Binge Drinking and Ambulatory Blood Pressure

Kaija Seppä, Pekka Sillanaukee

Abstract—The effect of alcohol drinking in raising blood pressure (BP) is rapidly reversible. However, there is only limited information on the effect of binge drinking on BP values. In this study, 20 healthy men who were all social drinkers drank alcohol (2.2 g/kg) in controlled circumstances on a Saturday evening. Ambulatory BP measurement (ABPM) values were compared with ABPM values of the same subjects during the previous sober Saturday, separately throughout 6 hours of intoxication, throughout 6 hours when blood alcohol levels decreased, and throughout 6 hangover hours. During the intoxication period, both mean systolic BP and mean diastolic BP were 5 mm Hg higher ($P=0.0183$ and $P=0.0529$, respectively) and the pulse was 18 beats per minute faster ($P=0.0001$) compared with the corresponding sober period during the previous weekend. While blood alcohol levels decreased after drinking, mean systolic BP was 4 mm Hg lower ($P=0.0331$), diastolic BP was 5 mm Hg lower ($P=0.0058$), and pulse was 15 bpm faster ($P=0.0001$) than during the sober weekend. No statistically significant difference was found between the weekends in BP values during the hangover period. Drinking seems to increase both systolic and diastolic BP during intoxication but not during hangover. During the period when blood alcohol levels are decreasing, usually at night, both pressure levels fall to less than the basic level. These major and rapid changes in BP values might increase the likelihood of strokes, which are seen in increased numbers among young adults, especially during weekends and holidays. (Hypertension. 1999;33:79-82.)

Key Words: blood pressure monitoring, ambulatory ■ alcohol ■ binge drinking ■ blood pressure ■ pulse ■ stroke

The effect of alcohol drinking in raising blood pressure (BP) has been known since the 1960s.1–3 When the daily alcohol consumption is more than 30 g of absolute alcohol, BP begins to rise in both men and women.4,5 The Kaiser Permanente study demonstrated that individuals drinking 6 to 8 drinks per day have 9.1 mm Hg higher systolic and 5.6 mm Hg higher diastolic BP values than nondrinkers.6 Because alcohol abuse is a common problem, it can also be considered an important cause of increased BP values.7,8 Half of alcoholics have BP values $\geq 160/90$ mm Hg; however, these values have been found to normalize during abstinence.9 A similar trend was found in population studies,6 and the present opinion is that the effect of alcohol in raising BP is rapidly reversible.8

Binge drinking is common among heavy drinkers. An increasing number of young adults, especially those who work during the week, seem to concentrate their drinking on weekends and holidays. It is probable that binge drinking has different consequences on BP compared with daily drinking. However, only a few studies have examined the relationship between drinking pattern and BP. Epidemiological evidence shows that there is no difference between BP values in teetotalers and those who drink every now and then.6 In Finland, where binge drinking is the prevalent pattern of heavy drinking, we have found in a cross-sectional study that binge drinking does not permanently affect BP, at least not diastolic values.11 In their retrospective study, Maheswaran et al12 likewise concluded that the BP effect of alcohol is due predominantly to alcohol consumed in the days immediately preceding BP measurement.

Ambulatory measurement of BP (ABPM) offers accurate results because it takes into account patient-related and physiological variations during the recording. Noninvasive ambulatory equipment has developed considerably during the last few years and is beginning to overcome validation problems.13,14 Only a few studies have evaluated the BP and alcohol relationship using ambulatory methods. Maiorano et al15 examined alcoholics and found that 1 week of abstinence did not influence 24-hour BP levels in normotensive subjects but altered the diurnal pattern characterized by a fall in systolic BP and increased BP variability. Short-term alcohol consumption (1 g/kg) among social drinkers for a few days has not been found to increase office or ambulatory BP.16,17 The effect of “binge” amounts on BP measured with ambulatory methods has not been examined previously.

Methods

Twenty male volunteers aged 19 to 61 years (mean age, 33 years) participated in the study, which had been approved by the Ethics Committee of the Biomedical Research Center of Alko Ltd. In...
formed consent was obtained from all volunteers; risks of binge drinking were outlined, and it was recommended that participants stay at home during drinking under the supervision of a sober spouse or friend. None of the participants were taking medication, all were moderate drinkers (<280 g absolute alcohol per week; range, 70 to 200 g; eg, ≈5 to 17 drinks per week or 5 to 10 drinks per 1 or 2 occasions during the week), and 17 were nonsmokers. BP was measured using ABPM-Meditech equipment over 2 consecutive weekends from Friday morning until Tuesday morning. Every subject used the same gauge during the 2 separate periods. During the second weekend, the subjects consumed “binge” amounts of alcohol, 2.2 g/kg of nonchilled spirits, divided into 12 drinks over 6 hours beginning at 6 PM on Saturday. During the first weekend no alcohol was allowed, but an extra meal containing calories equivalent to the alcohol during the next weekend was added to the normal diet. Participants were not allowed to eat salted snacks, nuts, or crisps during the study. The 3 smokers were advised to smoke the same amount during both weekends. Extreme physical activity (eg, sport competition alone or in a group) was forbidden during the study weekends to avoid its disturbing effect on BP measurements and to make physical activity uniform during the 2 study weekends.

The BP monitoring was performed with oscillometric ABPM-Meditech ambulatory BP equipment. The accuracy of the equipment for diastolic BP measurements has been classified as A and that of systolic recordings as B, according to the British Hypertension Society recommendations. This equipment measures BP of 0 to 280 mm Hg and pulse of 40 to 200 bpm. The BP accuracy is within ±3 mm Hg or 2% of the reading, and the pulse accuracy is within 5% of the reading. The pressure is calculated based on arterial pulsations, which are electronically registered using a capacitive pressure sensor. The pulse rate is calculated based on the duration of 20 beats. Repeated measurements are taken if the pulse count is <40 bpm, pulse pressure is <50% of the previously measured value, pulse pressure is <20 mm Hg, or diastolic BP is >130% of the previously measured value. The information on the BP and pulse measurements was stored in the memory of the equipment and read into a computer using ABPM-Meditech software.

All subjects had arm circumference <35 cm, and a standard cuff was used. The monitor was applied to the nondominant arm. The equipment was programmed to measure BP every 15 minutes during the day (8 AM to 12 PM), every 30 minutes during the night (12 PM to 8 AM), and every 10 minutes during the intoxication period and during the corresponding times the week before (Saturday 8 PM to Sunday 4 AM). Values were excluded if pulse pressure was <15 mm Hg or diastolic BP was outside the range of 45 to 140 mm Hg.

The BP values of the 20 subjects during the first measurement day and night were compared with the values of the 3 following days and nights to determine the possible effect of the equipment on the pressure values. BPs were monitored during and compared between 2 weekends to separately analyze the possible effects of the weekend (leisure) on the values. To find out the effect of alcohol on BP values, the values of the first (sober) weekend were compared with the values of the second weekend during the drinking time (Saturday 6 PM to Sunday 2 AM), during the time when the blood alcohol concentration was falling (Sunday 2 AM to Sunday 10 AM), and during hangover time (Sunday 10 AM to Sunday 6 PM). Statistical analyses of the parameters (systolic BP, diastolic BP, and pulse) were performed using Student’s paired t test. P < 0.05 was considered statistically significant.

Results

To eliminate the known effect of wearing the ambulatory equipment, the daily variation, and the possible effect of weekend on BP values, the ABPM was conducted during 2 consequent weekends. Comparison of the systolic and diastolic BP as well as pulse values of the first day with those values during the following 3 days (Saturday to Monday) showed that during the first measurement day, both systolic and diastolic BPs were significantly higher (126 versus 122 mm Hg, P = 0.0185, and 83 versus 77 mm Hg, P = 0.0007, respectively); no difference was found in pulse values, nor was any change (P > 0.05) observed in nighttime values in systolic (110 versus 111 mm Hg) or diastolic (66 versus 67 mm Hg) values or pulse rate (43 versus 44 bpm). The decrease of daytime values in systolic and diastolic BPs was stabilized after the first measurement day (Table 1). This level also remained after the weekend, on Monday. Thus, it seems that weekend has no effect on BP values, but getting used to the equipment takes some time. No statistically significant differences were found in either systolic or diastolic BP values between sober and drinking periods. However, pulse frequency was significantly higher during the drinking period in daytime (78 versus 74 bpm, P < 0.001) and nighttime (68 versus 58 bpm, P < 0.001).

The BP and pulse values of the intoxication period (Saturday 6 PM to Sunday 2 AM) and the values of the corresponding time during the previous sober weekend are presented in Table 2. The monitoring should have resulted in a total of 44 values per person. In practice, the number of measured values

<table>
<thead>
<tr>
<th>Weekday</th>
<th>Mean ± SD</th>
<th>Range</th>
<th>Mean ± SD</th>
<th>Range</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sober</td>
<td></td>
<td></td>
<td>Intoxicated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systolic BP, mm Hg</td>
<td>119 ± 10.5</td>
<td>97–137</td>
<td>124 ± 12.4</td>
<td>105–153</td>
<td>0.0183</td>
</tr>
<tr>
<td>Diastolic BP, mm Hg</td>
<td>75 ± 10.5</td>
<td>54–91</td>
<td>80 ± 13.6</td>
<td>58–117</td>
<td>0.0529</td>
</tr>
<tr>
<td>Pulse, bpm</td>
<td>69 ± 6.6</td>
<td>58–79</td>
<td>87 ± 13.9</td>
<td>68–116</td>
<td>0.0001</td>
</tr>
</tbody>
</table>
ranged from 9 to 43 during the sober period (mean, 34) and from 21 to 43 during the drinking period (mean, 36). According to our exclusion criteria, none of the values were excluded. The mean systolic BP was 5 mm Hg higher during the state of intoxication, the diastolic BP was 5 mm Hg higher, and the pulse 18 bpm faster; all differences were statistically significant.

The comparisons of values measured when the blood alcohol level was falling are shown in Table 3. After drinking, BP values were lower than during the corresponding sober period the previous weekend. Systolic BP was 4 mm Hg lower, diastolic BP was 5 mm Hg lower, and pulse was 15 bpm higher; all differences were statistically significant.

No statistically significant difference was found between the weekends in BP values during the hangover period. Mean systolic BP during hangover was 124 mm Hg, and the corresponding figure during the previous weekend was 125 mm Hg (P = 0.6743). The corresponding values for diastolic BP were 79 mm Hg and 81 mm Hg (P = 0.2704). By contrast, the pulse rate was significantly higher during hangover (81 versus 76 bpm, P = 0.0016).

The BP values before, during, and after drinking and during the corresponding sober period 1 week earlier are shown in the Figure (top). The decrease in both systolic and diastolic BP values is clear when blood alcohol concentrations are falling and also is significant compared with the corresponding values during the sober weekend. During the drinking period, the pulse values are also significantly higher, a trend that is also seen during hangover (Figure, bottom).

### Discussion

In the present study a complicated design was used. The 20 male volunteers wore ambulatory BP equipment for 2 consecutive weekends from Friday morning through Tuesday morning. This design was based on the need for reliable results where several biasing effects could be eliminated. First, we wanted to acclimate the subjects to ABPM and stabilize the known increasing effect of the equipment observed at the beginning of the follow-up period.21 Second, we wanted to eliminate the physiological variation of BP during different time periods of the day by comparing values for exactly the same period of the day. Furthermore, we wanted to eliminate the possible impact of weekend (ie, holiday) on BP; that is why values were followed up until the next week. At the same time, we wanted to study separately the period of intoxication, the time when blood alcohol levels were falling, and the hangover period.

Earlier studies on BP and alcohol are mostly epidemiological and based on self-reports of alcohol consumption.1–6 Experimental studies have measured mainly BP without taking into account the above-mentioned biasing items and without separating the period of rising and falling blood alcohol levels and hangover.15–17 This may explain the differences in the results. In our study the BP and pulse values were high while blood alcohol levels rose and were low when they fell. If these results are combined, the net effect is near zero, as in several earlier studies.15–17

In our study the calorie intake was stabilized during the sober weekend, with an extra meal with calorie content equivalent to the alcohol consumed during the following weekend. Thus, extra alcohol calories do not explain the changes in the BP values. Physical activity was also standardized, and extreme effort was forbidden during the study weekends. None of the participants was a teetotaler, and most sometimes “binge drink.” Thus, only 2 participants felt tired

### Table 3. BP and Pulse Values During the Time When Blood Alcohol Concentration Was Falling (Sunday 2 AM–Sunday 10 AM) and Corresponding Values at the Same Time Period During the Sober Weekend

<table>
<thead>
<tr>
<th>ABPM Value</th>
<th>Sober</th>
<th>After Drinking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean±SD</td>
<td>Range</td>
</tr>
<tr>
<td>Systolic BP, mm Hg</td>
<td>112±10.4</td>
<td>94–127</td>
</tr>
<tr>
<td>Diastolic BP, mm Hg</td>
<td>68±11.9</td>
<td>47–97</td>
</tr>
<tr>
<td>Pulse, bpm</td>
<td>61±9.5</td>
<td>49–82</td>
</tr>
</tbody>
</table>

Comparison of systolic and diastolic BP (top) and pulse (bottom) values between sober and drinking weekends. *P<0.05, **P<0.01, ***P<0.001.
after drinking, and none had to stop drinking because of adverse effects.

Our study emphasizes the short-lasting effect of short-term alcohol consumption on BP values. This finding is in accordance with earlier studies.\textsuperscript{6,8,10} It also may explain the contradictory findings in some studies where drinking pattern has not been taken into account.\textsuperscript{22,23} Some of the different results may be due to the fact that the studies concentrated on alcoholics or hypertensive patients.\textsuperscript{15,22} Among these subjects, the alcohol-BP relation may be different from that among social drinkers. It seems that lifetime alcohol doses may affect BP levels.\textsuperscript{24} This may explain the different findings here compared with epidemiological studies, as does the fact that consistent regular drinking is a more important determinant of the alcohol-BP relationship than intake in the 24 hours before study.\textsuperscript{25} Our study does not answer the question of whether repeated weekend binge drinking has any permanent effect on BP values.

The important finding in the present study is that binge drinking increases both systolic and diastolic BP. When blood alcohol concentration falls, these values fall to less than normal levels. Although binge drinking usually occurs during weekends and in the evening, the huge change in BP values takes place during the early morning hours. It has been documented previously that binge drinking appears to be a risk factor for stroke in young persons.\textsuperscript{26} It has also been shown that recent moderate and heavy alcohol consumption seem to be independent risk factors for intracerebral hemorrhage.\textsuperscript{27} Furthermore, young adults are frequently stricken by brain infarction during weekends and holidays.\textsuperscript{28} The present finding that binge drinking increases both systolic and diastolic BP during periods of intoxication and decreases BPs while blood alcohol levels fall, usually at night, might partially explain these vascular alcohol-related events.

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References

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