

Alcohol Consumption and Hypertension

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Many observational studies have shown a relationship between three or more alcoholic drinks daily and hypertension. Reduction in alcohol intake is associated with lowering of blood pressure in randomized clinical trials: each drink per day reduction in intake lowers systolic and diastolic blood pressure by approximately 1 mm Hg. Although regular alcohol consumption seems to reduce the incidence of atherothrombotic cardiovascular events, excessive alcohol intake increases the risk of many medical and psychosocial problems. For persons with hypertension who drink excessively, average maximum alcohol intake of one drink per day in women and two drinks per day in men is a reasonable goal, if drinking is not otherwise contraindicated. (J Clin Hypertens. 2001;3:166-170).

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Regular alcohol consumption can produce positive psychosocial effects and some beneficial effects on health, especially reduced atherothrombotic events and death. However, excessive alcohol intake results in many serious adverse psychosocial and health consequences. One of the harmful effects of excess alcohol intake is its association with hypertension.

As early as 1915, the French physician Lian¹ reported a relationship between alcohol consumption and elevated blood pressure: sailors who drank several liters of wine daily were more likely

to have hypertension, and blood pressure (BP) increased with increasing intake. Most of the studies on the relationship between alcohol intake and blood pressure, however, have been reported in the past several decades.

EPIDEMIOLOGY

The positive relationship between the amount of alcohol consumed and BP is one of the strongest associations of potentially modifiable risk factors for hypertension.²⁻⁶ Scores of cross-sectional epidemiologic studies from many cultures have shown progressively higher BP levels or a higher prevalence of hypertension with increasing levels of alcohol intake. A standard drink in the United States is usually defined as 14 g of alcohol (ethanol). This amount of alcohol is present in 12 oz of beer, 5 oz of table wine, or 1.5 oz of 80 proof (40%) distilled spirits. The higher the alcohol intake the higher the BP, above an average intake of two drinks per day. This relationship usually persists even when other factors are taken into account, such as age, weight (or body mass index), sodium and potassium intake, cigarette smoking, and education. Alcohol has been found to increase BP in whites, blacks, and Asians.²⁻⁴ Sometimes a “J”-shaped relationship is found, in which lower BP levels are noted with low levels of alcohol intake compared to no drinking or drinking three or more drinks per day.^{2,5} Occasionally, low levels of alcohol intake are associated with higher BP levels than no drinking.^{2,7} Usually, however, there is no BP difference on average between nondrinkers and those who consume no more than two drinks per day.² When BP is reported to be different between these two groups, the difference is small.

In prospective, observational studies,⁸⁻¹⁰ it has been found that BP decreases over time when alcohol intake decreases. BP also decreases in inpatient studies of alcoholics who stop drinking.^{11,12} The hypertensive effect of alcohol usually subsides within several days of abstinence, and the relation-

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ship between alcohol intake and BP is strongest for alcohol drunk within the previous 24 hours.¹³ Weekend drinkers, but not daily drinkers, have significantly higher blood pressure on Monday than on Thursday.¹⁴ Although some studies suggest that one type of alcoholic beverage, such as beer or liquor, is more strongly associated with BP levels than another, it appears that the relationship between alcohol and BP levels is dependent on the amount of alcohol ingested.

Alcohol intake has also been associated with resistance to antihypertensive therapy.¹⁵ Some of the apparent resistance may be from poor medication adherence in heavy drinkers, but there may also be true interference with the BP-lowering effects of some medications.¹⁶

Consuming three or more drinks of alcohol per day approximately doubles the risk of having hypertension. The actual contribution of alcohol to the prevalence of hypertension in a population

varies according to the prevalence of heavy drinking and the prevalence of hypertension in that population. Alcohol has been estimated to account for about 5%–20% of hypertension in populations.

RANDOMIZED, CONTROLLED TRIALS

At least 12 randomized studies have been conducted to examine the effect of a reduction in alcohol intake on BP (Table).^{14,16–27} Although the majority of these studies included relatively few subjects, were of short duration, and were not designed as effectiveness trials, the results are generally consistent with the epidemiologic evidence for the relationship of alcohol to BP.

The largest and longest of the randomized, controlled trials of the effects of alcohol reduction on BP is the Prevention and Treatment of Hypertension Study (PATHS).^{26,27} The primary objectives of this U.S. National Institutes of Health and Veterans Affairs Cooperative Studies Program trial were to de-

TABLE. RANDOMIZED, CONTROLLED TRIALS OF THE EFFECT OF ALCOHOL REDUCTION ON BLOOD PRESSURE

STUDY, YEAR	N	AGE IN YEARS (MEAN±SD OR RANGE)	DURATION (WEEKS)	BASELINE BP (MM HG)	ALCOHOL INTAKE DIFFERENCE (DRINKS/DAY)*	BP DIFFERENCE (MM HG)	P VALUE
Puddey, 1985 ¹⁷	46	35±8	6	133/76	3.7	3.8/1.4	<0.001/<0.05
Howes, 1985 ¹⁸	10	25-41	0.6	120/66	5.7	8/6	<0.025/<0.001
Puddey, 1987 ¹⁶	44	53±16	6	142/84	4.0	5/3	<0.001/<0.001
Ueshima, 1987 ¹⁹	50	46±7	2	148/93	2.6	5.2/2.2	<0.005/ns
Wallace, 1988 ²⁰	641	42±20	52	136/82	1.0	2.1/?	<0.05/ns
Parker, 1990 ²¹	59	52±11	4	138/85	3.8	5.4/3.2	<0.01/<0.01
Cox, 1990 ²²	72	20-45	4	132/73	3.4	4.1/1.6	<0.05/<0.05
Maheswaran, 1992 ²³	41	40s	8	144/90	3.1	Not reported	ns
Puddey, 1992 ²⁴	86	44	18	137/85	3.0	4.8/3.3	<0.01/<0.01
Ueshima, 1993 ²⁵	54	44±8	3	144/96	1.7	3.6/1.9	<0.05/ns
Rakic, 1998 ¹⁴							
Weekend (pattern)	14	41	4	122/72	3.1	1/0	ns/ns†
Daily	41	48	4	124/77	2.6	2/2	<0.05/<0.01**
Cushman, 1998 ^{26,27}	641	57±11	104	140/86	1.3	0.9/0.6	0.16/0.10

BP=blood pressure

*A standard drink is defined as 14 g of ethanol and is contained in a 12-oz glass of beer, a 5-oz glass of table wine, or 1.5 oz of distilled spirits.

**Supine office BP; 24-hour ambulatory systolic BP (but not diastolic BP) was lowered by 3.1 mm Hg ($p<0.001$) and 2.2 mm Hg ($p<0.001$) in weekend and daily drinkers, respectively.

termine, in 641 moderate to heavy drinkers with diastolic blood pressure (DBP) of 80–99 mm Hg, if alcohol could be reduced for at least 6 months, and if BP is lowered by a sustained reduction in alcohol intake. Anyone with evidence of alcoholism, complications of excess alcohol intake, or significant cardiovascular or psychiatric diseases was excluded. Although the differences in alcohol intake were highly significant from 3–24 months of follow-up, the difference averaged only 1.3 drinks per day rather than the 2.0 drinks per day needed to determine if BP is lowered. This shortfall resulted in part because the control group lowered alcohol intake more than anticipated. The average difference in BP reduction was 0.9/0.6 mm Hg. Although not statistically different, this BP difference is consistent with the approximately 1 mm Hg change in BP for each drink per day change in alcohol intake seen in controlled studies with larger alcohol intake differences.

In most of the other controlled trials of alcohol reduction and blood pressure, larger BP differences between randomized groups were seen than in PATHS (Table). In those trials, however, baseline levels of alcohol intake were higher and changes in alcohol intake were larger than in PATHS. The average differences in alcohol intake ranged from 1.0–5.7 drinks per day and resulted in significant reductions in systolic blood pressure (SBP) and/or DBP in all but two studies. The five studies from Perth, Australia^{16,17,21,22,24} in normotensive and hypertensive participants are probably the best from which to estimate the change in BP that might be expected with a change in alcohol intake. The investigators typically recruited middle-aged, male heavy drinkers and randomized them to continue their usual intake of beer or to drink low-alcohol beer, usually in a crossover design. In these studies the difference in alcohol intake in the randomized groups averaged three to four drinks per day; this resulted in an average difference in BP of 3.8–5.4 mm Hg/1.4–3.3 mm Hg, even though most of the participants in these trials did not have hypertension or were normotensive on therapy. In the first two studies, a net reduction of three drinks per day in alcohol intake produced a 4.4/2.2 mm Hg average reduction in BP.²⁷ Across all studies, for every one drink per day reduction in alcohol intake, SBP or DBP was reduced by approximately 1 mm Hg. The randomized, controlled trials provide solid evidence that a reduction in alcohol intake in individuals who drink three or more drinks on average per day is effective in significantly lowering BP. However, the results of PATHS, the primary effectiveness clinical trial in this area, do not provide strong support that a recommendation to reduce alcohol consumption should be the only method to prevent or treat hypertension in

moderate to heavy drinkers.²⁷ However, in my opinion, the recommendations of consensus committees^{28,29} to limit alcohol consumption to no more than one to two drinks per day are reasonable because of the potential efficacy of this intervention, the reduction in risk of many other adverse consequences of drinking, and the apparent relative ease of achieving a reduction in alcohol intake in nondependent drinkers.

POTENTIAL MECHANISMS OF EFFECT ON BP

Several mechanisms have been proposed for the relationship between alcohol and elevated BP. An immediate effect of alcohol ingestion is vasodilation in some vascular beds. Sustained intake accompanied by high blood alcohol levels, however, results in short-term elevation of BP.³⁰ In addition, BP levels usually correlate best with alcohol intake within the prior 24 hours, and fall within hours to days after cessation or reduction in intake.^{13,14} Therefore, it is likely that the effect of alcohol on BP is not mediated by long-term structural alterations, but by neural, hormonal, or other reversible physiologic changes.

According to one hypothesis, the hypertensive effect of alcohol is from a chronic state of alcohol withdrawal in frequent, heavy drinkers, but there is much evidence in favor of a direct effect of alcohol on BP. Suggested mediators of a direct effect include: 1) stimulation of the sympathetic nervous system, endothelin, renin-angiotensin-aldosterone system, insulin (or insulin resistance), or cortisol; 2) inhibition of vascular relaxing substances, e.g., nitric oxide; 3) calcium or magnesium depletion; 4) increased intracellular calcium or other electrolytes in vascular smooth muscle, possibly mediated by changes in membrane electrolyte transport; and 5) increased acetaldehyde.^{31–33} There appears to be more evidence to support the role of the sympathetic nervous system or cellular transport and electrolytes, or both, than the other mechanisms suggested, but this remains an open question.

CARDIOVASCULAR PROTECTIVE EFFECTS OF ALCOHOL INTAKE

Low to moderate alcohol intake is associated with a lower incidence of atherosclerotic cardiovascular events, such as myocardial infarction and atherothrombotic stroke, compared with no alcohol ingestion.^{34–36} These epidemiologically observed benefits of alcohol may be related to increases in high-density lipoprotein (HDL) and apolipoproteins A₁ and A₂, antioxidant effects, and reduced platelet aggregability.^{34–37} However, higher intake levels are associated with increased risk for hypertension, cardiomyopathy and other

cardiac complications, hemorrhagic and thrombotic strokes, certain kinds of cancer, hepatitis, cirrhosis, pancreatitis, gastritis, suicide, accidents, violence, and alcohol abuse and dependence.^{28,31} Because of these risks, most medical authorities and consensus guidelines do not encourage initiation of alcohol consumption to reduce cardiovascular risk. However, for those who choose to drink and have no contraindication, low levels of drinking can be considered prudent.

RECOMMENDATIONS

Because of the association between heavy drinking and hypertension, other detrimental health and psychosocial effects, and the potential benefits of alcohol consumption, current public health recommendations in the United States are: for those who drink, average alcohol intake should not exceed two drinks per day in men and one drink per day in women, since women are generally smaller and have markedly less gastric alcohol dehydrogenase than men (more alcohol is absorbed).^{28,29} Many persons should not drink at all—for example, pregnant women and anyone with a history of, or a potential risk for, a drinking problem or serious medical complications from alcohol. For those who are not in a high-risk category and who drink within the limits outlined above, the risk of developing hypertension is probably not increased and beneficial effects of alcohol may predominate. Anyone who drinks more than one to two drinks per day should be encouraged to reduce his or her intake in the interest of reducing BP and the risk of developing hypertension and other alcohol-related problems.

Most adults who drink more than one or two drinks per day do not have evidence of alcohol dependence and it does not appear to be difficult for them to reduce their alcohol intake. In the PATHS trial, for example, alcohol intake was reduced from an average of six drinks per day (in the 6 months prior to screening) by about 1.5 drinks per day during the week prior to randomization and before explanation that the trial concerned alcohol intake.^{26,27} During the study, the intervention group further reduced their intake by 2.3 drinks per day to approximately two drinks per day. The total reduction in alcohol intake was four drinks per day. In the studies performed in Perth, Australia, participants reduced their beer intake by three to four drinks per day for weeks at a time, merely by substituting equal quantities of low-alcohol beer for their usual beer.

All hypertensive patients should be asked about recent drinking, including quantity and frequency of drinking. Those who drink should be given appropriate screening for alcohol dependence, such

as the CAGE questions. Effective interventions, such as the cognitive-behavioral technique used in the PATHS trial, have been developed to reduce alcohol consumption in nondependent heavy drinkers.^{26,27,38,39} Referral to alcohol treatment specialists is necessary in many cases, if there is evidence of alcohol dependence or more serious health consequences of drinking. Primary care physicians and other health care providers should routinely discuss alcohol consumption with their patients and recommend limitation of excessive intake whenever it occurs.

The observed reductions in BP following reduction of alcohol intake in randomized, controlled trials are comparable to or quantitatively greater than the differences found for most other lifestyle interventions.^{40–42} The Trials of Hypertension Prevention, Phase I (TOHP-I) was a randomized, controlled trial of lifestyle interventions and nutritional supplementation in persons with high normal blood pressure. In TOHP-I, weight reduction was most effective in reducing BP (by 2.9/2.3 mm Hg), while sodium reduction also significantly reduced BP (by 1.7/0.9 mm Hg), and these results were comparable to the results of alcohol intervention in PATHS.⁴¹ Exercise has also produced reductions in BP of at least this magnitude.^{29,43} Therefore, reduction in alcohol intake should be considered along with weight reduction, limitation of sodium intake, and exercise as the primary lifestyle changes to encourage in patients with, or at risk for, hypertension. If alcohol intake exceeds an average of one or two drinks per day, a reduction in alcohol consumption should be included in the initial management plan.

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