THE EFFECT OF ALCOHOL ON THE INITIAL RESPONSES TO COLD WATER IMMERSION

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INTRODUCTION

A large percentage of drowning victims (51% of males between the ages of 20 and 89 years in an Australian study) have alcohol in their blood stream (Plueckhahn, 1984). However, it is not clear whether alcohol increases the chances of drowning by: (i) altering the physiological responses to immersion; (ii) increasing the likelihood of an accident occurring; (iii) causing confusion and lack of co-ordination on immersion; or (iv) a combination of these factors.

Whilst the effect of alcohol on long-term cooling has been investigated (Keatinge and Evans, 1960), little is known of its effect on the initial responses (hyperventilation and tachycardia) to immersion in cold water; this is despite the fact that they are now regarded by some, as the most dangerous responses associated with cold immersion (Tipton, 1989). Martin et al. (1977) investigated the effect of alcohol on a 20 minute immersion in water at 13°C. They found no difference in the ventilatory response measured over one minute periods, with and without alcohol. In the present study, the hypothesis that moderate levels of alcohol would attenuate the initial response was tested by a detailed examination of its effect on subjects immersed in water at **15°C.**

METHODS

The experimental protocol was approved by a local Ethisal Committee, and all subjects gave informed written consent before participating in the study. Sixteen subjects (15 male, 1 female) underwent **two** immersions, the order of which was counter-balanced and separated by at least 48 hours. The immersions were

performed at the same time of day to reduce any circadian effects. One hour before entering the water, subjects drank either 3.68 ml.kg body water.' of 40% proof vodka or water, both of which were mixed with 6.15 ml.kg body water" of orange cordial.

Subjects were seated on a chair and lowered into stirred water at 0.2 $m.s^{-1}$ to the level of the laryngeal prominence for three minutes. Respiratory rate (f_R) and inspiratory volume ($\dot{V}_I$) were measured using a pneumotachograph placed on the inspiratory side of a mouthpiece. Heart rate was monitored continuously throughout the immersions with a 3-lead ECG. In eight of the subjects, rectal and mean skin temperature ($\bar{T}sk$: calculated from the unweighted mean of forehead, chest, thigh and hand temperatures) were also monitored. Blood alcohol concentration (BAC) at 60 min prior, and 2 min prior to the immersion was estimated using a breath alcohol meter (Lion Instruments plc, Wales). Within-subject data were analysed using a repeated measures analysis of variance.

RESULTS

On immersion, **BAC** averaged 105 $mg.100ml^{-1}$ (range 80 to 130 $mg.100ml^{-1}$) after alcohol consumption, and zero in the control condition,

Analysis of the ventilatory responses showed that alcohol consumption reduced f_R by 11% and by 9% in the first and second 10 second periods of immersion ($P<0.05$; $n=16$; Figure 1). No significant differences were found at other times. Owing to technical difficulties, $\dot{V}_I$ was obtained from only 12 subjects and during the first 10 seconds of immersion was found to be increased after alcohol consumption by 17% from 54 $l.min^{-1}$ to 62 $l.min^{-1}$ ($P<0.05$) compared to the control condition. No significant differences were found at other times. Tidal volume was unaltered between the two conditions. When the f_R data were restricted to the 12 subjects in which $\dot{V}_I$ was obtained, the reduction in f_R after alcohol consumption was not found to be statistically significant.

Heart rate both before and during the immersions was similar in both conditions.

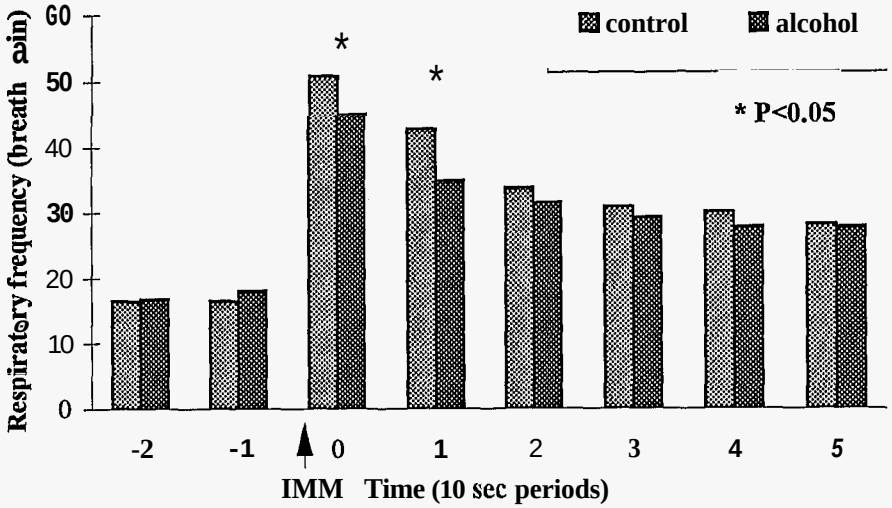

Figure 1. Effect of alcohol on f_R during immersion in water at **15°C** (n=16). Each bar represents the mean f_R over 10 second periods. The start of the immersion is indicated by the arrow (IMM).

Neither the rectal nor skin temperatures differed between conditions just prior to immersion. The $\bar{T}sk$ followed the same profile in both conditions falling by 8.2°C after three minutes of immersion.

DISCUSSION

Respiratory frequency is thought to give a better indication of respiratory drive than $\dot{V}_i$ on cold water immersion (Tipton et al., 1991). The hypothesis that alcohol should attenuate the initial responses to cold water immersion is based on the fact that it is a pharmacological depressant, In the present study, whilst moderate levels of intoxication had a tendency to attenuate f_R during the first **20** seconds of immersion, this reduction was small. Given this, it is concluded that moderate alcohol consumption is unlikely to prevent or facilitate drowning by altering the initial responses significantly on immersion. It may, however, increase the chance of accidental immersion, or decrease co-ordination and swimming proficiency when in the water.

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