Effects of moderate ethanol drinking on the GH and cortisol responses to physical exercise

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Abstract

OBJECTIVE: To evaluate the effects of moderate amounts of ethanol on the GH and cortisol responses to physical exercise.

METHODS: Ten normal men underwent three bicycle ergometer tests. Test were carried out in basal conditions (control test) or after drinking 0.5 or 0.75 g/kg BW ethanol. Tests lasted 15 min in all subjects; the workload was increased at 3 min intervals from time 0 until exhaustion. Non-endocrine physiological parameters (NEPP), such as heart rate, blood pressure, ventilation, frequency of breathing, tidal volume, oxygen consumption, carbon oxide production and respiratory exchange ratio were measured from time 0 until exhaustion. Serum GH and cortisol levels were evaluated in blood samples taken at 5–10 min intervals over a 50 min period from time 0.

RESULTS: Neither basal values, nor exercise-induced changes in NEPP were altered by ethanol drinking. Both GH and cortisol levels significantly rose during the exercise control test. The hormonal responses did not change after 0.5 g/kg BW ethanol, whereas they significantly decreased after 0.75 g/kg BW ethanol.

CONCLUSIONS: Modification of the GH and cortisol responses to exercise represents an "endocrine window" of the effects that even moderate ethanol drinking produces in the CNS. The data show that 0.75 g/kg BW ethanol is the minimal amount producing significant inhibitory effects on the GH and cortisol responses to physical exercise. In view of the important roles played by GH and cortisol during physical activity, even moderate ethanol drinking must be avoided before sport.

ORIGINAL ARTICLE

INTRODUCTION

Ethanol has been found to act as an antagonist of anterior pituitary hormone secretions in various experimental conditions; for example, reduction of GH and cortisol responses to hypoglycemia has been reported after administration of ethanol in normal human subjects [6, 10]. Physical exercise is known to stimulate growth hormone (GH) and adrenocorticotropic (ACTH) responses from the anterior pituitary [2]. Ethanol is the substance, which is most widely used by athletes [8]. Eighty-eight % of them drink ethanol in moderate amounts [8]. In fact, because of its anti-anxiety properties, ethanol is used to reduce tension and improve performance. We wondered whether ethanol drinking reduces exercise-induced GH and cortisol responses, and thus modifies neurotransmission in the central nervous system. In order to clarify this issue, exercise tests were performed in normal men in the absence and in the presence of moderate ethanol drinking.

MATERIALS AND METHODS

Ten healthy male subjects (mean weight(±SE): 68.3±1.5 kg; mean height: 173±1.6 cm; mean body mass index 23.3, aged 26–32 years) volunteered for the study. All subjects were informed of the purpose of the study and gave their informed consent; the study was in accordance with the Helsinki II declaration and received ethical approval.

Men performed three exercise tests: in basal conditions (0.0 g/kg body weight (BW) ethanol) and after drinking 0.5 g/kg BW or 0.75 g/kg BW ethanol. Tests were performed in random order at weekly intervals.

All men were in good health, without clinical or laboratory evidence of hepatic, renal, heart or other organic disease. None was a smoker or was addicted to excessive alcohol drinking (<30 ml ethanol per week). None had taken any drug for at least 1 month before the study or was under drug therapy at the time of the tests. All men were used to taking regular physical exercise, but they were not trained athletes. All tests were carried out after a 10-h overnight fast and rest.

Exercise control test

At 08:30 on the test day, an intravenous cannula was placed into an antecubital vein and was kept patent with a slow saline (NaCI 0.9%) infusion; it was used for blood sampling.

Basal blood samples were collected at time –30, just after the intravenous cannula insertion and thirty min later (time 0), when subjects started the exercise test. Further samples were taken after 5, 10, 15, 20, 30, 40 and 50 min. The subjects exercised for a period on an electrically braked cycle ergometer. An initial load of 50 W was increased by 50 W every 3 min until subjective exhaustion. The subjects with a low maximal capacity (as established in a preliminary test carried out at least 1 week before the study) pedalled for 3–4 min against no workload at the beginning of the test, so that the exercise lasted about the same time (15 min) in all individuals. During exercise the subjects breathed through a low resistance one-way valve connected to a PK Morgan measurement system (Avinton Corp., Seattle, WA, USA), which had been appropriately

Table 1. Basal and peak values (mean ± SE) of non-endocrine physiological parameters (NEPP) during physical exercise following the administration of 0 (control test), 0.5 or 0.75 g/kg BW ethanol in ten normal men.

VARIABLE	EXERCISE		EXERCISE + 0.5 g/kg BW ETHANOL		EXERCISE + 0.75 g/kg BW ETHANOL	
	BASE	PEAK	BASE	PEAK	BASE	PEAK
Heart rate (beats/min)	74±3	169±7*	73±2	170±8*	74±2	171±8*
Systolic BP (mmHg)	110±9	153±7*	111±8	155±10*	108±9	151±9*
Diastolic BP (mmHg)	70±6	48±5*	68±7	52±6*	71±5	52±5*
Respiratory rate (min^{-1})	12.7±0.9	30±3*	13±0.8	29.5±2.5*	12.5±1.0	31±3.5*
Tidal volume (L)	0.7±0.2	2.4±0.3*	0.8±0.3	2.3±0.4*	0.7±0.3	2.5±0.4*
Ventilation (L/min)	10.6±0.6	73±3*	11±0.5	70±3*	10.5±0.7*	75±5*
VO_2 (ml/min)	332±10	2100±150*	345±12	2080±160*	340±10	2090±145*
VCO_2 (ml/min)	286±18	2280±135*	290±20	2270±130*	295±21	2290±135*
R	0.86	1.08*	0.84	1.09*	0.86	1.09*

*p<0 01 versus basal value.

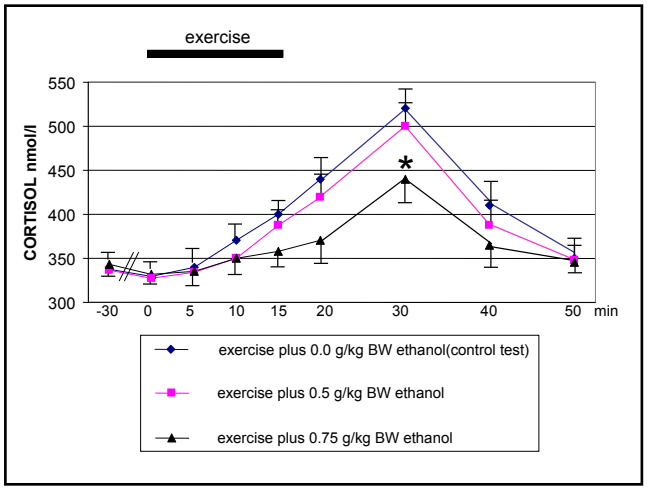

Figure 1. Cortisol response to exercise and exercise plus 0.5 or 0.75 g/kg BW ethanol in ten healthy normal subjects. Each point represents the mean ± SE of the observations.
p<0.01 exercise plus 0.75 g/kg BW ethanol vs exercise control test

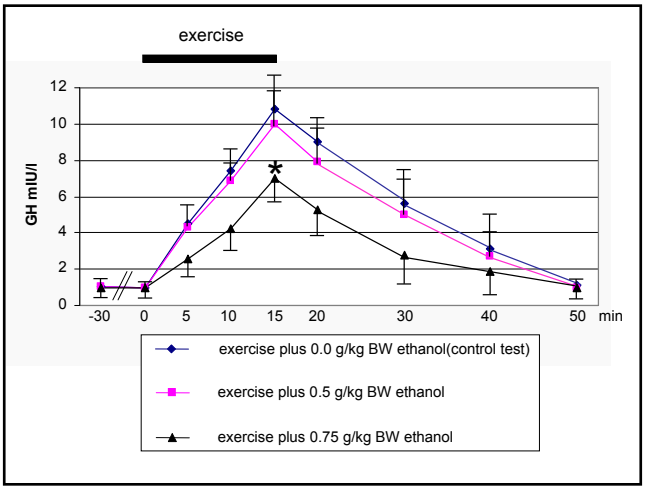

Figure 2. GH response to exercise and exercise plus 0.5 or 0.75 g/kg BW ethanol in ten healthy normal subjects. Each point represents the mean ± SE of the observations.
p<0.01 exercise plus 0.75 g/kg BW ethanol vs exercise control test

calibrated. The following parameters were measured: ventilation, frequency of breathing, tidal volume, oxygen consumption (VO_2), carbon oxide production (VCO_2) and respiratory exchange ratio (R). Determinations of heart rate and blood pressure were carried out by an experienced cardiologist. Heart rate was measured by auscultation over the precordium; blood pressure was evaluated with a sphygmomanometer.

Exercise plus ethanol tests.

Two tests were performed as the previously described exercise control test, except for the administration within 15 min after the intravenous cannula insertion (time –30) of a drink containing 0.5 or 0.75 g/Kg BW ethanol.

Assays

Serum GH and cortisol concentrations were measured with specific radioimmunoassays, using commercial kits. The intra- and inter-assay coefficients of variation were 2.8 and 5.6% for GH and 4.0 and 7.0% for cortisol, respectively. The lower limit of sensitivity was 0.04 mIU/l for GH and 16.5 nmol/l for cortisol. All samples from the same subjects were measured in the same assay, in duplicate and in random order.

Blood glucose, free fatty acids (FFA) and plasma lactate were measured at time 0 of all tests. Blood glucose was measured with a glucose oxidase-peroxidase procedure, utilizing an IL 918 autoanalyzer (Instrumentation Laboratory, Italy). Plasma lactate and FFA were measured by kit methods (Boehringer Diagnostic, Mannheim, Germany).

Statistical analysis was performed with the paired t-test and analysis of variance, as appropriate. Results are reported as mean ± SE.

RESULTS

None of the subjects experienced untoward side effects after alcohol administration. No significant differences in maximum work load and work time was observed between tests (data not shown).

Physical exercise significantly (p<0.01) modified all examined NEPP (Table 1). Both basal and exercise-induced changes in NEPP were unaltered by administration of either 0.5 or 0.75 g/kg BW ethanol (Table 1). Basal blood glucose, plasma lactate and FFA levels were similar in all tests (data not shown).

Serum GH and cortisol levels significantly rose during exercise control test; the mean maximum peaks were observed at 15 min for GH and at 30 min for cortisol (p<0.001 vs baseline) (Figure 1 and 2). Mean peak GH and cortisol levels were 10 and 1.58 times higher than baseline, respectively.

Exercise-induced GH and cortisol rises did not change after the administration of 0.5 g/kg BW ethanol (Figure 1 and 2).

In contrast, in the presence of 0.75 g/kg BW ethanol, both GH and cortisol responses to physical exercise were significantly reduced (F=19.05 vs control test, p<0.01 for GH; F=17.58 vs control test, p<0.01 for cortisol) (Figure 1 and 2).

In this test, both GH and cortisol increments induced by exercise were significant (p<0.001 vs baseline), but the mean peak responses were only 7 times (for GH) and 1.3 times (for cortisol) higher than baseline.

DISCUSSION

The data presented here failed to show significant effects of ethanol on the basal and peak values of the non-endocrine physiological parameters (NEPP) examined during physical exercises. We only used two doses of ethanol; and thus, we cannot exclude possible effects induced by higher ethanol amounts.

At the lower dose of 0.5 g/kg BW ethanol, the exercise-induced GH and cortisol rises were not modified. In contrast, the higher dose of ethanol (0.75 g/kg BW) produced a significant decrease in both hormonal responses.

The effects of ethanol on GH and cortisol responses to exercise cannot be attributed to changes in blood glucose, lactate and/or FFA levels, because these parameters were similar regardless of ethanol administration.

Intense exercise induces a significant activation of the hypothalamic-pituitary adrenal (HPA) axis and of the GH secretory system. Therefore, possible effects of alcohol at hypothalamic-pituitary level may be hypothesized for both hormones.

Previous studies suggested inhibitory effects of ethanol on GH secretion at both hypothalamic [4] and pituitary level [3]. Concerning the HPA axis, the ACTH/cortisol rise in humans during exercise is thought to be mediated by arginine vasopressin (AVP) [11]. In a variety of experimental conditions ethanol has been found to act as an antagonist of AVP secretion [1,9]; therefore, it is possible that the inhibitory effect of ethanol on the exercise-induced cortisol response was consequent to inhibition of AVP mediation.

The reduced cortisol rise in response to physical exercise might represent an aspect of the overall sedative action of moderate doses of oral ethanol in the central nervous system. In case of sport competition, even moderate drinking is not ethically acceptable, because it must be regarded as a form of doping.

Athletes might erroneously believe that the reduced activation of the HPA axis induced by low alcohol amounts during exercise in the absence of changes in NEPP is a positive phenomenon. In fact, in these conditions alcohol may diminish the stress associated with physical activity, without reducing the athletic performance. This view is misleading because it does not take into account that ethanol may alter the perception of danger during sport activities, reducing safety control. Furthermore, alcohol antagonism vs AVP secretion [1,9] may lead to dehydration during physical activity. Therefore, even moderate drinking before exercise must be avoided.

The HPA axis plays a critical role in maintaining the organism under conditions of stress. Repetitious and/or stronger HPA inhibitions can be detrimental to the organism during stress, with deleterious consequences, such as tissue damage [7], vascular collapse and death [5]; this makes alcohol particularly dangerous in athletes undergoing agonistic competitions.

Reduction of exercise-induced GH rise after moderate ethanol drinking must be regarded as a negative phenomenon, particularly in young growing subjects. In fact, frequent alcohol drinking before physical activity may diminish the anabolic and growth stimulating effects of exercise mediated by enhanced GH secretion.

Further studies are needed on this matter.

REFERENCES

1 Chiodera P, Coiro V: Inhibitory effect of ethanol on the arginine vasopressin response to insulin-induced hypoglycemia and the role of endogenous opioids. Neuroendocrinology. 1990; **51**: 501–504.

2 Coiro V., Saccani Jotti G., Volpi R., Magotti M.G., Galli P., Finardi L., Maffei M.L., Chiodera P., Casti A.: Difference between diabetic and nondiabetic smokers in the pituitary response to physical exercise. Metabolism. 2004; **53**: 1140–1144,.

3 Dees WL, Skelley CW, Rettori V, Kentroti MS McCann SM: Influence of ethanol on growth hormone secretion in adult and prepubertal female rats. Neuroendocrinology. 1988; **48**: 495–499.

4 Emanuele MA, Kirsteins L, Reda D, Emanuele NV Lawrence AM: The effect of in vitro ethanol exposure on basal growth hormone secretion. Endocrine Research. 1989; **14**: 283–291.

5 Hadley ME. In Endocrinology 2nd Edition 1988. Englewood Cliffs, N.J. Prentice-Hall, Inc.

6 Kolaczynski JW, Ylihahri R, Harkonen M and Koivisto VA : The acute effect of ethanol on counterregulatory response and recovery from insulin induced hypoglycemia. J Clin Endocr Metab. 1988; **67**: 384–388.

7 Munck A, Guyre PM Holbrook NJ: Physiological functions of glucocorticoids in stress and their relation to pharmacological actions. Endocrine Rev. 1984; **5**: 25–44.

8 O'Brien C: Alcohol and sport. Impact of social drinking on recreational and competitive sports performance. Sports Med. 1993; **15**: 71–77.

9 Oiso Y, Robertson GL: Effect of ethanol on vasopressin secretion and the role of endogenous opioids. In Vasopressin, Schrier ed, pp 265–269, Raven Press, New York.

10 Priem HA, Shanley BC, Malan C: Effect of alcohol administration on plasma growth-hormone response to insulin-induced hypoglycemia. Metabolism. 1976; **25**: 397–403.

11 Wittert GA, Stewart DE, Graves MP, Ellis MJ, Evans MJ, Wells JE, Donald RA Espiner EA: Plasma corticotrophin releasing factor and vasopressin responses to exercise in normal man. Clin Endocrinol. 1991; **35**: 311–317.