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Alcohol: Its Influence In Sport And Exercise

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1. INTRODUCTION

Alcohol is both a food and a drug but is widely misused in many societies. This misuse has health-related consequences. When taken in moderate doses, it has acute effects on the nervous system that may be of beneficial used for ergogenic purposes. These include its tranquillizing properties and the reduction of tremor in aiming sports. Its utility as an ergogenic aid depends on a variety of factors which include dosage, timing of ingestion, nature of the sport, individual response and whether it is permitted in the sport in question.

In many societies alcohol is taken to aid relaxation and reduce occupational stress. Its repeated use can lead to addictions and ill-health, manifested in liver disease, cardiac and skeletal myopathies and impaired brain function. Alcohol was formerly used as an anaesthetic until it was realised that it was too dangerous to supply in large quantities for that purpose. Acute overdose can lead to liver intoxication and death.

As alcohol is a drug, its habitual use can lead to a dependency on it. It is estimated that alcohol dependency costs British industry at least £2 billion a year in absenteeism. The National Health Service spends £150 million a year in treating the effects of alcohol dependency. Annually in Britain up to 40,000 people die of alcohol related diseases and there is an average of 10 deaths each week due to 'drink driving'. Alcohol use is implicated in over 40% of violent domestic incidents and in 65% of attempted suicides. Even among sports practitioners, alcohol is the most widely used drug and an alcohol dependency may develop in athletes.

Competing in sports brings its own unique form of stress, usually before the more important contests. The anxiety reaction varies enormously between individuals, with some people coping extremely poorly. Many find their own solutions to attenuate anxiety levels, albeit sometimes with exogenous aids. Anxiety may adversely affect performance, especially in activities that call for high degrees of mental concentration and limb steadiness. This has prompted the use of anti-anxiety drugs (such as alcohol in small to moderate quantities), although some are not permitted in many sports.

There is a delicate balance between on the one hand reducing anxiety to enhance well-being and mental states prior to competing in sport and on the other hand impairing performance because of a disruption in motor co-ordination accompanying the treatment. The outcome depends on the concentrations of the drug, the timing of ingestion and the individual susceptibility to it. There are also possibilities of tolerance to the drug with chronic use, in addition to that of a drug dependence developing. Residual effects may carry over to the following day, affecting training or subsequent competitive performance.

2. METABOLISM OF ALCOHOL

The alcohols are a group of chemicals, most of which are toxic. The most common is ethanol or ethyl alcohol which is obtained by the fermentation of sugar. It is non-toxic except in large and chronic doses and has been enjoyed as a beverage for many centuries.

Ethyl alcohol is both a drug and a food, accounting for about 420 kJ (100 kcal) of energy per adult of the U.K. population each day. Its energy value per unit weight (kcal/g), the Atwater factor, is 7 compared with a value of 9 for fat but this is higher than the value of 4 for both carbohydrate and protein. Wine contains about 12% alcohol and so a litre bottle will contain about 120 g with a calorific content of 3516 kJ (840 kcal). Alcohol is metabolized mainly in the liver at a fixed rate of about 100 mg/kg body weight/hour; for a 70 kg individual this amounts to 7 g alcohol hourly. The energy is not available to active skeletal muscle and consequently it is not possible to exercise oneself back to a sober state. Beer contains some electrolytes but its subsequent diuretic effect means it is not ideal as an agent of rehydration following hard physical exercise.

Alcohol is a polar substance which is freely miscible in water since alcohol molecules are held together by the same sort of intermolecular forces as water, namely hydrogen bonds. The alcohol molecule is also soluble in fat, it is small and has a weak charge. (As the lipophilic alkyl group becomes larger and the hydrophillic group smaller, the alcohol molecules associate preferentially with other alcohol, hydrocarbon or lipid molecules rather than water.) It penetrates biological membranes easily and can be absorbed unaltered from the stomach and more quickly from the small intestine. The rate of absorption is influenced by the amount of food in the stomach, whether there are gas molecules in the drink and the concentration of alcohol in the drink. Absorption is quickest if alcohol is drunk on an empty stomach, if gas molecules are present in the drink and the alcohol content is high. Intense mental concentration, lowered body temperature or physical exertion tend to slow the rate of absorption.

From the gastrointestinal tract the alcohol is transported to the liver by means of the hepatic circulation. The enzyme alcohol dehydrogenase, present chiefly in the liver, governs the disappearance of alcohol from the body. In the liver, alcohol dehydrogenase converts the alcohol to acetaldehyde; it is then converted to acetic acid or acetate by aldehyde dehydrogenase. About 75% of the alcohol taken up by the blood is released as acetate into the circulation. The acetate is then oxidized to CO_2 and water within the Krebs (or citric acid) cycle. An alternative metabolic route for acetate is its activation to acetyl coenzyme A and further reactions to form fatty acids, ketone bodies, amino acids and steroids.

Ethyl alcohol is distributed throughout the body by means of the circulatory system and enters all the body water pools and tissues, including the central nervous system. Its distribution among the body fluids and tissues depends on several factors such as blood flow, mass and permeability of the tissue. Organs such as the brain, lungs, liver and kidneys reach equilibrium quickly while skeletal muscle with its relatively poorer blood supply attains its peak alcohol concentration more slowly. Initially, alcohol moves rapidly from blood into the tissues. When absorption is complete, arterial alcohol concentration falls and alcohol diffuses from the tissues into the capillary bed. The alcohol concentration remains high in the peripheral venous blood due to the slower rates of metabolism and excretion.

The level of alcohol in the blood does not affect its metabolism in the liver. A small amount of alcohol is eliminated in the breath, usually less than 5% of the total amount metabolized. This route is utilized in assessing safe levels for driving, forming the basis of the breathalyser tests. Small amounts of alcohol are excreted in urine and also in sweat if exercise is performed while the blood alcohol level is high. Higher excretion rates through the lungs, urine and sweat are produced at high environmental temperatures and at elevated blood alcohol levels.

The blood alcohol level usually peaks about 45 minutes after ingestion of a single drink. Any influence on performance will be most evident at this point. Effects on performance will generally be greater on the ascending limb than for a corresponding value on the descending limb of the blood alcohol curve; the rate of change and the direction of change of the blood alcohol concentration are more crucial factors than is the length of time alcohol is in the bloodstream. The peak is delayed by about 15 minutes if strenuous exercise precedes the ingestion. This may be due to the reduction in blood flow to the gut that accompanies exercise, the increased blood flow to skeletal muscle and thermoregulatory needs post-exercise.

Experimental investigations of alcohol and exercise are very difficult to control, as most subjects will recognize the taste of the experimental treatment. Most researchers use vodka in orange or grapefruit juice as the alcohol beverage: the placebo can include enough vodka to taste but not enough to produce a measurable blood alcohol concentration. Another strategy is to put a noseclip on the subject who is then given anaesthetic throat lozenges. Subjects vary in their responses to alcohol as does the same subject from day to day, which makes inferences from laboratory studies problematic. As the effects of alcohol differ with body size, dosage is usually administered according to body weight [1]. Effects also vary with the level of blood alcohol induced but there is no general international agreement on acceptable maximum levels for day to day activities such as driving a motor vehicle. Alcohol doses that render subjects intoxicated have little practical relevance in exercise studies and so experimental levels are usually low to moderate. Besides, experiments that entail alcohol ingestion should be approved by the local Human Ethics Committee and high alcohol dosages are unlikely to gain acceptance in experimental protocols.

3. ACTION OF ALCOHOL ON THE NERVOUS SYSTEM

The effects of ethanol administration on central nervous tissue are due to direct action rather than to acetaldehyde. Following ethanol ingestion very little acetaldehyde crosses the blood-brain barrier, despite elevated levels in the blood. Alcohol has a general effect on neural transmission by influencing axonal membranes and slowing nerve conduction. The permeability of the axonal membrane to potassium and sodium is altered by the lowered central calcium levels that result from ingesting alcohol [2]. Alcohol has differential effects on the central neurotransmitters, acetylcholine, serotonin, noradrenaline and dopamine.

Alcohol blocks the release of acetylcholine and disrupts its synthesis. Transmission in the central cholinergic pathways is lowered as a result. The ascending reticular cholinergic pathway determines the level of cortical arousal and the flow of sensory information to the cortex for evaluation. The lowering of electrocortical arousal reduces the awareness of stressful information and the ability of the individual to attend to specific stimuli. These de-arousing changes are reflected in alterations in the electroencephalogram (EEG) with moderate to large doses of alcohol. Impairments in concentration, attention, simple and complex reaction times, skilled performance and eventually short-term memory occur as a consequence.

Alcohol decreases serotonin turnover in the central nervous system by inhibiting tryptophan hydroxylase, the enzyme essential for its biosynthesis. Activity in the neurones of serotonergic pathways is important for the experience of anxiety; output of corticosteroids from the adrenal cortex increases the activity in these neurones. Alcohol has an opposing action and so may reduce the tension that is felt by the individual in a stressful situation.

Alcohol increases activity in central noradrenergic pathways. This effect is transient and is followed, some time later, by a decrease in activity. Catecholaminergic pathways are implicated in the control of mood states, activation of these particular pathways promoting happy and merry states. The noradrenaline turnover falls as the blood alcohol concentration drops: this ties in with the reversal of mood that follows the initial drunken euphoric state. This change is exacerbated by large doses of alcohol as these tend to give rise to depression.

Cerebral energy metabolism is affected by alcohol as the drug decreases glucose utilization in the brain. Glucose is the main substrate furnishing energy for nerve cells, and so the lowered glucose levels may induce mental fatigue. This will be reflected in failing cognitive functions, a decline in concentration and in information processing. It is unlikely that exercise will offset these effects.

A consequence of the disruption of acetylcholine synthesis and release is that alcohol acts as a depressant, exerting its effect on the reticular activating system, whose activity represents the level of physiological arousal. It also has a depressant effect on the cortex: it first affects the frontal centres of the cortex and then the cerebellum. In large quantities it impairs speech and muscular co-ordination, eventually inducing sedation. In smaller doses it inhibits cerebral control mechanisms, freeing the brain from its normal inhibition. This release of inhibition is linked with aggressive and violent conduct of individuals behaving out of character when under the influence of alcohol.

Alcohol will impair performance in sports that require fast reactions, complex decision making and highly skilled actions. It will also have an impact on hand-eye co-ordination, on tracking tasks such as driving and on vigilance tasks such as long-distance sailing. An effect on tracking tasks is that control movements lose their normal smoothness and precision and become more abrupt or jerky. In vigilance tasks, some studies show a deterioration in performance with time on task [3]. At high doses of alcohol, meaningful sport becomes dangerous and even impractical. Progressive effects of alcohol at different blood alcohol concentrations are summarized in Table 1. An important effect of alcohol, not listed, is that it diminishes the ability to process appreciable amounts of information arriving simultaneously from two different sources.

The classical study reporting facilitatory effects of alcohol on human performance was that of Ikai and Steinhaus [4]. They showed that in some cases moderate alcohol doses could improve isometric muscular strength. This result was similar to that obtained by cheering and loud vocal encouragement. The authors explained the effect on the basis of central inhibition of the impulse traffic in the nerve fibres of the skeletal muscles during maximal effort. This depression of the inhibitory effect of certain centres in the central nervous system may allow routine practices to proceed normally without any disturbances. This finding has not generally been replicated when other aspects of muscular performance are considered.

Studies of maximum muscular strength, in the main, show no influence of moderate to medium doses of alcohol on maximum isometric tension. Similar results apply to dynamic functions, such as peak torque measured on isokinetic dynamometers. Muscular endurance is generally assessed by requiring the subject to hold a fixed percentage of maximum for as long as possible. Here, too, the influences of moderate alcohol doses are generally found to be non-significant. This may be because the tests represent gross aspects of muscular function and as such are insensitive to the effects of the drug.

Table 1
Demonstrable effects of alcohol at different concentrations in blood.

Concentration level (mg/100 ml blood)	Effects
30	Enhanced sense of well-being; retarded simple reaction-time; impaired hand-eye co-ordination
60	Mild loss of social inhibition; impaired judgement
90	Marked loss of social inhibition; co-ordination reduced; noticeably 'under the influence'
120	Apparent clumsiness; loss of physical control; tendency towards extreme responses; definite drunkenness is noted
150	Erratic behaviour; slurred speech; staggering gait
180	Loss of control of voluntary activity; impaired vision

4. ALCOHOL AND PHYSIOLOGICAL RESPONSES TO EXERCISE

The ingestion of alcohol lowers muscle glycogen at rest compared with control conditions. As pre-start glycogen levels are important for sustained exercise at an intensity of about 70-80% VO_2max, taking alcohol in the 24 hours before endurance activities is ill-advised. Effects of alcohol on the metabolic responses to sub-maximal exercise seem to be small. Alcohol does not impair lipolysis or free fatty acid utilization during exercise [5]. It may decrease splanchnic glucose output, reduce the potential contribution of energy from liver gluconeogenesis, cause a more pronounced decline in blood glucose levels and decrease the leg muscle uptake of glucose towards the end of a prolonged (up to 3-hours) run. The impairment in glucose production by the liver would lead to an increased likelihood of hypoglycaemia developing during prolonged exercise.

Some authors have reported an increase in oxygen uptake (VO_2) at a fixed sub-maximal exercise intensity after alcohol ingestion [1]. This was accompanied by an increase in heart rate (HR), blood pressure and blood lactate in a study of 10 females exercising at 70% HR max [6]. The extra oxygen cost may have been due to a poorer co-ordination of the active muscles as the decrease in mechanical efficiency, implied by the elevation in VO_2, is not a consistent finding. Related to this is the increase in blood lactate levels with alcohol; metabolism of alcohol shunts lactate to pyruvate. It is possible that elevated blood lactate concentrations during exercise, after taking alcohol, reflects a disturbance of the citric acid cycle.

Alcohol in low doses does not seem to have adverse effects on VO_2max or on metabolic responses to high intensity exercise approaching VO_2max levels. At high doses (up to 200 mg%, i.e. 0.20% blood alcohol level) it is understandable that athletes may feel disinclined towards maximal efforts that elicit VO_2max values and a reduction in peak ventilation (VE) is usually observed [7]. Similarly, they may be poorly motivated to sustain high intensity exercise for as long as they would normally do. In middle-distance running events with an appreciable aerobic component, performance was found to be detrimentally affected in a dose-related manner with increasing blood alcohol concentrations from 0.01 to 0.10% [8].

It has not been shown conclusively that alcohol alters VE, stroke volume, or muscle blood flow at sub-maximal exercise levels whereas it does decrease peripheral vascular resistance. The vasodilatory effect of alcohol on the peripheral blood vessels would increase heat loss from the surface of the skin and cause body temperature to fall. This is dangerous if alcohol is taken in conjunction with exercise in cold conditions. Sampling whisky on the ski slopes may bring a feeling of comfort and warmth but its disturbance of normal thermoregulation may put the recreational skier at risk of hypothermia. Frost-bitten mountaineers especially should avoid drinking alcohol as the peripheral vasodilation it induces would lead to a further drop in body temperature. In hot conditions, alcohol is also inadvisable as it acts as a diuretic and would exacerbate problems of dehydration.

5. ALCOHOL IN AIMING SPORTS

In aiming sports, a steady limb is needed to provide a firm platform for launching the missile at its target or to keep the weapon still. Examples of such sports are archery, billiards, darts, pistol shooting and snooker. Two pistol shooters were disqualified during the 1968 Olympics, due to taking alcohol with a view to improving their performance. There are also aiming components in sports such as fencing and modern pentathlon, especially in the rifle shooting discipline of the latter. In some of these sports alcohol levels are now officially monitored, while in others, notably darts, drinking is a conventional complement of the sport itself.

The governing body of archery in the U.K., The Grand National Archery Society, has not yet banned the use of alcohol in its competitions and so alcohol is taken in small doses in the belief that it relaxes the archer, thereby steadying the hand as well as the nerves. In order to avoid fluctuating blood alcohol concentrations, the archer, like the dart thrower, tries to keep topping up the levels to prevent them from falling down the descending limb of the curve.

It is important to look at the task of the archer in total in order to understand how alcohol might affect the performance. The competitor has to shoot three dozen arrows at each of four targets - 90, 70, 60 and 50 m away - to complete a FITA (the world governing body) round. The system of scoring is modified for different competitive levels. Technological improvements in bow design have helped to produce outstanding scores, the gap to perfection being now due mainly to human factors. The modern bow has two slot-in-limbs which insert into a magnesium handle section and stabilizers which help to minimize vibration and turning of the bow. Muscle strength is employed in drawing the bow while muscle endurance is needed to hold it steady, usually for about 8 s for each shot, while the sight is aligned with the target. A minor deflection of the arrow tip will at 90 m cause the arrow to miss the target, which indicates the importance of hand steadiness. The archer, before release or loose, pulls the arrow towards and through the clicker (a blade on the side of the bow which aids in measuring draw length). He/she reacts to the sound of the clicker hitting the side of the bow handle by releasing the string which in effect shoots the arrow. Archers are coached to react to the clicker by allowing the muscles to relax; a slow reaction to the clicker is generally recognised as hesitation. This affects the smoothness of the loose and is reflected in muscle tremor, thereby causing a 'snatched loose'. For these reasons, the effects of alcohol on reaction time, arm steadiness, muscle strength and endurance, and the electromyogram of one of the arm muscles were investigated under experimental conditions [9].

Nine subjects underwent a battery of tests under four conditions - sober, placebo, 0.02% and 0.05% blood alcohol levels. The alcohol doses were administered in three equal volumes to total 500 ml over 15 minutes, 45 minutes being allowed for attainment of peak blood alcohol levels. The dose eliciting the desired blood alcohol level can be predicted from the subject's body weight [10].

Alcohol had no significant effect on the muscular strength and muscular endurance measures (Table 2). The holding time in the endurance test was about the same time as the archer normally holds the bow drawn before shooting, so that this test turned out to be reasonably realistic.

Table 2
Effects of the alcohol treatments on four experimental tests (mean ± s.d.)[9]

Variables	Sober	Placebo	0.02% BAL	0.05% BAL
Arm steadiness: [time-off-target(s)]	2.64 ± 0.89	3.05 ± 0.74	3.24 ± 1.01	8.17 ± 1.49
Isometric strength (N)	546 ± 48	560 ± 37	541 ± 56	523 ± 78
Muscular endurance(s)	11.4 ± 2.1	12.0 ± 2.0	12.0 ± 2.0	10.8 ± 2.0
Reaction time (ms)	211 ± 6.5	223 ± 9.6	223 ± 9.6	226 ± 11.2

Reaction time was significantly slowed by the lower alcohol dose, a further small delay occurring at the higher blood alcohol dose. The more sensitive response of auditory reaction time to alcohol would mean, in practice, a slower reaction to the clicker and a faulty loose. Another adverse effect noted was the impairment in steadiness of the extended arm. Performance was degraded, especially at the 0.05% blood alcohol level (BAL), and the variability in arm steadiness also increased with alcohol. This effect contradicts the conventional wisdom in archery and may have been due to the high load on the arm muscles when holding the bow drawn. It may be that alcohol only operates to advantage in steadying the limb in contexts more competitive than laboratory experiments.

A clearer loose was observed in the electromyographic profile at the low alcohol levels, which would be valuable in promoting a smoother release. This was supplemented by a tendency towards a reduced tremor in the muscle with both alcohol treatments. Together, these effects would indicate increased muscle relaxation, the tremor being normally associated with a snatched loose. This was partly offset by the longer holding time prior to loose induced by the alcohol treatments. Overall, it seems that alcohol has differential effects on tasks related to archery, depending on the concentrations, the components of the performance analysed and individual reactivity to the drug.

The detrimental effects of alcohol on some aspects of archery would not apply to other aiming sports such as darts and pistol shooting. In these the loading on the arm muscles is light, so a greater arm steadiness is likely to be induced by the drug. Another consideration is that the timing of the release is at the discretion of the subject and also is unaffected by a retarded reaction time. Reactions will have importance where the target is moving: it is noteworthy that the discipline of clay-pigeon shooting, for example, is not steeped in a history of alcohol use.

Bar-room sports such as snooker, billiards and darts have the alcohol industry as an adjunct to their matches. At the highest level of competition these sports are popular television spectacles. It is widely thought that the top performers consume large quantities of alcohol at a time, but this is not the case. Drinking is regular but in small doses so that a moderate blood alcohol level is continually maintained. At high blood alcohol levels, 0.15% or more, whole-body stability and mental concentration would be degraded and any possible ergogenic effect would be swamped. Alcohol is not prohibited in these sports though other drugs are.

A study of the effects of elevating blood alcohol levels (BAL) on tasks related to dart throwing confirmed the findings from archery [11]. While there were negative effects from the light alcohol dose (BAL 0.02%) on hand-eye co-ordination, effects were positive for balance and dart throwing. A higher level of 0.05% led to a fall-off in performance on all tasks which was not evident at a BAL of 0.02%. Results indicated some improvement with a light dose of alcohol for dart throwers but performance deteriorated when BAL values reached 0.05%.

In those sports that discourage alcohol for competition there is a disharmony in standards for what constitutes legality (alcohol is banned in several sports, for example modern pentathlon, fencing and shooting). The Amateur Fencing Association in Britain has adopted the value 50 mg/100 ml (0.05%) as its limit for competition and has incorporated dope testing at its contests since 1984. At the request of the international governing body for fencing, alcohol tests are now carried out at the Olympic Games, although it is generally accepted that alcohol abuse is not a major problem in this sport.

Testing for alcohol is performed on competitors in the shooting event of the modern pentathlon. In the biathlon also, participants are disadvantaged by losing time in settling down to prepare for taking their shots due to whole-body tremor. Recovering from their prior activity is important if the shots are to be on target. Although alcohol might help competitors to relax while taking aim, it has little ergogenic benefits in the other disciplines of the pentathlon or the biathlon. For various reasons, tranquillizers and beta-blocking agents have been preferred.

6. ALCOHOL AND SPORTS ACCIDENTS

It has been recommended that alcohol should be outlawed prior to aquatic activities because of the potential for catastrophic accidents in the water [12]. Alcohol is a significant factor in spinal injuries occurring in recreational water sports. In scuba diving the potential for fatal nitrogen narcosis increases at shallower depths when alcohol is consumed. Of 752 drowning victims studied in North Carolina, 53% tested positive for alcohol and 38% had BAL values of 0.10% or greater.

Peak effects on motor performance following administration of alcohol are typically observed 45-60 min later but impairment is evident for up to 3 hours after dosing [13]. This could render the drinker susceptible to accidents if alcohol is imbibed after sports competitions before driving the journey home.

There is evidence also of impaired exercise performance the morning after a bout of nocturnal drinking, adverse effects being observed in aerobic performance [12]. This has implications for the behaviour of players the night before competition or serious training.

Alcohol can compound the adverse effects of other drugs on motor performance tasks [14]. Attention and reaction time tasks are impaired by a combination of temazepam and ethanol in doses which may not cause impairment when each is given alone. Subjects tend to be unaware of their reduced performance capabilities when taking these drugs in combination. There are likely to be increases also in injury risk. Of 402 victims of ski accidents, 20% were positive for alcohol, 8.5% had taken benzodiazepines and 2.5% were positive for both drugs. Subjects positive for both tended to be older than the other persons examined [15].

7. CONCLUSION

Alcohol appears not to be much misused as an ergogenic aid in contemporary Olympic Games. Its ergolytic effects discourage its use in locomotor sports. Its main ergogenic applications are in the 'bar-room' and target sports when optimal blood alcohol levels are induced. It is likely to be used extensively for relaxation purposes by sports practitioners, particularly in the off-season when hang-over effects will not influence competitive performances.

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Discussion: Alcohol; Its Influence in Sport and Exercise

J.P. Clarys:

I think it is important that you point out the influences of alcohol.

T. Reilly:

There is quite a lot of literature demonstrating that alcohol in moderation can be protective against stress-related and cardiovascular diseases. The mechanisms are not clear. There have been suggestions of affecting lipoprotein carriers, and more recently, El-Sayed and his group at Liverpool have focused on the effects on blood clotting and fibrinolysis. The picture is not yet clear but it is likely to be that the positive effects are due to alcohol within a very narrow range of doses. That is the good news, the side that is positive. The bad news is that it is probably restricted to the equivalent of two bottles of Spanish beer per day. So positive effects are likely but at low to moderate levels of alcohol intake.

A.D. Martin:

I was just interested in your curve of accident risk against blood alcohol concentration. I seem to recall that that is not just monotonically increasing as you have shown it but if you go to the lower level and amplify that, maybe it is a bit of a U-shaped curve. Is there in fact any beneficial effect of alcohol on those kinds of performances at the very low levels of alcohol? I seem to recall some studies done on driving cars and lower levels seem to be beneficial. I can appreciate why that would not want to be made public, but we do tend to work around these higher levels. Your graduations there were 0.03%, 0.06% and so on. But if you enlarged the zero to 0.03 region, would you get a reduced risk in that?

T. Reilly:

You are probably correct. You are also right to say that there is not any way that it could be publicized or promoted for driving skills. Even at low doses of alcohol, drivers tend to underestimate their speed. But effects are closely dependent on the time of day; lunchtime is probably the worst time. If you raise alcohol a little bit then you have quite a dramatic effect on the post-lunch dip in performance which is generally associated with the circadian cycle. So, it may be that at low levels alcohol is beneficial in some tasks in the evening but not at midday.

K.A. Perkins:

I was glad to hear you distinguishing between ascending and descending dose response curves. They can also play a role in the subjective effects of alcohol. The ascending is often associated with positive elation effects, and the descending with fatigue. I think it may have some relevance for your inverted-U arousal curve, that it could actually shift you one way on the ascending and then back the other way on the descending. Also, we have found that nicotine can counter some of the deleterious effects of alcohol and I do not know if you have looked at other factors that can counteract some of those effects. Finally, you have rightly mentioned that alcohol is a food and yet most of the research does not seem to show that it has an effect on energy expenditure. I do not know if you could comment on that. And that is just at rest. I am not really talking about during activity.

T. Reilly:

The relevance of alcohol as a food in exercise is minimal simply because the muscle cannot take it up and use it. You cannot exercise yourself sober. So exercise does not seem to have any effect on alcohol concentration. We have not any data on resting energy expenditures, to answer your question directly. I had commented on the elevation in oxygen consumption that shows up in some exercise studies. We probably are talking about high levels of blood alcohol. We cannot maybe separate the metabolic effects from those that are associated with changes due to impaired mechanical efficiency. So at that level I would find it hard to separate the potentially reduced mechanical efficiency from any elevations in oxygen consumption that is a consequence of increasing the values at rest.

J.B. Leiper:

Alcohol does have some positive attributes. One of the problems that occurs after exercise is that most people have an inadequate capacity to ingest voluntarily sufficient fluid to euhydrate. Alcohol, in moderation, appears to maintain the thirst response and stimulate a greater fluid intake. We have previously shown that low alcohol drinks, up to about 4 per cent, will adequately rehydrate without producing a marked diuretic effect. Would you like to comment on the possible use of alcohol in this situation.

T. Reilly:

The first comment is that it reflects the fact that the brewing industry has been much better in getting palatable drinks than has the sports drink industry. Don MacLaren has shown that exercise itself will slow up the rise in blood alcohol. But if the athlete drinks on an empty stomach that will speed up the absorption and you are likely to raise blood alcohol levels with low concentrations in the drink to a point where it becomes dangerous. I do think as well that the time of day of the ingestion is quite critical. Even low alcohol drinks can have an adverse effect on the post-lunch dip in performance, so if you are exercising at six or seven o'clock in the evening, that is not any problem. If you are exercising later in the day, then there may be even a marginal diuretic effect which will disturb sleep. So I do think that the timing is quite important, but a low-dose alcoholic drink could be a beneficial rehydration agent.

F. Brouns:

Is it right that light endurance exercise increases the rate of alcohol clearance and if so, would you recommend to an athlete who has been "on alcohol" to do some endurance exercise to get rid of it earlier?

T. Reilly:

I have not seen any convincing data which would demonstrate that, but one should also consider the arousing effect of exercise. This may compensate for any depressant effect.