking has been reported to produce an acute rise in blood pressure[1~2]. Paradoxically, in epidemiologic studies, smokers have been found to have lower blood pressure (BP) than non-smokers[3~6]. Furthermore, ex-smokers tend to have BP resembling those of people who never smoked[4,6,7]. On the other hand, recent epidemiologic studies report a significant association between alcohol consumption and elevations in both systolic (SBP) and diastolic (DBP) blood pressure[8~10]. The combined effects of smoking and alcohol drinking on BP remain to be definitively assessed. In this report we examined the association between cigarette smoking and blood pressure in the drinkers and nondrinkers, whilst controlling for sex and age.

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MATERIAL AND METHODS

The subjects were 991 males from 30 to 39 years of age, who attended the Shizuoka Medical Center for adult health examination between 1981 and 1986. They were mostly white-collar workers in clerical and sales occupations. Their clinical and laboratory tests revealed no abnormal findings in any part of

the body.

They came for the examination between 8 : 00 and 9 : 00 a.m. and were asked to refrain from having breakfast and from smoking at least for one hour prior to the examination.

At the beginning of the examination, informations about the age, sex, smoking and drinkig habits, and occupation of the subjects were obtained by a self-administered questionnaire which, when completed, were reviewed by nurses. For the present study, smoking habit was categorized into six levels; never smoked (non-smokers), ex-smokers, current smokers of 10 cigarettes or less per day, 11~20 cigarettes per day, 21~30 cigarettes per day, and 31 cigarettes or more per day. Drinking habit was also classified into two groups; drinkers (drink alcohol daily or most days) and nondrinkers (not in the habit of drinking).

Height and weight were recorded to the nearest millimeter and 0.1 kg by nurses with the subjects dressed in examining gowns and without shoes. BP was recorded in the the supine position in the morning (9 to 11 a.m.). A cuff was selected that was at least 20 percent wider than the diameter of the arm. The cuff was deflated at a rate of 2 mmHg per heartbeat, and readings were made to the nearest 2 mmHg interval on the scale. DBP was taken at cessation of Korotkoff sounds (fifth phase) unless there was no loss of sounds, in which case, the point of muffling (fourth phase) was used as DBP.

Biochemical analyses of serum (serum-γ-glutamyl transferase activity (γ-G.T.) etc.) were done on a 16-channel auto analyzer (Hitachi Model 726, Hitachi Ltd., Tokyo). The carboxyhemoglobin concentration was determined by automatic spectrophotometry (IL 282 Co-oximeter, Instrumentation Laboratory Inc., Lexington, Mass).

Statistical analyses were performed on personal computer (PC9801F, Nihondenki Ltd.) using SPSS/PC+[11]. Lower and upper limits of 95 percent confidence intervals for SBP, DBP and body mass index (weight/height^2 (kg/m^2), BMI) by smoking category were calculated. If the intervals are non-overlapping, then significant differences exist between two groups at a 5 percent level of significance.

RESULTS

There was a stepwise rise in the mean carboxyhemoglobin level and γ G.T. with increasing cigarette consumption and alcohol intake, indicating that the questionnaire had been accurately written by the subjects (Fig. 1).

The mean blood pressure levels (SBP and DBP) for each smoking category of drinkers and nondrinkers are presented along with their standard deviations and lower and upper limits of 95% confidence intervals in table 1. Mean ages for each smoking category were almost the same. Drinkers had higher blood pressure levels in all smoking categories than nondrinkers. In both groups of drinking habit the more men smoke, the less their blood pressure levels with some exceptions; among drinkers, heavy smokers (31 cigarettes or more per day) had higher DBP compared with moderate smokers. Ex-smokers tended to have slightly lower blood pressure levels than non-smokers both in drinkers and nondrinkers (Fig. 2).

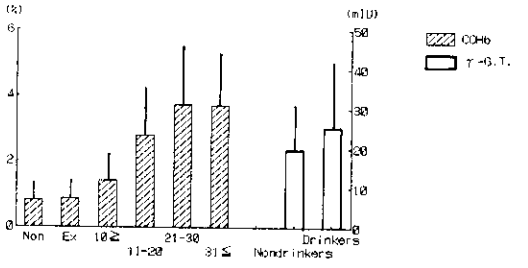

Fig. 1 Carboxyhemoglobin and serum γ-G.T. related to smoking and drinking habits in whole group of 991 subjects. Data are expressed as mean±S.D..

Smoker's BMI varied with the amount smoked

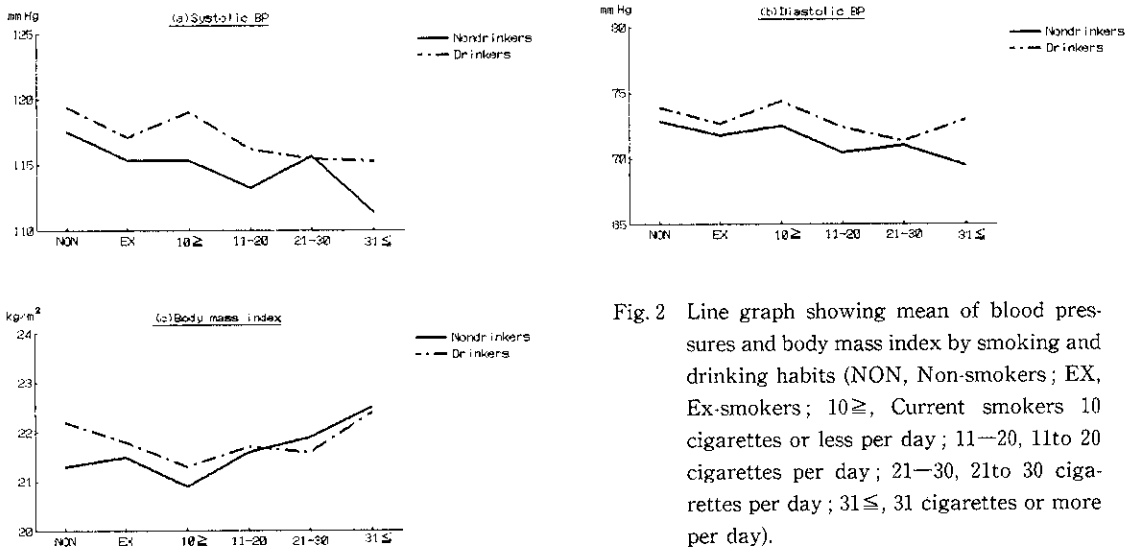

Fig. 2 Line graph showing mean of blood pressures and body mass index by smoking and drinking habits (NON, Non-smokers; EX, Ex-smokers; 10≧, Current smokers 10 cigarettes or less per day; 11—20, 11to 20 cigarettes per day; 21—30, 21to 30 cigarettes per day; 31≦, 31 cigarettes or more per day).

Table 1. Means, standard deviations, and lower and upper limits of 95% confidence intervals for blood pressure and body mass index by smoking and drinking habits.

Variables		Non-smokers	Ex-smokers	Current smokers (cigarettes/day) 10≧	11-20	21-30	31≦
Number of nondrinkers		95	66	35	133	89	39
Systolic BP (mmHg)	M[1]	117.5	115.4	115.4	113.3	115.7	111.4
	SD[2]	11.3	8.9	9.6	9.6	9.2	8.4
	U[3]	119.79	117.55	118.67	114.95	117.62	114.11
	L[4]	115.20	113.17	112.07	111.67	113.75	108.66
Diastolic BP (mmHg)	M	72.9	71.8	72.5	70.5	71.0	69.5
	SD	7.5	8.4	7.9	6.8	8.2	6.9
	U	74.43	73.85	75.17	71.67	72.74	71.72
	L	71.38	69.73	69.75	69.32	69.28	67.25
Body mass index (kg/m^2)	M	21.3	21.5	20.9	21.6	21.9	22.5
	SD	2.1	2.8	2.4	2.2	2.5	2.8
	U	21.77	22.15	21.75	22.03	22.43	23.40
	L	20.91	20.78	20.12	21.27	21.38	21.60
Number of drinkers		119	119	39	156	60	41
Systolic BP (mmHg)	M	119.4	117.1	119.0	116.2	115.5	115.3
	SD	9.3	9.5	8.9	9.6	9.1	11.2
	U	121.12	118.67	121.85	117.77	117.85	118.86
	L	117.74	115.42	116.10	114.72	113.15	111.77
Diastolic BP (mmHg)	M	73.9	72.7	74.4	72.4	71.4	73.0
	SD	7.1	7.4	7.4	8.4	7.8	7.5
	U	75.16	74.06	76.76	73.72	73.41	75.40
	L	72.57	71.36	71.96	71.05	69.39	70.65
Body mass index (kg/m^2)	M	22.2	21.8	21.3	21.7	21.6	22.4
	SD	2.2	2.0	2.2	2.4	2.4	3.0
	U	22.64	22.14	22.00	22.04	22.26	23.33
	L	21.84	21.40	20.59	21.29	21.04	21.47

1)M, Mean; 2)SD, Standard deviation; 3)U, Upper limit=Mean+1.96×(Standard error)
4)L, Lower limit=Mean-1.96×(Standard error).

Table 2. Percentages of heavy drinkers drinking 40 g ethanol or more per day by cigarette consumption.

Cig. consumption (cigarettes/day)	%	No.
10≧	17.6	13/74
11~20	25.3	73/289
21~30	15.4	23/149
31≦	18.8	15/80

per day. There was a dose-response gradient from the mild smokers to the heavy ones in that heavier smokers had greater BMI. This trend was observed both in drinkers and nondrinkers (Fig. 2).

Table 2 shows that the percentages of heavy drinkers drinking 40 g ethanol or more per day by cigarette consumption. High alcohol consumption according to the amount smoked per day was not observed.

The chi-square test and Mantel's test for trend[12] were applied to examine the association of smoking with blood pressure levels statistically. The number of individuals were distributed among four blood pressure groups of smokers and non-smokers (Table 3). The chi-square values revealed significant associations and dose-response relationships between smoking category and SBP and DBP except for drinker's DBP ($p<0.05$).

DISCUSSION

Despite the repeated observation of a negative association between smoking and blood pressure(BP)[3~6], various investigators have suggested that the difference in blood pressure between smokers and non-smokers is small and of no real physiologic or clinical significance[4]. However, in clinical practice and in public health programs it is of considerable importance to determine whether cigarette smoking can be considered a risk factor for hypertension or whether it has a negative or non-significant effect on BP.

The mean BP differences found between smokers and non-smokers are generally not large. Nevertheless, a dose-response relationship has been reported in several studies, with lower BPs observed at increasing levels of cigarette consumption[4,5]. In our study the 4 to 5 mmHg average difference was found and significant dose-response relationships between smoking and BPs were revealed by the Mantel's test[12]. However, definite linear relationships were not necessarily observed; among drinkers, heavy smokers had higher DBP compared with moderate smokers. Since smoking and high alcohol consumption tend to go together[8,13] and many studies have reported an positive association between alcohol consumption and hypertension[14], the inversion in trend for drinker's DBP would seem to be attributed to the tendency for heavy smokers to consume more alcohol. In present study, however, the percentages of heavy drinkers drinking 40 g ethanol or more per day by cigarette consumption were about 20% for each smoking class; that is, the rising trend among drinker's DBP was not explained by a high alcohol consumption according to the amount smoked per day.

The positive association between BMI and BP has been extensively described[15]. The lower BPs found in smokers have occasionally been attributed to reduced BMI[16]. In our study, however, mean values of BMI increased with the increase in the

Table 3. Number of individuals distributed among four blood pressure levels.

SBP(mmHg)	Drinkers		Nondrinkers		DBP(mmHg)	Drinkers		Nondrinkers	
	Smokers	Non-smokers	Smokers	Non-smokers		Smokers	Non-smokers	Smokers	Non-smokers
105≧	33	8	52	10	65≧	57	12	62	13
105~115	110	28	114	32	65~70	82	35	100	33
115~120	69	35	69	25	70~80	120	54	114	33
120<	84	48	61	28	80<	37	18	20	16

Non-smokers are not included Ex-smokers. Among smokers are included all current smokers.

amount of smoked per day both in drinkers ($r = 0.130$, $p<0.025$) and nondrinkers ($r = 0.195$, $p<0.001$), indicating that the reduction in BP seen in smokers was not the result of differences in BMI.

The mechanism of smoking-related BP reduction is not known. Cotinine might explain the blood pressure-lowering effect of cigarette smoking. Cotinine is a metabolite of nicotine that is eliminated from the body much more slowly than its parent[17]. Cotinine relaxes vascular smooth muscle and dilates blood vessels in vitro[18], and it decreases BP in anesthetized rats and dogs[19,20]. In anesthetized rats, cotinine showed dose-dependent depressor responses, with BP lowering observed at the lowest test dose, 6μmol/kg[20]. This level is close enough to the serum cotinine level of 300 ng/ml (an average value for smokers) to suggest that cotinine might be potent enough to decrease BP in tobacco users. Benowitz et al.[21] found a significant inverse correlation between serum cotinine and SBP and DBP.

Another possibility of a "withdrawal phenomenon" cannot be excluded, in the sense that BP rises during smoking due to an acute effect of nicotine exposure, and the pressor effect of nicotine leads to compensating blood pressure-lowering adjustments that are more evident between cigarettes than during smoking. Benowitz et al.[1] found that BP in smokers tended to be markedly lower during abstinence than during smoking, although the heart rate remains persistently elevated. Since in epidemiologic studies BP is generally measured after the subject has refrained from smoking for some time, the value obtained may not reflect the higher BP experienced while smoking.

As alcohol has widespread biologic effects, such as direct effects on the central nervous system controlling vasomotor centers, peripheral vascular effects, or psychological stress reaction, the blood pressure-lowering effect of cigarette smoking might be countered to some extent by these actions. Above mentioned rising trend of the relation between smoking and DBP among drinkers might then be affected in part by such effects of alcohol. The complex relation between smoking and alcohol consumption needs to be considered in future epidemiologic studies.

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