High Blood Pressure Due to Alcohol

A Rapidly Reversible Effect

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The hypothesis that the action of alcohol on blood pressure is rapidly reversible and that its effect is therefore mainly due to very recent alcohol consumption was examined in this study. Five hundred and seventy-seven subjects were screened in an occupational survey. Alcohol consumption, documented with a 1-week retrospective diary was divided into two categories: "recent" and "previous" intake. Recent intake was defined as the amount consumed on days 1, 2, and 3 immediately preceding blood pressure measurement. Previous intake was defined as the amount consumed on days 4, 5, and 6 preceding blood pressure measurement. High recent alcohol intake significantly raised systolic and diastolic blood pressure in both men and women. Previous alcohol intake, however, did not appear to influence blood pressure. We conclude that the effect of alcohol on blood pressure appears to be predominantly due to alcohol consumed in the few days immediately preceding blood pressure measurement, with alcohol consumption before those few days exerting little effect on blood pressure. (*Hypertension* 1991;17:787–792)

The relation between regular alcohol consumption and blood pressure has been described in several epidemiological surveys.[1-4] Consumption of a single alcoholic drink may cause an acute rise in blood pressure that resolves within 2 hours.[5,6] Clinical studies with small sample sizes of subjects have suggested that alcohol consumption over several days may cause a more sustained rise in blood pressure.[7,8] In alcoholics, hypertension is common but settles after withdrawal from alcohol.[9] This raises the possibility that alcohol may only exert a short-term effect on blood pressure. The hypothesis that the effect of alcohol on blood pressure is mainly due to alcohol consumed in the few days preceding measurement of blood pressure was therefore examined in this study.

Methods

Five hundred and seventy-seven subjects were examined in an occupational screening survey. They were volunteers from a factory work force of 1,000 people. All subjects were examined by a single investigator. The survey was conducted in a warm, quiet, uniformly heated room at the factory on weekdays (i.e., Monday to Friday). Informed verbal consent was obtained from all subjects; height and weight were then measured with the subjects wearing light clothing without shoes. Subjects were then seated for 5 minutes and then two blood pressure measurements were obtained following British Hypertension Society recommendations.[10] A Hawksley random-zero sphygmomanometer (Hawksley and Sons Ltd., Lancing, UK) was used, and diastolic blood pressure was recorded at phase five Korotkoff sounds. A detailed questionnaire, which included a 7-day retrospective alcohol intake diary,[11] was then administered. Subjects were asked to recall their alcohol intake on each of the 7 previous days, starting with the first day preceding the interview. Alcohol consumption was recorded as beer, spirits, wine, and fortified wine. Daily alcohol consumption was quantified in grams. Ten g alcohol is roughly equivalent to half a pint of beer, a glass of wine, a glass of fortified wine, or a single measure of spirits.[12]

Statistics

The influence of alcohol on blood pressure was examined by regression and analysis of covariance methods using the Statistical Package for Social Sciences.[13] Blood pressure was adjusted for the effects of age, body mass index (weight/height^2), and cigarette smoking. Two separate analyses were carried out.

The first analysis used total alcohol intake for the whole week (i.e., 7 days) as the measurement of alcohol consumption.

A second analysis was then undertaken, but this time alcohol consumption was reclassified into two categories: "recent" and "previous" alcohol intake.

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TABLE 1. Characteristics of Men and Women Examined in the Occupational Screening Survey

Characteristics	Men	Women
Subjects (*n*)	272	305
Antihypertensive treatment (*n*)	14	22
White Caucasians	256	282
Afro-Caribbeans	8	22
Asians	8	1
Age (yr)	44.1±12.2	45.8±9.7
Body mass index (kg/m^2)	25.5±3.4	25.8±4.2
Systolic BP (mm Hg)	127±17	119±15
Diastolic BP (mm Hg)	75±11	72±10
Average alcohol intake (g/wk)		
Beer	154	19
Spirits	10	18
Wine and fortified wine	7	9
Total	171	45

Numbers, mean±SD, or average amounts per subject are shown as appropriate. BP, blood pressure.

TABLE 3. Effect of Alcohol Intake Over 7 Days on Systolic and Diastolic Blood Pressures in Men and Women

Categories of alcohol consumption	*n*	Systolic BP (mm Hg)	Diastolic BP (mm Hg)
Men			
0 g/day	44	123±2	74±1
1–20 g/day	108	125±1	74±1
21–40 g/day	51	127±2	74±1
>40 g/day	55	130±2	78±1
Significance	Systolic BP F=1.9, NS		
	Diastolic BP F=2.8, p<0.05		
Women			
0 g/day	105	119±1	72±1
1–20 g/day	157	115±1	70±1
>20 g/day	21	119±3	73±2
Significance	Systolic BP F=3.0, p<0.05		
	Diastolic BP F=2.4, NS		

Values for blood pressure are mean±SEM. Blood pressure is adjusted for age, body mass index, and cigarette smoking. BP, blood pressure.

Recent intake was defined as the total amount of alcohol consumed on days 1, 2, and 3 immediately preceding the day of blood pressure measurement. Previous intake was defined as the total amount of alcohol consumed on days 4, 5, and 6 preceding blood pressure measurement. The influence of these two factors on blood pressure was examined.

Results

Of the 577 subjects, 272 were men and 305 were women. The characteristics of all subjects screened are shown in Table 1. Mean age±SD for men and women was 44.1±12.2 years and 45.8±9.7 years, respectively. Fourteen men and 22 women were being treated with antihypertensive medication at the time of the study, and they were excluded from further analysis to avoid the possible confounding effect of antihypertensive treatment on the alcohol–blood pressure relation. Alcohol consumption among men was almost four times as much as that in women. Beer intake accounted for 90% of alcoholic beverages consumed by men. In women, beer and spirits each accounted for approximately 40% of alcoholic beverages consumed.

The frequency distributions of alcohol consumption on each of the 7 days preceding blood pressure measurement in men and women who reported drinking any alcohol in the previous week are shown in Table 2. Apart from the seventh day, when alcohol consumption was lower, the frequency distribution on each of the 6 preceding days was similar.

Men

In the first analysis, the effect for the whole week of alcohol intake on blood pressure was examined. The men were divided into four groups of alcohol consumption: 0, 1–140, 141–280, and greater than 280 g/wk. For ease of comparison with the subsequent analysis, however, these groups are expressed as the average amount of alcohol consumed per day, the groups thus being 0, 1–20, 21–40, and greater than 40 g/day. There was a significant difference between the adjusted diastolic blood pressure of men

TABLE 2. Frequency Distribution of Alcohol Intake on Each of the 7 Days Preceding Blood Pressure Measurement by Men and Women Who Reported Drinking Any Alcohol in the Previous Week

Day preceding BP measurement	Men (*n*=214)				Women (*n*=178)			
	Alcohol intake (g/day)				Alcohol intake (g/day)			
	0	1–20	21–40	>40	0	1–20	21–40	>40
1	50.9	15.0	8.9	25.2	68.0	16.9	9.5	5.6
2	50.9	14.5	14.5	20.1	59.0	21.3	10.7	9.0
3	45.3	13.1	11.2	30.4	64.6	16.3	14.6	4.5
4	51.4	10.7	9.9	28.0	62.4	18.0	11.8	7.8
5	50.9	10.3	11.2	27.6	59.6	19.7	10.7	10.0
6	49.1	12.1	10.3	28.5	68.0	19.7	7.9	4.4
7	61.7	8.9	7.9	21.5	80.3	14.0	5.1	0.6

Values are percentage of frequency distribution. BP, blood pressure.

TABLE 4. Breakdown Table Demonstrating the Effect of Recent and Previous Drinking Categories on Blood Pressure in Men

Previous alcohol intake (g/day)	Recent alcohol intake (g/day)		
	0	1–40	>40
0	123±2/75±1	125±2/72±2	126±6/76±4
(n)	(46)	(35)	(7)
1–40	125±3/74±2	123±2/73±1	127±3/77±2
(*n*)	(30)	(64)	(18)
>40	119±5/72±3	124±4/73±3	134±3/79±2
(*n*)	(10)	(15)	(33)
Significance			
Systolic BP	Recent intake	$F=5.7, p<0.01$	
	Previous intake	$F=0.2$, NS	
	Interaction	$F=1.0$, NS	
Diastolic BP	Recent intake	$F=6.8, p<0.01$	
	Previous intake	$F=0.0$, NS	
	Interaction	$F=0.5$, NS	

Values for blood pressure are mean±SEM. Systolic and diastolic blood pressures (mm Hg) are shown within each cell (blood pressure adjusted for age, body mass index, and cigarette smoking). Number of men within each category is given in parentheses. BP, blood pressure.

in these alcohol categories ($F=2.8$, $p<0.05$) with a threshold level of alcohol consumption of 40 g/day on average above which diastolic blood pressure rose (Table 3). Systolic blood pressure appeared to rise progressively with increasing alcohol consumption and, although there were no significant differences between the alcohol categories, a linear trend over the categories was statistically significant ($p<0.05$).

In the second analysis on men, the effect of recent and previous alcohol intake on blood pressure was examined. Both of these categories were subdivided into three groups of alcohol consumption: 0, 1–40, and greater than 40 g alcohol/day on average. The adjusted mean values for systolic and diastolic blood pressure, cross-classified by recent and previous alcohol intake are shown in Table 4. High recent alcohol intake significantly raised both systolic and diastolic blood pressure ($F=5.7, p<0.01$ and $F=6.8$, $p<0.01$, respectively). Previous alcohol intake, however, did not appear to affect blood pressure. There was no significant interaction between these two categories in the analysis. Exclusion of nondrinkers from the analysis yielded similar results, except that the number of men in the first cell (0 g/day) was very small.

Mean daily alcohol intake in men in the high intake category (greater than 40 g/day) was examined to see if there was any difference between recent and previous alcohol intake. Men reporting high recent alcohol intake ($n=58$) consumed a mean±SEM of 80±4 g/day over the 3 days, whereas those reporting high previous alcohol intake ($n=58$) had a mean of 77±4 g/day over the 3 days. Thirty-three men reported both high recent and previous intake and their mean daily recent intake was 89±6 g, their mean daily previous intake was not significantly different (paired t test $p>0.1$) at 79±5 g.

Women

In women, reported alcohol consumption was generally much lower than in men. When alcohol intake for the whole week was considered, only four women consumed more than 40 g/day on average. For the purposes of the first analysis, they were combined with the category who consumed 21–40 g/day on average. Thus, for the first analysis, using alcohol intake for the whole week (i.e., 7 days), there were three categories of alcohol consumption: 0, 1–20, and greater than 20 g/day on average. There was a significant difference between these categories for adjusted systolic blood pressure ($F=3.0$, $p<0.05$). This was because women consuming 1–20 g/day alcohol on average had lower systolic blood pressure than both nondrinkers and those consuming more than 20 g/day on average (Table 3). There appeared to be no significant effect of alcohol on diastolic blood pressure.

In women, in the second analysis, the effect of recent and previous alcohol intake on blood pressure was examined. Each of these two categories was subclassified into three groups of alcohol consumption, these being 0, 1–20, and greater than 20 g alcohol/day on average. These groups were different from those for men due to the lower amounts of alcohol consumed by women. The adjusted mean values for systolic and diastolic blood pressure in women, cross-classified by recent and previous alcohol intake, are shown in Table 5. High recent alcohol intake significantly raised both systolic and diastolic blood pressure ($F=3.3$, $p<0.05$ and $F=3.5$, $p<0.05$, respectively), whereas previous intake did not appear to affect blood pressure. The analysis for systolic blood pressure was complicated by an interaction between recent and previous intake ($F=3.1$, $p<0.05$). There was, however, no significant interaction between these factors with regard to diastolic blood

TABLE 5. Breakdown Table Demonstrating the Effect of Recent and Previous Drinking Categories on Blood Pressure in Women

Previous alcohol intake (g/day)	Recent alcohol intake (g/day)		
	0	1–20	>20
0	118±1/71±1	113±2/68±1	123±6/77±4
(n)	(108)	(48)	(5)
1–20	113±2/68±1	114±2/70±2	127±4/75±3
(*n*)	(46)	(35)	(12)
>20	110±5/69±4	119±4/72±3	113±5/73±3
(*n*)	(7)	(14)	(8)
Significance			
Systolic BP	Recent intake	$F=3.3, p<0.05$	
	Previous intake	$F=0.8$, NS	
	Interaction	$F=3.1, p<0.05$	
Diastolic BP	Recent intake	$F=3.5, p<0.05$	
	Previous intake	$F=0.7$, NS	
	Interaction	$F=1.1$, NS	

Values for blood pressure are mean±SEM. Systolic and diastolic blood pressures (mm Hg) are shown within each cell (blood pressure adjusted for age, body mass index, and cigarette smoking). Number of women within each category is given in parentheses. BP, blood pressure.

pressure. Exclusion of nondrinkers from the analysis yielded similar results, except that the number of women in the first cell (0 g/day) was very small.

Mean daily alcohol intake in women in the high intake category (greater than 20 g/day) was examined to see if there was any difference between recent and previous alcohol intake. Women reporting high recent alcohol intake ($n=25$) consumed a mean±SEM of 41±5 g/day over the 3 days, whereas those reporting high previous alcohol intake ($n=29$) had a mean of 37±3 g/day over the 3 days. Eight women reported both high recent and previous intake; their mean daily recent intake was 44±8 g, whereas their mean daily previous intake was similar at 43±6 g.

Oral contraceptive use may affect blood pressure. In this study population, however, only 23 women were taking this medication, and adjustment for this factor did not affect the results presented above.

Blood Pressure Variation From Monday to Friday

It is possible that blood pressure could vary over the week and any underlying trend might bias the observed alcohol–blood pressure relation. Mean systolic and diastolic blood pressures, adjusted for age, body mass index, and cigarette smoking, from Monday to Friday for men and women, are shown in Table 6. There were, however, no significant trends or differences in blood pressure through the week. Adjustment for the day of examination did not affect the significant effect of recent alcohol intake on blood pressure in men and women described above.

Discussion

The results of the present study support the hypothesis that the effect of alcohol on blood pressure is predominantly related to alcohol consumed in the few days immediately preceding blood pressure measurement, with alcohol consumption before the few days preceding measurement exerting little influence on blood pressure. Alcohol therefore appears to exert a fairly prompt and rapidly reversible effect on blood pressure. This is consistent with small clinical studies that have demonstrated a rise in blood pressure after 3–4 days of regular alcohol consumption, with pressures settling to normal levels after a similar period of abstinence.[7,8] Puddey and coworkers[14,15] have reported two studies examining the effect of alcohol on blood pressure over a longer period of time. These were both crossover studies during which subjects consumed high-alcohol beer for 6 weeks followed by low-alcohol beer for a further 6 weeks and vice versa. The changes in blood pressure occurred during the first 2 weeks of altering alcohol intake. It is possible that the major changes in blood

TABLE 6. Systolic and Diastolic Blood Pressures on Monday to Friday in Men and Women

Day of the week	*n*	Systolic BP (mm Hg)	Diastolic BP (mm Hg)
Men			
Monday	71	126±2	74±1
Tuesday	30	128±3	76±2
Wednesday	60	128±2	75±1
Thursday	42	125±2	76±1
Friday	55	124±2	74±1
Women			
Monday	82	118±1	72±1
Tuesday	30	118±2	72±2
Wednesday	66	118±2	72±1
Thursday	36	119±2	71±2
Friday	69	117±2	70±1

Values are mean±SEM. Blood pressure is adjusted for age, body mass index, and cigarette smoking. BP, blood pressure.

pressure could have occurred during the first few days.

The 7-day retrospective diary appears to be a reasonably accurate and acceptable method of evaluating alcohol intake.[11] However, it is difficult to be certain that subjects did not underestimate their alcohol consumption. Subjects may have remembered their recent intake more accurately and either underestimated previous intake or extrapolated from their recent to previous intake. If the former was true, then reported alcohol intake would gradually decrease from the first to the seventh day before examination perhaps with increasing scatter reflecting less accurate recall. However, this was not the case in this study. Even in heavy drinkers, in whom recall bias if present might be substantially greater, averages for previous intake were only minimally lower than those for recent intake. Alcohol consumed on day 7 was lower than the amounts consumed on the other days, but this anomaly may simply be due to the fact that subjects were screened on weekdays only, thereby excluding weekend alcohol consumption from day 7 for all the subjects. The general lack of interaction between the previous and recent intake categories suggests that subjects did not extrapolate from their recent to their previous alcohol consumption to any great extent. Observer bias causing more accurate documentation of recent alcohol consumption is unlikely to have occurred in this study since the concept of classifying alcohol consumption into recent and previous intake was only thought of after the survey had been completed.

Alcohol consumption tends to be higher at weekends, highlighted by "weekend binge drinking." At first glance, it might appear that this has biased the analysis and results, with the effect of weekend drinking on blood pressure only seen in subjects examined early in the week. This suggestion, however, assumes that high alcohol intake over a few days raises blood pressure, which then settles quite quickly; this was in fact the aim of the present study as opposed to being a factor causing bias. It was indeed desirable that some people were examined early in the week, when the hypothesized short-term or binge effect of alcohol would be operative and others later in the week when this effect should have worn off.

A further possible factor for bias was an underlying trend or variation in blood pressure during the week. However, in the present study there was no suggestion of any trend in blood pressure through the week that could have affected the results. In any case, the effect of recent intake on blood pressure remained after adjustment for day of examination.

Two published studies have examined the effect of recent versus usual alcohol intake on blood pressure with conflicting results.[16,17] Both studies defined recent intake as alcohol consumed within the last 24 hours. Criqui et al[16] found that alcohol consumed in the 24 hours before the study was much more strongly associated with elevated blood pressure than alcohol consumed in the week, excluding the previous 24 hours, before the study. Puddey et al[17] estimated 7-day retrospective alcohol intake and 24-hour intake on separate occasions and showed the same magnitudes of correlation between both these estimates of alcohol consumption and blood pressure. However, when they adjusted for 7-day (usual) intake, the effect of 24-hour (recent) intake on blood pressure was no longer significant, which is opposite to the conclusion drawn by Criqui et al.[16] A possible explanation for this discrepancy is that "usual" alcohol intake estimated by a 7-day retrospective diary by definition includes recent (24-hour) intake, and a second estimate of recent intake in the same regression equation is unlikely to have any further significant effect on blood pressure.

In the present study, it should be noted that previous intake is not equated to usual alcohol intake. It is possible that recent intake may simply be a better measure of usual intake than the 7-day diary. The discussions above on underreporting and extrapolation within the 7-day period and the fact that the spread of alcohol intake within the first 6 days was similar make this possibility less likely but do not exclude it.

The present study provides further supportive evidence for the suggestion that alcohol has a "slow pressor" effect that is quite reversible.[18] The mechanism mediating this effect, however, remains unclear.[19]

If alcohol does have such reversible effects on blood pressure, then it is possible that it does not cause sustained hypertension. The important question is whether the alcohol-induced rise in blood pressure confers the same cardiovascular risks as those due to other forms of hypertension. There is now substantial evidence linking high alcohol consumption with stroke[20,21] and to a lesser extent with coronary heart disease,[22,23] and it is possible that alcohol-induced hypertension partially mediates these associations. Friedman et al[24] found that admissions and death from cardiovascular complications, apart from coronary heart disease, were similar in hypertensive patients with high alcohol consumption compared with those with low alcohol consumption. It therefore appears that alcohol-induced hypertension leads to an increase in cardiovascular disease, but the evidence is not conclusive.

The knowledge that alcohol exerts a reversible effect on blood pressure may be useful in the management of hypertensive patients. Patients may have consumed excessive quantities of alcohol in the few days preceding clinic attendance, and it would be worthwhile advising them to reduce alcohol consumption while withholding institution of or changes in antihypertensive therapy and then reviewing them within a few days. Preliminary results suggest that such advice is an effective form of treatment for these patients.[25]

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