SOBER-STATE CORTISOL AS A PREDICTOR OF DRUNKEN VIOLENCE
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(Received 25 November 1996; in revised form 15 May 1997; accepted 16 May 1997)

Abstract — Basal cortisol levels were compared in prisoners convicted of violent crimes, in men previously convicted of violent crimes but currently not in prison, in non-violent alcoholics, and in randomly selected control males. Most of the violent men were diagnosed with antisocial personality disorder (DSM-III-R 301.70). Morning, afternoon, and evening levels of plasma cortisol were assessed after a minimum alcohol abstinence of 24 h. The imprisoned violent men had significantly lower cortisol levels than the unimprisoned, which may reflect their prolonged alcohol abstinence and/or habituation to chronic stress. The unimprisoned violent men were heavy drinkers and their elevated sober-state cortisol may reflect temporary alcohol withdrawal or acute stress. We suggest that variations in basal cortisol are influenced more by environmental factors than by violent predisposition or antisocial personality disorder.

INTRODUCTION
Violent acts such as assault, rape, and wife abuse are often committed under acute alcohol intoxication (Murdoch et al., 1990; Bushman and Cooper, 1990). Alcohol-induced violence is believed to be prompted by the convergent effects of the acute pharmacological state induced by alcohol, contextual or situational cues (Gantner and Taylor, 1992), and personality (Boyatzis, 1983). Impulsiveness, irritability, low socialization, monotony avoidance, high rates of psychoactive substance abuse, and high verbal aggression have been observed in alcoholics suffering from antisocial personality disorder DSM-III-R 301.70 (Virkkunen et al., 1994a). Alcohol also affects cortisol, a hormone believed to be involved in aggressive conduct. Virkkunen (1985) has suggested that recurrent violent behaviours and a history of antisocial behaviours from early adolescence may be related to low basal cortisol levels in adulthood.

In a previous study of spouse abusers (Lindman et al., 1992), incidents involving physical aggression were not specifically linked to elevated blood alcohol levels or to alcohol-induced changes in plasma testosterone or cortisol. However, in contrast to the lowered cortisol levels observed in violently predisposed men in previous studies (Virkkunen, 1985; Virkkunen et al., 1994a), significantly elevated basal cortisol and glucose levels were found in these spouse abusers when sober. Elevated cortisol could have been caused by any of several factors, such as personality, life stress, or withdrawal symptoms linked to alcohol abuse. The impact on behaviour of chronic heavy drinking, personality factors, and concurrent variations in cortisol and testosterone could not be separately assessed in our previous study (Lindman et al., 1992), since alcohol abuse could have been confounded with a violent personality trait in the spouse abusers. Our aim was to separate the effect of heavy drinking or alcohol abuse on basal cortisol from the effects of the violent personality trait by comparing prisoners convicted of aggressive crimes, without access to alcohol, to individuals convicted of similar crimes but currently at large with access to alcohol. The basal cortisol levels of these subjects were compared with those in alcoholics not characterized by violent predisposition and to data from a control group composed of non-violent, non-alcoholic males.

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SUBJECTS AND METHODS

Participants

Four groups of male subjects were studied. A group of violent men included two subgroups consisting of a group of prison inmates serving sentences for violent acts and a group of convicted assault offenders presently at large due to served or suspended jail sentences or court settlements. Non-violent subjects were a group of alcoholics in treatment programmes and a group of non-violent male control subjects.

Imprisoned violent men. Inmates in a state prison were selected according to their crime records (n = 13). All had committed at least two violent acts during the preceding 5-year period, including assault, homicide, manslaughter, robbery, or attempted rape. The mean duration of alcohol deprivation at the time of the study was 12 months (SD = 6.5 months).

Unimprisoned violent men. Potential subjects were identified from court documents showing convictions on assault charges. These men were located while currently free and were offered paid participation by letter. Fifteen men consented to participate in the study. The only apparent difference between the imprisoned and the unimprisoned violent men regarding the selection criteria was that the crimes committed by the prisoners generally entailed more serious consequences for the victims.

Alcoholics. A group of 15 non-violent alcoholics was selected from an alcohol treatment clinic. They were diagnosed as alcoholic according to the DSM-III-R criteria (American Psychiatric Association, 1987) for alcohol dependence 303.9X, but had been abstinent for a minimum of 4 days before participation in the study. Non-violence was assessed by interviews conducted by qualified medical staff at the clinic.

Controls. A control group of 16 subjects was recruited from cafés, restaurants, building sites and in the street. The control subjects were approximately matched with the subjects in the other groups as to physical characteristics and educational background. All were dispositionally non-violent by self-report and mainly light or moderate alcohol drinkers. The background characteristics of all subjects are presented in Table 1.

Procedures

All subjects were instructed to abstain from alcohol and drugs for the 24 h preceding the blood sampling. Compliance with the non-drinking instructions was checked by verbal report and Alcometer.
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Table 2. Aggressive behaviour in violent and non-violent men by Aggression Questionnaire

<table>
<thead>
<tr>
<th></th>
<th>Controls (n = 16)</th>
<th>Alcoholics (n = 15)</th>
<th>Imprisoned violent men (n = 13)</th>
<th>Unimprisoned violent men (n = 15)</th>
<th>F(3,54)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical aggression</td>
<td>19.2 ± 5.4</td>
<td>20.5 ± 4.0</td>
<td>27.1 ± 7.8</td>
<td>27.4 ± 7.2</td>
<td>6.96</td>
<td>0.0005*</td>
</tr>
<tr>
<td>Verbal aggression</td>
<td>12.4 ± 2.8</td>
<td>13.1 ± 3.9</td>
<td>14.1 ± 4.6</td>
<td>14.2 ± 3.4</td>
<td>0.81 ns</td>
<td></td>
</tr>
<tr>
<td>Anger</td>
<td>14.4 ± 3.9</td>
<td>16.9 ± 5.4</td>
<td>20.9 ± 4.4</td>
<td>21.9 ± 4.5</td>
<td>8.62</td>
<td>0.0001*</td>
</tr>
<tr>
<td>Hostility</td>
<td>15.7 ± 4.8</td>
<td>22.3 ± 5.6</td>
<td>24.4 ± 5.5</td>
<td>23.8 ± 5.3</td>
<td>8.67</td>
<td>0.0001**</td>
</tr>
</tbody>
</table>

*Violent men more aggressive than controls; ** controls less hostile than other groups. Values are means ± SD.

Blood samples. Three consecutive blood samples were taken to control for the circadian variation of hormonal concentrations: at 09:00, 15:00 and 21:00. Samples (10 ml each) were drawn from the vena basilica or vena cephalica at the cubital fossa into Vacutainer® heparin tubes containing Trasylol® (500 IU/ml). The samples were centrifuged at 2000 rpm for 10 min at 4°C and the plasma was stored at −22°C until analysed.

Hormonal determinations. Cortisol concentrations were determined by radioimmunoassay reagent kits (Farmos Diagnostica, Turku, Finland). Within-assay and between-assay variabilities were <10%.

Tests. General aggressiveness was assessed by the Buss and Perry (1992) Aggression Questionnaire, which includes measures of physical and verbal aggression, anger and hostility. The Michigan Alcoholism Screening Test (MAST; Selzer, 1971) was administered to probe alcohol abuse.

Interview. Histories of violence and drinking were obtained from each subject by semi-structured interviews in which both childhood and adult experiences of aggressive behaviours and substance abuse were investigated. Some questions were specifically phrased to obtain information conforming to the DSM-III-R diagnostic criteria for 301.70 antisocial personality disorder. Current drinking behaviour was appraised from self-reported frequency of drinking occasions and typical quantity consumed per occasion, except the prisoners, who were asked to describe their drinking habits as they were before imprisonment. These data were obtained by interview, rather than by questionnaire, since estimates of alcohol use can be biased by the response options in forced-choice questionnaire items (Poikolainen and Kärkkäinen, 1985).

Data analyses. Statistical analyses were done by the SPSS Statistical Package. Significant results reported below refer to α = 0.05 by Scheffé test for post-hoc comparisons unless stated otherwise.

RESULTS

Personality measures

Aggression questionnaire. The violent men described themselves as physically more aggressive and more prone to express anger than the controls. The alcoholics scored lower on physical aggressiveness and anger than the prisoners. The controls showed the least amount of hostility compared with the violent men and alcoholics (Table 2).

Antisocial personality disorder. According to the standard diagnostic criteria, i.e. three or more reported incidents suggesting conduct disorder before age 15 (category B) and four or more incidents of irresponsible and antisocial behaviour since age 15 (category C), antisocial personality disorder was present in 92% of the violent prisoners, in 73% of the unimprisoned violent men, and in 33% of the alcoholics. None of the subjects in the control group met the diagnostic criteria for ASP.

Alcohol and violence

Drinking habits and alcohol abuse. The subjects were classified according to self-reports as infrequent drinkers, light drinkers, moderate drinkers without binge drinking, moderate drinkers with binge drinking, episodic drinkers and heavy drinkers. Kruskal-Wallis analysis of variance revealed a highly significant group difference in terms of this classification [χ²(3) = 21.56, P < 0.0001; Table 1]. One-way analysis of
Table 3. Cortisol levels of violent and non-violent men

<table>
<thead>
<tr>
<th>Time of day of sampling</th>
<th>Controls (n=15)</th>
<th>Alcoholics (n=15)</th>
<th>Imprisoned violent men (n=11)</th>
<th>Unimprisoned violent men (n=13)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning (09:00)*</td>
<td>355 ± 74</td>
<td>384 ± 115</td>
<td>267 ± 104</td>
<td>456 ± 154</td>
</tr>
<tr>
<td>Day (15:00)</td>
<td>272 ± 68</td>
<td>252 ± 105</td>
<td>243 ± 96</td>
<td>293 ± 100</td>
</tr>
<tr>
<td>Evening (21:00)</td>
<td>136 ± 79</td>
<td>132 ± 91</td>
<td>104 ± 72</td>
<td>171 ± 117</td>
</tr>
</tbody>
</table>

*Significantly lower for imprisoned than for unimprisoned violent men. Values are means ± SD.

The data on alcohol consumption may be criticized, since they are based on self-report. Alcohol abusers have, however, been found to recall experiences of drinking and distant life events (including violence) with reasonable accuracy (Sobell et al., 1988). In the present study, alcohol consumption was appraised by interviews rather than questionnaires. This made it possible to appraise binge drinking patterns and minimized distortion due to the biases inherent in forced-choice items pointed out by Poikolainen and Kärkkäinen (1985).

**Drunken violence.** Of the prisoners and unimprisoned violent men, the majority (87%) stated that they were under the influence of alcohol when they committed the violent act for which they were convicted, and most (80%) reported having been intoxicated always or usually during previous crimes.

**Cortisol**

The concentrations of cortisol are presented in Table 3. Preliminary analyses suggested that subject age did not provide any significant adjustment to these data if used as a covariate. The morning, afternoon, and evening levels of cortisol were consequently examined for group differences by repeated measures ANOVA without age adjustment. Circadian variation was shown by significant time effects in all subject groups for cortisol \(F(2,100) = 108.42, P < 0.001; \) Fig. 1].

Significant group differences were found in cortisol levels \(F(3,50) = 4.03, P < 0.025; \) Fig. 1]. Cortisol concentrations were similar in alcoholics and control subjects, but the violent prisoners' cortisol levels were consistently lower throughout the day in relation to the unimprisoned violent men (mean 67%) and to the control subjects (mean 80%).

**DISCUSSION**

The data on alcohol consumption may be criticized, since they are based on self-report. Alcohol abusers have, however, been found to recall experiences of drinking and distant life events (including violence) with reasonable accuracy (Sobell et al., 1988). In the present study, alcohol consumption was appraised by interviews rather than questionnaires. This made it possible to appraise binge drinking patterns and minimized distortion due to the biases inherent in forced-choice items pointed out by Poikolainen and Kärkkäinen (1985).

**Dispositional versus environmental factors affecting cortisol**

Previous research has yielded inconsistent results. Low cortisol was linked to habitual violence and antisocial personality disorder by Virkkunen (1985), Virkkunen et al. (1994b) and Bergman and Brismar (1994), while elevated cortisol was found in sober Finnish spouse abusers by Lindman et al. (1992). In the present study, the mean cortisol level in the imprisoned violent men was about as much lower compared with the control males as it was elevated in the unimprisoned violent men. This outcome implies that differences in cortisol were linked to environmental influences, rather than to habitual violence and/or antisocial personality disorder.

Since all subjects were tested sober before blood samples were collected, and no indications
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Violent Men vs. Controls

Alcoholics vs. Controls

Fig. 1. Cortisol concentration as a function of time in violently predisposed men, in alcoholic men, non-violent, non-alcoholic men and controls.

Values are means ± SEM (bars).

of preceding intoxication were found, acute effects of alcohol are unlikely to explain the elevated cortisol levels of our unimprisoned violent men. Nevertheless, the possibility cannot be excluded that some men may have experienced withdrawal stress. Elevated cortisol levels may persist for up to 24 h following the ingestion of a 1.75 g/kg alcohol dose although they revert to normal within 48 h (Välimäki et al., 1984). This could explain why the hormonal levels were similar in the alcoholics and the control subjects as the former had been in a treatment programme and had been abstinent for a minimum of 4 days.

Alternatively, the cortisol differences could be understood as the opposite outcomes of acute and chronic stress which can affect cortisol conversely. Whereas elevated cortisol is a well-known indicator of acute stress (Van Thiel, 1983), chronic stressors can cause lowered cortisol through physiological adaptation (Errico et al., 1993). The imprisoned men were faced with long-term aversive prison conditions, enemies, debts, and uncertainty about the future. A chronic stress state could have been induced due to these conditions, particularly since coping resources were extremely limited in the prison environment. The unimprisoned violent men, on the other hand, were prone to acute everyday stressors such as unemployment, economic hardship, frequent intra-family conflicts, and housing problems.

Circadian rhythm

Blood samples were collected at times that were held constant for all subjects. Nevertheless, systematic differences in circadian rhythms might have caused apparent differences in baseline cortisol levels due to a phase shift between the imprisoned violent men, whose sleep and wakefulness periods were highly regulated, and the unimprisoned violent men leading a much more irregular existence. The circadian variation in cortisol accentuates the need for multiple sampling of hormonal data. Systematic comparisons with data from previous work are made difficult by variability in the times that samples were taken, which may account for some apparent inconsistencies.

CONCLUSION

The present results suggest that variations in basal cortisol are influenced more by environmental factors than by violent predisposition or antisocial personality disorder.
Acknowledgements — This study was financially supported by grants from the Council of Social Sciences, Academy of Finland (4618/3011/92) and the Finnish Foundation for Alcohol Studies.

REFERENCES


