ACUTE EFFECT OF ALCOHOL ON THERMAL SENSATION AND PERCEIVED EXERTION DURING EXERCISE IN A WARM ENVIRONMENT IN MEN

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INTRODUCTION

In humans, alcohol consumption has been shown to cause heat loss by inducing cutaneous vasodilation and skin blood flow increase resulting in a decrease in skin and body temperatures, particularly during cold exposure. These results are consistent with the subjective feeling of being less cold during exposure to cold air under alcohol intoxication. Other reports indicated that the subjects felt warmer and more comfortable after alcohol during immersion in cold water (1,2,3). Few studies have reported the effect of alcohol on thermal sensation during heat exposure. In one study, alcohol did not alter the thermal comfort sensation of heat stress during 40°C water immersion (4). In an other study, the rating of perceived exertion (RPE) was not affected by alcohol ingestion during a progressive exercise (5). The purpose of the study was to investigate for the first time the acute effect of moderate alcohol consumption on the subject's perception of: 1) ambient temperature, 2) body temperature, 3) thermal comfort, and 4) RPE during exercise in a warm environment.

METHODS

Eight male volunteers [(mean ± SEM) age: 23 ± 1 yr.; body mass: 69.6 ± 1.3 kg; height: 1.76 ± 0.02 m; body surface area: 1.86 ± 0.02 m^2; and maximal aerobic power ($\dot{V}o_{2max}$): 52 ± 1 $ml \cdot kg^{-1} \cdot min^{-1}$] gave their written informed consent to participate in the study. Each subject performed three trials differentiated between each other by two different amounts of alcohol and a placebo drink. At 9:10h, each subject drank 600 ml of cocktail over a 30-min period. The drink was composed of vodka in two amounts (either 0.8 (MODERATE) or 1.2 (HIGH) g alcohol /kg body mass) completed to 600 ml with water, orange juice and mint flavour. Alcohol was replaced by water in the PLACEBO drink. The subjects were blind to the experimental conditions. At 10:00h, each subject undertook 60-min of exercise at moderate intensity (45% $\dot{V}o_{2max}$ or 94 ± 4 W) on a cycle ergometer. The ambient air and wall temperatures were regulated at 28°C before the exercise, while the air humidity was controlled at a dew-point temperature of 17.5°C (45% RH). During exercise, the ambient air and wall temperature were adjusted to 35°C dry bulb, with a relative humidity of 35% (dew-point: 17.5°C). The air velocity was set at 0.5 $m \cdot s^{-1}$. Rectal temperature (T_{re}) was measured by a thermistor probe inserted 11 cm beyond the anal sphincter. Mean skin temperatures ($\bar{T}_{sk}$) were recorded by 10 sensors (± 0.01°C). Mean body temperature ($\bar{T}_b$) was computed from T_{re} and $\bar{T}_{sk}$ with a weighting of 80% and 20% respectively. Sweat rates were measured from a 12 cm^2 capsule (left scapular region) using an infrared spectrometer hygrometry technique. The skin temperature under the capsule was maintained at 36°C. Samples of plasma were analysed on the same day for alcohol concentration by gas chromatography.

The thermal sensation was assessed by a questionnaire at rest and every 20 min during exercise. The questions concerned the feelings about body temperature, ambient temperature and thermal comfort (pleasantness): the 7-point scales ranged between -3 (very cold or very unpleasant for temperature and comfort respectively) and 3 (very hot or very pleasant for temperature and comfort respectively), with the neutral sensation set at 0. The perceived exertion was also rated by using the RPE-scale (ranged between 6 (very very easy) and 20 (very very difficult) (5). Results (mean ± SEM) were analysed using ANOVA with repeated measures and Student' s paired *t*-tests. A P value less than 0.05 was considered to be significant.

RESULTS

Blood alcohol concentration raised rapidly at rest 30 min after its ingestion, and values were maximum at the end of the exercise. Blood alcohol concentration reached 0.66 ± 0.03 $g \cdot L^{-1}$ and 1.08 ± 0.02 $g \cdot L^{-1}$ with the MODERATE and HIGH dose respectively. At rest, no statistical difference was found between doses for any thermal perception factors. During exercise, ambient temperature, but not body temperature perception, was perceived significantly warmer with HIGH alcohol (1.3 ± 0.3) than with PLACEBO (0.9 ± 0.2) (Fig. 1). Meanwhile, the thermal comfort tended to be higher in both alcohol conditions compared to PLACEBO, but this result was not statistically significant (P = 0.06). A significant greater RPE was observed with HIGH alcohol (12.9 ± 0.2) than with PLACEBO (12.1 ± 0.3) throughout the exercise period. Conversely to thermal perceptions, the HIGH dose of alcohol significantly decreased (-0.22°C) the T_{re} at rest in neutral ambient temperature, while no significant difference was found in the other physiological parameters between experimental conditions during exercise in the heat.

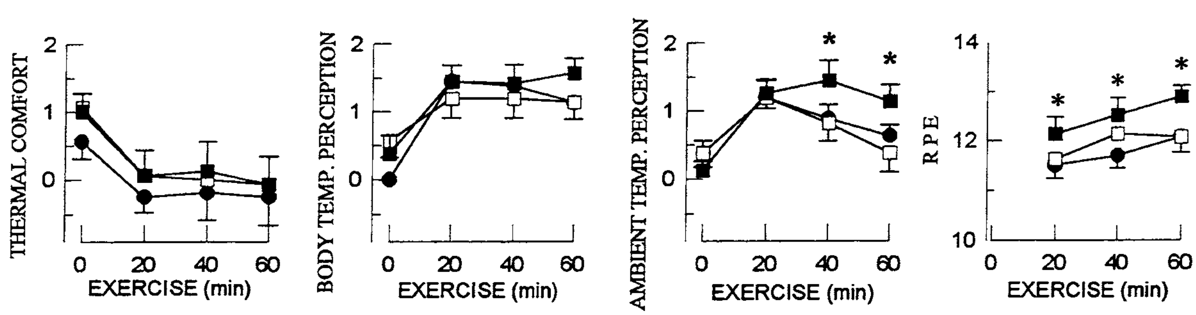

Figure 1. Thermal perception under placebo (●), moderate (□), or high (■) alcohol ingestion (* $P < 0.05$)

DISCUSSION

The present results did not indicate a significant effect of alcohol on thermal comfort and perception of the body temperature during exercise in the heat. This absence of effect of alcohol is explained by the absence of change in $\bar{T}_{sk}$, T_{re} and sweating rate measured during exercise. These results support previous findings that the ingestion of low doses of alcohol (0.27-0.54 $g \cdot kg^{-1}$) did not change significantly either the comfort assessment or the body temperature during immersion in 40°C water (4). It is possible that the high ambient temperature and the endogenous heat produced by exercise counteracted the warmer feeling response of alcohol observed normally at rest during cold exposure (1,2).

At rest in a neutral environment, the responses of alcohol contrast with those obtained during exercise. T_{re}, but not $\bar{T}_{sk}$, was significantly lowered by the HIGH dose of alcohol, but this was not associated with significant changes in the thermal comfort and perception of body temperature. These results suggest that physiological changes induced by alcohol are not necessarily confirmed by the thermal sensations. Previous studies have investigated the effect of alcohol during immersion in cold water, and have supported the lack of consistent association between body temperature and thermal perception: subjects felt warmer and more comfortable after ethanol consumption, regardless of whether it lowered the body temperature (3) or failed to do so (1,2). It is possible that alcohol prevented cutaneous vasoconstriction induced by the cold, resulting in greater skin blood flow and greater sensation of heat. However, in the present study, the heat loss did not seem to change significantly during exercise, considering that no changes were observed in sweating rate and skin temperature, and that heat loss by convection, radiation and conduction was prevented by having the air and wall temperatures at the same level as that of the skin temperature.

An interesting finding of the present study is that RPE was significantly higher only under the HIGH dose. These results do not support the observations of Borg et al. (5), who did not observe a significant effect of alcohol (1 $g \cdot kg^{-1}$) on RPE during progressive exercise at 50 and 100 W in thermoneutral environment. In the present study, the ambient temperature, which was perceived significantly warmer after 40 min of exercise under HIGH alcohol consumption, and the duration of exercise could explain the divergent results between the two studies. These results indicate, however, that alcohol may alter the RPE without being associated with major changes in $\bar{T}_{sk}$, T_{re} and sweating rate.

CONCLUSION

The alcohol intoxication changed both the perception of ambient temperature and RPE during physical exercise in a warm environment without a concomitant change in body temperature and sweating rate.

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