A Review of the Health Effects of Stimulant Drinks

Final Report

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Foreword

Over the last decade, stimulant drinks have developed a considerable share of the global soft drinks market. Legislation controlling their sale and marketing and scientific research into their ingredients lags behind the development of these 'functional' beverages.

Some countries, within the European Union (EU), and also Australia and New Zealand have had concerns regarding the potential health effects of stimulant drinks. There are a number of countries where these products are not sold owing to statutory limits on the concentrations of their ingredients, while others stipulate for additional labelling of the products.

At the request of the Minister of State at the Department of Health and Children in the Republic of Ireland, the Food Safety Promotion Board (FSPB) convened an expert Committee to review the health effects of stimulant drinks. This report is the outcome of the Committee's work.

The lack of scientific research into some of the ingredients found in stimulant drinks, and the unrecorded health effects of the combined ingredients, has made this task a difficult one. However, this report should prove to be valuable. It aims to raise awareness regarding the health effects of these products for particular subsections of the population on the island of Ireland, and it sets out recommendations to address the gaps in the current knowledge. It is hoped that the concerns highlighted in this report will be addressed by policy makers and researchers, and will ultimately influence the behaviour of the population.

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Stimulant Drinks Committee

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Executive Summary

Background

The Food Safety Promotion Board, following a request from the Minister of State at the Department of Health and Children, Dr. Tom Moffatt T.D., established the Stimulant Drinks Committee (consisting of external experts) to carry out research into the health effects of stimulant drinks.

The task and terms of reference for the group were:

- to review the potential health effects on the population of Ireland from the consumption of stimulant drinks
- to assess the knowledge gaps
- to consider the need for any action to protect public health.

In addition to this, the Committee agreed to take into account claims made in relation to the advertising and marketing of stimulant drinks, as well as the legislation and regulations pertaining to these products in other countries. The Committee reviewed the available information regarding the main ingredients of stimulant drinks and relevant research studies into the health effects. However, it was limited by the lack of information and adequate risk assessment data pertaining to stimulant drinks.

The Definition of a Stimulant Drink

There is no agreed definition in the regulatory framework for the products referred to as 'energy' or 'stimulant' drinks. For the purpose of this report, the term 'stimulant drinks' was adopted and these drinks are defined as 'beverages, which typically contain caffeine, taurine and vitamin(s), and may contain an energy source (e.g. carbohydrate), and/or other substance(s), marketed for the specific purpose of providing real or perceived enhanced physiological and/or performance effects'.

Availability

There are several stimulant drink products available to the consumer on the island of Ireland. These products all contain caffeine at a typical concentration of 80 mg per 250 ml can, with the majority of drinks containing taurine and some containing glucuronolactone. The report considers these ingredients in detail.

Sales of stimulant drinks grew rapidly following their introduction on to the market on the island (1999/2000). However, sales of stimulant drinks appear to have slowed thereafter.

Legislation

Although there is no legislation relating specifically to stimulant drinks in Ireland or the United Kingdom (UK) these beverages are governed by the existing food legislation. In the UK the Food Advisory Committee (FAC) of the Ministry of Agriculture, Food and Fisheries (MAFF) recommended in 1999 that products, such as stimulant drinks, containing caffeine at concentrations greater than 125 milligram per litre ($mg.l^{-1}$) should carry a clear statement on the label regarding the levels of caffeine present and an indication that they are unsuitable for children or individuals sensitive to caffeine. In February 2002, EU Member States agreed changes to the labelling regulations. These changes will require drinks with caffeine contents greater than 150 $mg.l^{-1}$ to be labelled 'high caffeine content' and the amount of caffeine present must be given. The new rules must come into effect by July 1st 2004.

Consumption

A survey of the consumption of stimulant drinks in a representative sample of 11 – 35 year olds in the Republic of Ireland (total sample number (n) = 625) and in Northern Ireland (n = 635) was commissioned by the FSPB in 2001. This age group was chosen as it was thought to be most akin to the young population who use these products. Results of the survey showed the following:

- 51% (Northern Ireland) and 37% (Republic of Ireland) of individuals in this age group have consumed stimulant drinks at least once
- 10% those who had ever consumed stimulant drinks were regular consumers with the highest prevalence among males aged 19 - 24 years
- The most common location of consumption was 'pubs/clubs', but stimulant drinks were also consumed 'with friends', 'at home', 'before or after sport' and occasionally in association with 'study/work'. Very few reported drinking stimulant drinks in association with driving
- Stimulant drinks were frequently consumed with alcohol, particularly vodka
- The weekly consumption of stimulant drinks was approximately three cans (each can containing 250 ml) among 'ever' consumers, rising to about eight cans among the highest 'ever' consumers
- Similarly, in a single session the average amount of stimulant drinks consumed was approximately three cans and among the highest consumers this rose to eight cans. This would suggest that the weekly consumption of stimulant drinks takes place in a single session.

Stimulant drink consumers reported strong or moderate agreement for consumption of stimulant drinks with the following reasons:

"to perk themselves up when tired"

"on big nights out"

"to perk themselves up if they have too much to drink"

"with alcohol to enable them to drink more in an evening"

Qualitative research was carried out to assess the concerns of the public regarding the consumption of stimulant drinks. Results of the research demonstrated that the main concerns *vis à vis* stimulant drinks were its consumption with alcohol, the perceived '*high*' caffeine content and the sense of ambiguity and uncertainty regarding the other ingredients. Parents were more actively concerned than consumers, the latter acknowledging the risks but continuing to drink the product.

Possible Adverse Health Effects of Stimulant Drink Ingredients

Caffeine

Caffeine is one of the main ingredients of stimulant drinks and it is also present in tea, coffee and other beverages and foods. The average total intake of caffeine in the Republic of Ireland and the UK is estimated to be 214 and 278 mg per person per day, respectively. Data from the consumption survey, based on weekly intake, indicates that among stimulant drink consumers, the average daily caffeine intake from stimulant drinks alone would be approximately 35 mg, rising to about 90 mg among the highest consumers. This does not appear excessive, however, when the consumption of stimulant drinks in a single session was investigated, the average caffeine consumed was approximately 240 mg (3 cans), rising to about 640 mg (8 cans) among the highest consumers. Such large intake levels among the highest consumers are a cause of concern, particularly in relation to the known potential acute health effects of caffeine such as tachycardia, increases in blood pressure and dehydration, as well as behavioural and cognitive effects. The health effects of chronic or habitual caffeine consumption remain uncertain.

Although no data is available on stimulant drink consumption during pregnancy, the relatively high caffeine content requires that these beverages be

taken into consideration with regard to advice on caffeine intake during pregnancy. On the basis of a possible association of high caffeine intake (in excess of 300 mg per day) with low birth weight and spontaneous abortion, both the FSAI and the FSA UK recommend that pregnant women should limit their daily intake of caffeine to 300 mg (equivalent to about four average cups of coffee, six average cups of tea, eight cans of regular soft drink or four cans of stimulant drinks).

There is limited data available on stimulant drink intake by children under 11 years, the relatively high caffeine content of stimulant drinks requires that these beverages be taken into consideration with regard to advice on caffeine intake by children. In experimental studies in which single doses of caffeine up to 10 milligram per kilogram ($mg.kg^{-1}$) body mass were given to children, either no effect or small, inconsistent effects were noted on mood, behavioural, cognitive and motor functions. Some of the effects may be interpreted as beneficial. However, some studies have indicated that a dose of 5 $mg.kg^{-1}$ body mass (equivalent to 150 mg caffeine per day, 4 – 5 cans of a cola drink, for a 10 year-old, 30 kg child) increased arousal, irritability, nervousness or anxiety in some children, particularly if they were normally low consumers of caffeine.

Information on the possible interactions in humans of caffeine with other constituents of stimulant drinks, such as taurine, is very limited. These interactions warrant further investigation.

Guarana

Guarana (*Paullinia cupana*) is a native South American plant containing guaranine, a substance chemically similar to caffeine with comparable stimulant effects. Guarana is often added to stimulant drinks, either in combination with caffeine or on its own.

The stimulant effect of guarana is related to its caffeine content; one gram of guarana contains as much caffeine (40 mg) as a medium strength cup of coffee. While the precise source and nature of the stimulant activity of guarana is not well understood, it has been reported that guarana exerts a more prolonged effect than an equivalent amount of caffeine.

There are reports in the literature of toxicosis associated with guarana in experimental animals. However, the information is limited. The Food and Drinks Administration (FDA) in the USA currently prohibits the use of guarana in food and drinks while awaiting further clarification on its safety. The FSA UK and the European Commission (EC) are also reviewing the use of guarana in foodstuffs.

Taurine

The data on stimulant drink intake among stimulant drink consumers indicate that average daily taurine intake from stimulant drinks was approximately 0.4g, increasing to about 1g among the highest consumers. The most taurine consumed from stimulant drinks in a single session was averaged at approximately 3g, rising to about 8g by the highest consumers. Stimulant drink intake at the maximum level of intake provides taurine far in excess of that from other foods or beverages in the diet. While limited, the data available indicate no evidence of adverse effects of taurine at such intakes and in a recent report the EU Scientific Committee for Food (SCF) was unable to conclude that the '*safety-in-use*' of taurine in the concentration range reported for stimulant drinks has been adequately established. Further research into this ingredient is required.

Glucuronolactone

The data from the consumption survey indicate that average daily glucuronolactone intake from stimulant drinks was approximately 0.25g, rising to about 0.7g among the highest consumers. The most glucuronolactone consumed from stimulant drinks in a single session was averaged at approximately 1.8g, rising to about 4.8g among the highest consumers. These maximum levels of intake provide more glucuronolactone than would otherwise be achieved through other foods or beverages in the diet. There is very little information available for risk assessment of glucuronolactone at such intakes. While there is no indication from the available data that there is any risk to health from consumption of high amounts of glucuronolactone, these data are limited.

Similar to taurine, the EU SCF was unable to conclude that the '*safety-in-use*' of glucuronolactone in the concentration range reported for stimulant drinks has been adequately established.

Stimulant Drink Consumption in Association with Sport and Exercise

Stimulant drinks are sometimes promoted for use in sport. Caffeine has been shown to enhance performance in some sporting activities and for this reason, caffeine intake in sport is regulated by the International Olympic Committee (IOC). It is not clear whether other ingredients of stimulant drinks (taurine and glucuronolactone) have effects on performance during sport and exercise or whether these ingredients potentiate or attenuate the actions of caffeine when used in sport.

Stimulant drinks are not suitable for use as rehydration drinks in association with sport or exercise. Unlike isotonic sports drinks, stimulant drinks do not meet the compositional requirements (with respect to osmolarity and concentrations of carbohydrate and electrolytes) recommended for such beverages to ensure optimum hydration. Little is known about the possible adverse effects on exercise performance and fluid balance during sport and exercise occurring from the interaction of the principal ingredients contained in stimulant drinks. Further research is necessary.

Stimulant Drink Consumption in Association with Alcohol

The consumption survey showed that stimulant drinks were frequently consumed with alcohol, particularly vodka. There is little information on the possible interactions between alcohol and the ingredients of stimulant drinks, such as caffeine and taurine, when consumed at the relatively high levels observed with some consumers. This warrants investigation in humans, particularly under conditions of exercise and consequent dehydration through sweating.

Furthermore, the survey also provided evidence that some individuals consume stimulant drinks to 'perk' themselves up if they had too much to drink and with alcohol to enable them 'to drink more in an evening'. Such use of stimulant drinks may contribute to increased alcohol consumption. While the manufacturers of stimulant drink assert that they do not encourage the consumption of the drinks with alcohol, some of the promotional materials and information supplied by the manufacturers are ambiguous with regard to this and appear to ostensibly promote the use of stimulant drinks with alcohol.

Marketing and Claims

The FSPB commissioned an assessment of the marketing of stimulant drinks in Ireland in March/April 2001. Market analysis indicates that the sales of stimulant drinks on the island of Ireland have peaked, and in 2001 sales were running at approximately 20% below those of 2000. Recent analysis suggests that other more 'trendy' products on the market are replacing stimulant drinks with alcohol. However, there remains a strong and loyal consumer base of stimulant drinks and there are indications that many consumers continue to consume these drinks with alcohol.

The analysis of the marketing activity of stimulant drinks highlights a number of areas for concern including:

- Some of the verbal messages being given by the sampling staff may be over-emphasising the benefits of the product
- Some promotional brochures encourage people to drink stimulant drinks rather than to sleep
- In general, no recommended upper consumption limits are provided (other than for athletes concerned with sports regulations on permissible levels of caffeine).

Recommendations

In reviewing the adverse health effects of stimulant drinks, the Committee was constrained by the limited amount of comprehensive information, risk assessment data and peer reviewed scientific research in this area. In light of this limited information and in order to protect public health, the Committee has adopted a precautionary approach to its review and makes the following recommendations:

Labelling

The Committee welcomes the changes to the labelling regulations requiring drink products with caffeine contents greater than 150 $mg.l^{-1}$ to be labelled 'high caffeine content' and the amount of caffeine present be given. This should be implemented as soon as is practicable.

The Committee also recommends that stimulant drinks should be labelled with an indication that they are unsuitable for children (under 16 years of age), pregnant women and individuals sensitive to caffeine.

Groups for special consideration

In the context of advice to pregnant women to limit caffeine intake owing to the possible adverse effects of high caffeine intake on pregnancy outcome, stimulant drinks should be classified with other beverages of high caffeine content.

Consumption of stimulant drinks by children under 16 years should be discouraged on the basis of possible transient behavioural effects of high caffeine intake, such as increased arousal, irritability, nervousness or anxiety.

Circumstances under which stimulant drinks are consumed

Consumers should be advised that caution be exercised in the consumption of stimulant drinks with alcohol and the products should carry a clear statement on the label to this effect.

It is recommended that stimulant drinks not be consumed in association with sport and exercise as a thirst quencher and that the products should carry a clear statement on the label that they are unsuitable rehydration agents for use in sport and during exercise.

Marketing

The Committee has a number of concerns about the marketing and promotion of stimulant drinks including:

- misleading claims
- suggestion that stimulant drinks reduce the requirement for sleep
- lack of recommended upper consumption limits
- ambiguous information on the consumption of stimulant drinks with alcohol
- promotion of stimulant drinks consumption in association with sport.

It is recommended that the industry regulators and relevant authorities address such practices.

Further research

The Committee recognises that in order to undertake a full risk assessment of the ingredients of stimulant drinks and their interactions, extensive research would need to be conducted. Such research would require toxicological investigations that would best be carried out at a concerted international level.

It is recommended that further research be carried out to:

- monitor patterns of stimulant drink consumption
- establish an upper safe level for daily intake of glucuronolactone and taurine in humans
- investigate possible adverse effects of interactions between stimulant drink ingredients such as caffeine and taurine and between such ingredients and alcohol, particularly under conditions of exercise and consequent dehydration through sweating.

‘Large caffeine intake levels are a cause of concern, particularly in relation to known potential acute health effects such as tachycardia, increases in blood pressure and dehydration, as well as behavioural and cognitive effects.’

‘There is no agreed definition in the regulatory framework for the products referred to as ‘energy’ or ‘stimulant’ drinks’.

Chapter 1
Introduction

1.1 Background to the Committee

On November 14th 2000, an inquest was held into the death of an 18 year old, male student. The inquest heard evidence that the student collapsed and died during an interval at a basketball tournament in which he was participating. Following autopsy the coroner concluded that the young man had died from sudden unexplained adult death syndrome, possibly resulting from cardiac dysrhythmia. In its verdict, the jury concluded that death was as a result of this rare syndrome. However, on the basis of evidence from witnesses who described having seen the young man drink up to three cans of a stimulant drink, during the tournament, the jury added a rider to the verdict that immediate research be carried out into the safety of stimulant drinks available on the Irish market.

Following the inquest and the jury's recommendations, the Minister of State at the Department of Health and Children, Dr. Tom Moffat T.D., requested that the Food Safety Promotion Board commission independent scientific research into the health effects of stimulant drinks.

It is on this basis that the FSPB established the Stimulant Drinks Committee comprising medical and scientific experts to review the issue. This report is the outcome of the Committee's deliberations.

1.2 Terms of Reference of the Committee

In consultation with the Department of Health and Children, the Committee developed the following terms of reference:

- *To review the potential health effects on the population of Ireland from the consumption of stimulant drinks*
- *To assess the knowledge gaps*
- *To consider the need for any action to protect public health.*

1.3 Scope of Work of the Committee

The Committee agreed that the broad areas of work should be to:

i) review the research on the health effects of stimulant drinks

ii) ascertain consumption patterns of stimulant drinks within population groups

iii) advise on the need for research and identify priority areas

iv) advise on the need for action, if required, to protect public health.

In addition to the above, the Committee also agreed to take into account, claims made in relation to the advertising and marketing of stimulant drinks, as well as the legislation and regulations pertaining to these products in other countries.

‘There is currently no specific legislation governing stimulant drinks within the EU, nor is there a general consensus with regard to the permissible concentrations of the individual ingredients’.

Chapter 2
Stimulant drinks – Definition and Regulatory Framework

2.1 Definition of Stimulant Drinks

Stimulant drinks are a relatively recent introduction to the global soft drink market. These drinks contain a caffeine source and a carbohydrate source such as glucose or sucrose. They may also contain other ingredients including glucuronolactone, taurine and some of the B vitamins.

The drinks are generally packed in visually attractive slimline cans and positioned at the upper end of the soft drink market. Stimulant drinks belong to a new class of food known as 'functional foods'. These foods purport to target and favourably affect particular functions of the body.

While falling into the non-alcoholic beverage category, there is no agreed definition applicable for these products in the regulatory framework. The Committee considered the terms 'energy drinks' and 'formulated caffeinated beverages' but selected the term 'stimulant drinks' to describe the products under examination. The Committee considered that the term 'stimulant drinks' more precisely reflected the perceived stimulant effect of the drinks, which was the focus of the review. Moreover, while caffeine may play a significant role in the functional properties of stimulant drinks, it is possible that the other ingredients present, such as taurine and glucuronolactone, may also contribute to the overall effect. For the purposes of this report the Committee, therefore, agreed on the following definition of stimulant drinks:

> *Beverages, which typically contain caffeine, taurine and vitamin(s) and may contain an energy source (e.g. carbohydrate) and/or other substance(s), marketed for the specific purpose of providing real or perceived enhanced physiological and/or performance effects.*

It is important to differentiate between stimulant drinks and the drinks referred to as 'sports' or 'isotonic' drinks as these products have distinctly differing functions and composition.

Sports drinks provide two major functions:

i) maintenance of fluid balance and electrolyte concentration

ii) provision of energy for use either during exercise or in recovery from exercise.

Sports drinks, as so described, do not normally contain the principal ingredients of stimulant drinks, i.e. caffeine, taurine and glucuronolactone and hence do not fulfil the criteria of the definition of a stimulant drink as outlined above. Furthermore, it should also be noted that the IOC currently considers caffeine to be a stimulant which can result in athlete disqualification at urinary concentrations in excess of 12 milligram per litre ($mg.l^{-1}$) of urine.

2.2 Range of Stimulant Drink Products

There is a wide range of stimulant drink products available to the consumer on the island of Ireland. These products all contain caffeine at a typical concentration of 80 mg per 250 ml can (Table 2.1), and the majority of drinks also contain taurine and carbohydrate, while some contain glucuronolactone.

Table 2.1 Stimulant drink products typically available on the island of Ireland and their ingredients

Brand Name	Concentration of ingredient as shown on label mg per 250 ml can			
	Caffeine	*Taurine*	*Glucuronolactone*	*Carbohydrate*
Absolute Bull	80	1000	600	28.3
American Bull	80	*	**	28.0
Dynamite	80	1000	**	31.3
Indigo Extra	63~	1000	**	35.0
Jolt Cola	±	**	**	*
Lipovitan B3	50	1000	**	27.0
Red Bull	80	1000	600	28.3
Shark	75~	1000	*	37.5
Spiked Silver	80~	1000	600	33.8
V	80~	500§	62.5§	28.0

* Not given
** Not listed in the ingredients listing
~ Includes caffeine in the form of guarana
± No indication of actual concentration given on label but states that the level of caffeine present is '*equivalent to one cup of coffee*' (see Table 3.1)
§ Actual concentrations not given in ingredients listing (1)

While all these products have at some time or another been available on the market on the island, the product '*Red Bull*', manufactured by *Red Bull* GmbH, dominates the market with an 87% share (2, 3).

2.3 The Growth of the Stimulant Drink Market

Since the original launch of stimulant drinks in 1987 in Austria, there has been enormous growth in their sales worldwide. Market statistics for the Republic of Ireland in 2000 indicate that stimulant drinks represented less than 2% of the total soft drink market but that the category was growing rapidly (2). Sales of '*Red Bull*' on the island reached 1.43 million cases (8.58 million litre) in 2000 with approximately 70% of sales occurring in the Republic of Ireland and 30% in Northern Ireland. This represents a two-fold increase in sales on the previous two years (3). However, market analysis suggests that this trend has since slowed (Chapter 7).

2.4 Regulations and Legislation Pertaining to Stimulant Drinks

2.4.1 Ireland and other EU Member States

Currently there is no EU legislation pertaining specifically to stimulant drinks. Like other soft drinks, stimulant drinks are subject to the general EU labelling directives and applicable horizontal legislation.

While to date there is no specific legislation, a number of EU Member States have introduced their own domestic legislation governing stimulant drinks or ingredients therein, particularly caffeine. Certain Member States, including France and Denmark, have set statutory upper levels of caffeine in soft drinks of 150 $mg.l^{-1}$ and stimulant drinks are currently not sold within these jurisdictions.

As well as caffeine, the French authorities also have concerns regarding the health effects of some of the other ingredients of stimulant drinks namely taurine and glucuronolactone (4). In February 2001, the French food safety agency (Agence Française de Sécurité Sanitaire des Aliments, AFSSA) published its consultation findings on a

toxicological study of a stimulant drink product. In its report the AFSSA stated that in the case of taurine and glucuronolactone: "*it could not guarantee with certainty that the substances contained within the product did not present any health risk*". The report further added: "*it is recommended to proceed with further in-depth research to pinpoint a daily maximum absorption threshold for taurine and glucuro-ð-lactone* [glucuronolactone]".

Following a review of the toxicological study carried out on behalf of the manufacturer, the AFSSA concluded that authorisation for the use of the drink was:"*not acceptable, as their safety in the concentrations promoted by the petitioner has not been demonstrated*".

Up to 1996, Italy also had a statutory permitted level of caffeine of 150 $mg.l^{-1}$ (5). The EU initiated a procedure of infringement against Italy for creating a barrier to trade within the EU market. The Italian Health Superior Council subsequently conducted a study on the health effects of the high concentrations of caffeine and taurine. Following the completion of the study, the Council suggested that if the products containing caffeine were to be sold within Italy, that additional labelling was to be included on the product container to the effect:

- that children, pregnant women and caffeine sensitive individuals should avoid the products
- that moderate consumption of the products be advised with the contemporary consumption of caffeine from other sources
- that claims on the beneficial effects of these beverages which cannot be adequately documented should not be included on the label
- that the contemporary exposure to alcohol and tobacco with the drinks should be avoided.

In light of the review of the amendment to the labelling directive 2000/13/EC, the EU has stayed proceedings on this case.

In February 1999, the UK FAC of MAFF recommended that a statutory maximum limit of 125 $mg.l^{-1}$ be set for caffeine in soft drinks and that a voluntary statement outlining the unsuitability of caffeine for children and those sensitive to caffeine be included on the label of caffeine-containing products (6). Following the publication of the 1999 report from the EU SCF on 'energy' drinks (7), the initial statement was subsequently reconsidered and a new statement issued indicating that in soft drinks, more likely to be consumed in large quantities by children, caffeine concentrations should not exceed 125 $mg.l^{-1}$. It was recommended that products, such as stimulant drinks, containing caffeine at concentrations greater than 125 $mg.l^{-1}$, should carry a clear statement on the label indicating the levels of caffeine present and a statement advising their unsuitability for young children or those sensitive to caffeine (8).

The EU Standing Committee for Foodstuffs has considered an amendment to the labelling directive 2000/13/EC (9). Member States agreed in February 2002 to an amendment requiring specific labelling indicating the presence of caffeine and quinine in foods when used as a flavouring or ingredient. Products that contain levels of more than 150 $mg.kg^{-1}$ (or $mg.l^{-1}$) caffeine will in the future be labelled 'high caffeine content' and the exact amount present indicated on the label. The new rules must come into effect by July 2004.

2.4.2 Other international legislation

The issue of energy (stimulant) drinks was raised at the Codex Committee on Nutrition and Foods for Special Dietary Uses (CCFSDU) in June 2000 (10). At this session there were inconclusive discussions over whether stimulant drinks should be classed as soft drinks or require specific classification. There was also a call for further definition of the term 'high energy'. In November 2001, the CCFSDU further discussed the issue of stimulant drinks. It was decided at this session that no standard for energy (stimulant drinks) or sports drinks was necessary (11). In order to facilitate international trade by removing the existing regulatory inequalities between Australia and New Zealand in relation to formulated

caffeinated beverages (stimulant drinks), the Australian New Zealand Food Authority (ANZFA) commissioned a working group in 2000 to investigate the safety aspects of these products.

In the ANZFA 'Full Assessment Report and Regulation Impact Assessment' published in November 2000 (12), the group recommended that stimulant drink products should be labelled with the following information:

- an advisory statement regarding the presence of caffeine
- an advisory statement regarding the suitability of the product to particular segments of the population such as children and during pregnancy
- an advisory statement outlining consumption limits and quantitative compositional labelling including energy, carbohydrate, caffeine (from all sources) and other added substances.

In August 2001, the Australian and New Zealand Food Standards Council published a new standard of the Food Standards Code (standard no. 2.6.4) governing the labelling of formulated caffeinated beverages (stimulant drinks) (13). These products must now carry an advisory statement that the products contain caffeine and are not recommended for children, pregnant or breastfeeding women and individuals sensitive to caffeine. However, the new labelling does not make any recommendation regarding appropriate levels of consumption of energy drinks, nor does it link the consumption of the beverages with any adverse health effects. At the same time, health ministers from Australia and New Zealand permitted the manufacture of stimulant drinks within Australia.

2.5 Summary

There is a wide range of stimulant drink products available on the market and the concentration of the ingredients varies from product to product (Table 2.1). The Committee considered it valid and appropriate to define those drinks that contain caffeine, glucuronolactone and taurine as stimulant drinks. In the Committee's opinion the term 'stimulant drinks' more accurately reflects the market perception of these products. In considering its definition the Committee regarded the widely used term 'energy drink' to be ambiguous. Stimulant drinks are differentiated from isotonic or sports drinks. The use of stimulant drinks in sport is considered in more detail in Chapter 4.

There is currently no specific legislation governing stimulant drinks within the EU, nor is there a general consensus with regard to the permissible concentrations of the individual ingredients. Some countries, including France and Denmark, have a statutory limit set for caffeine in soft drinks of 150 $mg.l^{-1}$ and therefore, stimulant drinks are not sold. Other EU countries including Ireland and the UK, currently have no specific legislation governing these products.

The EU SCF agreed in February 2002 an amendment to the current labelling legislation and this harmonises the disparate legislation with regard to labelling of caffeine content of foods and drinks. The new rules must come into effect by July 2004.

“Stimulant drinks belong to a new class of food known as ‘functional foods’.”

‘Caffeine is one of the main active ingredients found in stimulant drinks and the content per serving of these products tends to be higher than that of other caffeinated beverages at similar volumes.’

Chapter 3
Individual Ingredients of Stimulant Drinks

3.1 Introduction

The launch of stimulant drinks in 1987 introduced a new genre onto the European soft drink market. Stimulant drinks purport to have 'functionality', including increasing concentration and improving cognitive performance of the consumer. The basis of many of the statements made by the manufacturers of these products lies in the combination of ingredients used. Stimulant drinks may contain a variety of components, including caffeine, guarana, taurine, glucuronolactone and some of the B vitamins.

In order to comprehensively assess the health effects of stimulant drinks, a prior understanding of the physiological, and potential behavioural effects of the individual ingredients was necessary. To this end, the Committee undertook a review of the scientific literature pertaining to the ingredients of stimulant drinks. Animal studies and acute human toxicity studies, where available, were reviewed as well as human epidemiological data.

3.2 Caffeine

3.2.1 Introduction

Caffeine (1,3,7-trimethylxanthine) is frequently described as the most widely used psychoactive substance in the world. Since the discovery of its chemical structure in 1895, caffeine has become one of the most comprehensively studied food ingredients (14). Caffeine is one of a group of plant alkaloids which occurs naturally in the leaves, seeds and fruit of more than 60 plant species, of which cocoa-beans, tea and coffee are the most well known. The dimethylxanthine derivatives, theophylline and theobromine, are also found in a variety of plants.

3.2.2 Sources of caffeine and caffeine content

Caffeine is present in coffee, tea, chocolate, cola soft drinks and stimulant drinks. It is also present in medications, including cold remedies, headache treatments, diet pills, diuretics and stimulants (Table 3.1). In order to estimate the consumption of caffeine by an individual, it is common to approximate intake by multiplying the number of cups of coffee, tea or cocoa by an estimated average caffeine content per cup. However, the caffeine content of tea and coffee can vary greatly depending on the method of preparation (e.g. filter coffee or instant coffee), cup/mug size, product brand and preferred strength (Table 3.1).

The North/South Ireland Food Consumption Survey 1997-2000 reported that 91% of respondents on the island drank tea, 55% coffee, 43% carbonated beverages and 21% diet carbonated beverages (15). In the UK, the mean caffeine intake from tea, coffee and carbonated beverages was reported to be 3.98 milligram per kilogram body mass ($mg.kg^{-1}$ body mass) per day. This equates to an approximate intake of 278 mg per day for a typical 70 kg male (as cited in Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT) Statement, 2001 (16)). In 1995, it was reported that the consumption of caffeine in the Republic of Ireland was 3.05 $mg.kg^{-1}$ body mass per day (approximate intake of 214 mg per day for a typical 70 kg male) (17).

Table 3.1: The caffeine content of some common beverages and foods [adapted from Gray, 1998 (14) and MAFF Food Surveillance Information Sheet no. 144, 1998 (18)]

Source of Caffeine	Caffeine Content	
	mg (range) in a typical serving	mg.l^{-1} (range)
***Average content in a standard 150 ml cup**		
Instant coffee	43.2 (31.5-51.0)	288 (210-340)
Filter and percolated coffee	27.0 (15.8-32.3)	180 (105-215)
Decaffeinated instant coffee	1.6 (0.5-2.0)	10.7 (3.3-13.3)
Tea – bag brewed	48.9 (36.8-64.5)	326 (245-430)
Tea – loose brewed	15.3 (14.3-15.8)	102 (95-105)
Tea – instant	27.5 (26.3-29.6)	183 (175-197)
Average content per 330 ml can		
Coca-Cola	30.7	93
Diet Coke	41.9	127
Pepsi	35.0	106
Pepsi Max	38.0	115
Diet Pepsi	33.3	101
Average content per 250 ml can		
American Bull	80.0	320
Dynamite	80.0	320
Indigo Extra	62.5	250
Jolt Cola	213.0	852
Lipovitan B3	50.0	200
Red Bull	80.0	320
Shark Energy Drink	75.0	300
Spiked Silver	80.0	320
V	80.0	320
Average content per typical 30 g		
Milk chocolate	5.5	183
Plain chocolate	10.2	340
White chocolate	Not detected	Not detected

* Tea and coffee infusions were prepared according to a standard method involving 200 ml of boiling water and either 1.6 g (1 teaspoonful) of loose tea or instant coffee, 2.6 g (1 dessertspoonful) of filtered or percolated coffee or one tea bag. Loose and bagged teas were allowed to brew for 5 minutes without stirring, while percolated coffees were prepared by refluxing the coffee under simulated percolated conditions for 10 minutes. Filter coffees were prepared using a domestic coffee filter apparatus (18).

3.2.3 Caffeine metabolism

About 90% of the caffeine contained in a cup of coffee is cleared from the stomach within 20 minutes of ingestion (19). The caffeine is absorbed from the gut and does not accumulate in the body before being rapidly metabolised by the liver and eliminated (14). In adults, caffeine is virtually completely metabolised in the liver to its three dimethylxanthine metabolites, paraxanthine (1,7-dimethylxanthine), theobromine (3,7-dimethylxanthine) and theophylline (1,3-dimethylxanthine), with less than 2% of the ingested compound recoverable in the urine unmetabolised (19).

The average plasma clearance half-life of caffeine in an adult is approximately four hours, although it should be noted that there is wide individual variation in metabolism and estimates vary from two to ten hours (20). In adult males, the caffeine half-life is reduced by 30 – 50% in smokers compared with non-smokers, while the half-life is approximately doubled in women taking oral contraceptives (21). Pregnant women also experience increases in the half-life of caffeine (16). These variations in half-life mean that smokers, if habitual caffeine consumers, need to drink more caffeine in order to avoid withdrawal symptoms. Pregnant women, on the other hand, should drink less caffeine in order to avoid any side effects.

Caffeine has a wide range of pharmacological and psychological effects (22). The most significant effect is its role as a stimulant, acting on the central nervous system (CNS) releasing epinephrine and increasing the metabolic rate (14).

3.2.4 Potential effects of caffeine

The consumption of caffeine in its many forms is prevalent worldwide. The daily intake of caffeine in adults varies enormously, from approximately 220 mg per person per day in the Republic of Ireland (17) to greater than 400 mg per person per day in Sweden and Finland (21). Caffeine is a pharmacologically active substance and despite extensive research its effects and health consequences are ambiguous.

3.2.4.1 Behavioural effects of acute and chronic exposure to caffeine

Most studies on the behavioural effects of caffeine have examined acute responses following a single large dose. There have been fewer studies on the effects of habitual or chronic consumption.

Low doses of caffeine (20 – 200 mg per day) have been associated with effects on mood, such as feelings of increased energy, imagination, efficiency, self-confidence, alertness, motivation and concentration (22). While caffeine is reported to reduce reaction time during simple tasks, the effect is thought to be in speeding up performance rather than increasing mental activity (23, 24). It has also been reported that regular caffeine consumers, as compared with non-consumers, have improved cognitive performance (25).

The acute and chronic effects of caffeine on cognitive performance, mood, headache and sleep were reported in 1998 (26). In this study subjects reported feeling more alert and less tired following acute ingestion of caffeine, but feeling less alert with chronic exposure to caffeine. In addition, it was reported that there was no evidence that caffeine improved performance either in the context of acute or chronic use. Performance was found to be significantly impaired when subjects, who were habitual caffeine consumers, were caffeine depleted. It was also concluded that caffeine rather than enhancing actual performance in habitual caffeine consumers, merely restored performance to 'normal' levels (i.e. levels of performance achieved when subjects were free from caffeine for a protracted period) (26). This was confirmed in a further study (27).

3.2.4.2 Cardiovascular effects of caffeine

In spite of numerous studies investigating the link between caffeine and cardiovascular disease (CVD), the relationship between them remains uncertain.

It was reported that individuals who consumed coffee with a concentration of caffeine of 150 mg in 250 ml exhibited acute effects on aortic waveform, blood pressure and arterial stiffness compared with those

individuals who had consumed a decaffeinated beverage (28). The authors proposed that this observation may be an additional vascular mechanism for the hypertensive effect of caffeine. A number of researchers have shown that a single high dose of caffeine (4 – 6 $mg.kg^{-1}$ body mass, 300 – 400 mg for average 70 kg male) can cause tachycardia and increases in blood pressure (23, 29, 30).

The longer-term effects of caffeine on blood pressure have been studied in several large epidemiological studies. A meta-analysis of eleven clinical trials has reported an association between caffeine consumption and higher blood pressure (31). In a case-control study of 887 patients, an increased daytime systolic blood pressure in coffee drinkers compared with non-drinkers was reported (32). High-normal blood pressure is a recognised risk factor for CVD (33).

Conversely, it was reported in 1998 that habitual coffee drinkers had significantly lower blood pressure than non-drinkers at any levels of alcohol use, cigarette smoking, obesity and glucose intolerance (34). Similar findings were later reported (35, 36). Moreover, other studies have demonstrated no effect of caffeine on blood pressure (37, 38).

The relationship between caffeine consumption and myocardial infarction has also been examined. An increased risk of myocardial infarction with increasing coffee intake was demonstrated in a group of 858 Massachusetts women with a previous history of CVD (39). A study conducted in Finland in 2000 reported that coffee drinking does not increase the risk of CVD or death (40).

A follow up study to the Scottish Heart Health Study in 1999, found that male coffee consumers had a lower risk of heart disease compared with those who did not consume coffee, even after adjustment for known risk factors (41). However, the authors acknowledged that the apparent benefits of coffee might reflect inadequate adjustment for lifestyle differences between consumers and non-consumers, rather than a protective effect of caffeine *per se*.

In June 2000, ANZFA produced a 'Report from the Expert Working Group on the Safety Aspects of Dietary Caffeine' (42). In that report, the literature pertaining to the relationship between caffeine and CVD was reviewed. In relation to blood pressure effects, the report stated that results from long-term epidemiological studies were 'inconclusive' and that if a relationship did exist it was likely to be 'weak and clinically unimportant'. The report concluded that, based on the evidence published in the literature, there was little to substantiate the theory that caffeine intake at normal consumption levels contributed to hypertensive disease. However, one of the original members of the ANZFA working group produced a minority report in which it was stated that there was sufficient evidence to implicate caffeine in a number of health conditions, including CVD and increased blood pressure (43). The minority report concluded that habitual use of caffeine has no demonstrable benefits and that its consumption leads to physical dependence.

3.2.4.3 Caffeine and diuresis

The diuretic effect of caffeine is well known (17). In one study, marked diuresis and natriuresis in both older and younger hypertensive subjects was observed following a 250 mg dose of caffeine, the subjects having abstained from caffeine for 2 – 3 weeks prior to the study (44). Another study demonstrated an increase in diuresis, and urinary sodium and potassium excretion, within one hour of caffeine ingestion (45).

In a further study, twelve healthy volunteers were supplied with a standardised diet for two days. During the first day, fluid requirement was met by mineral water. On the following day the same amount of fluid was supplied but the mineral water was, in part, replaced by six cups of coffee containing 642 mg of caffeine in total. An increase in 24-hour urinary excretion and a corresponding negative fluid balance, with a concomitant decrease in body weight, was observed in the subjects (46).

3.2.5 Groups for special consideration

3.2.5.1 Caffeine and pregnancy

It has been suggested that caffeine consumption may affect individuals or sub-groups of the population, such as pregnant women and children, who are perceived to be more sensitive to caffeine than the normal population.

During pregnancy, most women consume caffeine from one source or another (16). One of the primary concerns regarding caffeine consumption during pregnancy is that the half-life of caffeine is increased threefold, from 4 – 6 hours (in the non-pregnant woman) to 18 hours late in pregnancy (16). This delay in caffeine metabolism and excretion results in prolonged exposure of both the woman and foetus to caffeine (47, 48). Caffeine and its metabolites cross the placenta freely (47, 49, 50), thus exposing the foetus to higher concentrations of caffeine.

In animal models, caffeine ingestion during pregnancy has been demonstrated to cause skeletal abnormalities, including cleft palate and delayed ossification (51), foetal growth retardation (52), and spontaneous abortion (53). However, the levels of caffeine used in these studies were higher than those normally consumed by the average pregnant human adult.

In humans, there is contradictory evidence in the literature with regard to the effects of caffeine on pregnancy outcome. Epidemiological studies have indicated adverse effects of caffeine consumption during human pregnancy at intakes of greater than 300 mg per day (16). These effects included spontaneous abortion (54-57) and low birth weight (54, 58-60). It has also been reported that caffeine consumption during pregnancy increases the risk of pre-term birth (61, 62).

However, to the contrary, studies in Finland and North America found no association between maternal coffee and caffeine consumption during human pregnancy and congenital malformations (63), while another report suggests no discernible adverse effects of caffeine on the foetus (64). There is also contradictory evidence on the effect of caffeine intake on birth weight and it has been suggested that there is no clear association between caffeine intake and spontaneous abortion, delayed conception, pre-term delivery or congenital malformation (7).

In October 2001, having considered the available scientific evidence, the UK COT issued a statement on the effects of caffeine on reproduction (16). In its conclusions, the Committee suggested that there was sufficient evidence from research with experimental animals and from human epidemiological studies, to suggest that caffeine intakes above 300 mg per day showed a 'plausible' association with low birth weight and spontaneous abortion. On the basis of this review, in October 2001 the FSA in the UK advised that pregnant women limit their daily intake of caffeine to 300 mg per day (65).

This recommendation is similar to those currently in place for caffeine intake during pregnancy (7). In the Republic of Ireland the FSAI recommends that excess consumption of caffeine (in excess of 300 mg per day) during pregnancy should be discouraged (66).

3.2.5.2 Caffeine and children

There are conflicting data on the effects of caffeine in children. Caffeine (3 – 5 $mg.kg^{-1}$ body mass) was reported to have small and inconsistent effects on the classroom behaviour of pre-school children (3 – 5 years) (67). At levels in excess of 3 $mg.kg^{-1}$ body mass, caffeine appeared to cause subjective effects such as nervousness, jitteriness, stomach aches and nausea in children who normally consumed little caffeine (68). Withdrawal symptoms have been reported in children following exposure to levels of caffeine of 120 – 145 mg per day, equivalent to 3 – 4 cans of a cola drink (69).

A further study reported that following caffeine ingestion (2.5 and 5.0 $mg.kg^{-1}$ body mass) performances on attention and motor task tests were enhanced and children described feeling less 'sluggish' but somewhat more anxious (70).

3.2.5.3 Caffeine and individuals with caffeine sensitivity

References are frequently made to individuals who are described as being 'sensitive to caffeine'. There is no strict medical definition of this condition and in most cases the condition itself is often self-diagnosed and highly subjective. However, the condition is recognised among health professionals.

3.2.6 Drug interactions and caffeine

3.2.6.1 Caffeine and alcohol

Traditionally, coffee drinking has followed alcohol intake owing to the widespread belief that it ameliorates the intoxicating effects of alcohol and thus has a potential sobering effect.

The acute behavioural and cardiac effects of alcohol and caffeine, administered alone and in combination, have been assessed in humans (71). Alcohol administered alone showed increased heart rate, decreased blood pressure, disrupted response to behavioural tests and increased subject ratings of drunkenness. Caffeine administered alone increased blood pressure. However, when given in combination with alcohol, caffeine partially decreased the disruptive behavioural effects of alcohol. By contrast, this combination did not significantly alter breath alcohol levels or heart rate levels relative to the effects of each compound alone. The authors suggested that caffeine did not actually enhance performance effects, but rather offset the deterioration in performance effects observed for alcohol (71).

In another study the effect of a single dose of caffeine (200 or 400 mg) on alcohol-induced driving impairment was examined (72). Caffeine appeared to increase alertness and improve reaction time after alcohol-induced consumption in a laboratory environment. However, caffeine did not completely counteract alcohol impairment in the driver.

3.2.6.2 Caffeine consumption and tobacco

There is a strong interrelationship between coffee consumption and smoking with 86.4% of smokers consuming coffee compared with 77.2% of non-smokers (73).

It has been proposed that concomitant smoking and caffeine consumption is associated with a number of cancers including ovarian cancer amongst premenopausal women (74). Several studies have investigated the role of tobacco smoking and coffee consumption in pancreatic cancer. However, while tobacco smoke alone is positively correlated with the disease, caffeine consumption does not affect this relationship (75, 76).

3.2.6.3 Caffeine and analgesics and other prescription medicines

Caffeine has a variety of effects when combined with medicines. Caffeine has been reported to enhance the effect of certain analgesics, including ibuprofen (77). Conversely, it has been shown to reduce the effectiveness of tranquillisers such as benzodiazepines (78).

A reduction in caffeine intake is advised for those individuals prescribed certain antibiotics, for example quinolones, since these drugs may inhibit the elimination of caffeine from the body (79).

3.2.6.4 Caffeine and recreational drugs

Caffeine, as a competitive antagonist of adenosine receptors, has been shown to enhance dopaminergic activity (80). The subjective and behavioural effects produced by caffeine in humans (enhanced sense of well-being, delayed sleep, increased energy) are similar to those of some typical psychomotor stimulant drugs whose effects may also be mediated by interference with dopaminergic pathways.

In a recent study of the acute and chronic effects of MDMA (3-4 methylenedioxymethamphetamine or Ecstasy) in rats, the possible interactions of caffeine and MDMA were examined (81). Caffeine (5 mg.kg body mass^{-1}) exacerbated the acute hyperthermic response to MDMA and tended to increase the loss of serotonin (forebrain 5-HT or hydroxytryptamine)

and 5-HIAA (5-hydroxyindoleacetic acid). Thus, caffeine may aggravate the hyperthermic and neurotoxic effects of MDMA, possibly through a mechanism involving dopamine release. It was also found that higher doses of caffeine (10 and 20 $mg.kg^{-1}$ body mass) when co-administered with MDMA (20 $mg.kg^{-1}$ body mass) had lethal effects in experimental animals.

These results suggest that caffeine enhances the effects of MDMA and could possibly exacerbate dehydration due to separate diuretic effects.

3.2.7 Caffeine – summary

Caffeine is one of the main active ingredients found in stimulant drinks and the content per serving of these products (60 to 80 mg per 250 ml can) tends to be higher than that of other caffeinated beverages at similar volumes (Tables 2.1 and 3.1).

The use of caffeine in its many forms is universal. However, in spite of extensive research, the evidence with regard to the health implications of the ingredient remains inconclusive.

High acute intakes of caffeine (4 – 6 $mg.kg^{-1}$ body mass, 300 – 400 mg for average 70 kg male) are associated with tachycardia and acute increases in blood pressure. The longer-term risks, or indeed possible benefits, of caffeine in relation to CVD are less clear. The evidence for an association of habitual caffeine intake with increased blood pressure is conflicting. Increased blood pressure is a known risk factor for heart disease and stroke, and individuals with high blood pressure are generally advised to reduce their caffeine consumption.

The possible adverse effects of increased caffeine on pregnancy have recently been reviewed by the COT in the UK. On the basis of a possible association of high caffeine intake (in excess of 300 mg per day) with low birth weight and spontaneous abortion, the FSA in the UK recommend that pregnant women should limit their daily intake of caffeine to 300 mg (equivalent to about four average cups of coffee, six average cups of tea, eight cans of regular soft drink or four cans of stimulant drinks). The FSAI makes a similar recommendation.

In children single doses of caffeine up to 10 $mg.kg^{-1}$ body mass have been shown to have either no effect or small, inconsistent effects on mood, behavioural, cognitive and motor functions. Some of the effects may be interpreted as being beneficial. However, some studies have indicated that a dose of 5 $mg.kg^{-1}$ body mass (equivalent to 150 mg caffeine per day, 4 – 5 cans of a cola drink, for a 10 year-old, 30 kg child) increased arousal, irritability, nervousness or anxiety in some children, particularly if they were normally low consumers of caffeine.

Caffeine has been shown to partially ameliorate the effects of alcohol but enhance the effect of psychomotor stimulant drugs. As stimulant drinks are commonly consumed with alcohol and in social settings, these combined effects may be of significance when considering the effects of stimulant drinks in their contextual settings.

3.3 Guarana

3.3.1 Introduction

Guarana, a native South American plant, contains guaranine, a substance chemically similar to caffeine with comparable stimulant effects. Guarana (*Paullinia cupana*) is often added to stimulant drinks, either in combination with caffeine or on its own.

3.3.2 Sources of guarana

Guarana, a berry that grows in Venezuela and the northern parts of Brazil, is used in drinks that contain extract from the crushed guarana seeds and are commonly consumed in Brazil. The use of guarana as an ingredient in beverages is becoming increasingly more popular in Europe, particularly in energy or stimulant drinks.

The stimulant effect of guarana is related to its caffeine content; one gram of guarana contains as much caffeine (40 mg) as a medium strength cup of coffee (12). The precise source and nature of the stimulant activity of guarana is not well understood. However, it has been reported that guarana exerts a more prolonged effect than an equivalent amount of caffeine, even though the

stimulant action has been attributed to the presence of caffeine. This effect is thought to be owing to the complexing of caffeine with condensed tannins in guarana and to the presence of fats and saponins in the seeds. This may affect the solubility and absorption of caffeine in the gastrointestinal tract (82). In determining the overall caffeine content of a beverage, the guarana content must be taken into account along with the caffeine content.

3.3.3 Potential effects of guarana

The physiological effects of guarana may be attributed to its caffeine content and hence many of the observed consequences of guarana consumption will be similar to those discussed in the previous section on caffeine.

A review of the literature indicates that guarana is often used in conjunction with other herbal preparations such as yerba matte and ma huang as a weight loss agent in humans (83, 84). Results from these studies have shown these preparations to be effective, however, the authors acknowledge that the effects of long-term use of these substances are not known.

Suspected caffeine and ephedrine toxicity in dogs following supplementation with guarana and ma huang has been reported (85). The dogs were given guarana in the range of 4.4 – 296.2 $mg.kg^{-1}$ body mass and the symptoms observed ranged from vomiting and tachycardia, to death. The minimum dose at which death was reported was 19.1 mg $guarana.kg^{-1}$ body mass. Conversely, a study in 1998 reported that guarana was non-toxic in laboratory animals after acute administration at high doses (1 – 2 $kg.kg^{-1}$ body mass) and chronic treatment with lower doses (86). There is also some evidence that guarana may inhibit platelet aggregation in mammalian blood although the research is limited (87).

In 2001, the death of an Australian woman following consumption of a guarana-containing health drink product was reported (88). The caffeine concentration in the bottle of 'Race 2003 Energy Blast' (55 ml) was subsequently determined to be 10 $g.l^{-1}$ (equivalent to 35 cups of coffee). The woman, who had an underlying cardiac abnormality, mitral valve prolapse, had been previously advised by her doctor to reduce her daily caffeine intake, and on the day of her death had consumed only the guarana health drink. This report recommended that more careful regulation, including appropriate labelling of so-called natural or herbal products, was warranted.

In May 2001, the FDA in the USA informed manufacturers of foods and drinks containing guarana and other herbal substances including echinachea and ginseng, that the use of these herbs in food products was no longer permitted, forcing the withdrawal of a number of stimulant drink products from the USA market (89). The withdrawal of these products was based on USA legislation that states that manufacturers must prove that all ingredients are safe for use in foods, even if they have received prior approval for medical use. The manufacturers of the products involved will now have to produce scientific evidence to the FDA that their products are safe.

The FSA in the UK has asked the EU to investigate the use of guarana, and other herbs, as stimulants and flavourings in stimulant drinks.

3.3.4 Guarana – summary

There is very little information in the literature with regard to the effects of guarana, although it is conceivable that products high in guarana will have similar physiological and behavioural effects as caffeine.

It is highly likely that the majority of the public do not realise that guarana containing products are in fact high in caffeine. This is of concern particularly to those individuals who may be caffeine sensitive and adequate labelling of guarana containing products is, therefore, essential. Since the release and uptake of caffeine from guarana is the same as for preparations containing free caffeine (90), it is clear that the guarana content of drinks must be taken into account when estimating total caffeine.

3.4 Taurine

3.4.1 Introduction

Taurine (2-amino ethanesulphonic acid) is added to stimulant drinks at concentrations in the range of 2000 – 4000 $mg.l^{-1}$ (Table 2.1). It is naturally present in the diet and is a normal metabolite in humans, being synthesised in the body from the amino acid cysteine, or other sulphur or cysteine containing compounds.

3.4.2 Sources of taurine

Taurine is sometimes referred to as a 'conditionally essential' amino acid in adults based on evidence which indicates that in times of severe stress, such as during intense physical exercise, the stores of the amino acid become depleted. However, under normal physiological circumstances, taurine is very highly conserved in the adult human body and is present in large quantities (91). Indeed, it has been estimated that a 70 kg human is likely to contain up to 70 g of taurine (91, 92). The mean daily intake of taurine from the diet is estimated to be approximately 400 mg per day (7), with sea fish and red meat being the richest sources.

Taurine is thought to play an extensive role in numerous physiological processes, including the formation of bile salts, and modulation of calcium flux and neuronal excitability (92). The physiological roles of taurine are summarised in Table 3.2.

In adult humans, taurine can be synthesised within the body but, as outlined above, may also be obtained from the diet, particularly from meats and fish (17). Unlike most other amino acids, it is not used in protein synthesis in the human body, but is found mostly as the free amino acid or as simple peptides, dissolved in the cytosol and bound to cell membranes (91). It occurs in high concentrations in skeletal muscle, cardiac muscle, retinal tissues, the central nervous system (CNS) and the brain, white blood cells and platelets. Taurine is also considered to be essential for normal development of human infants and consequently, several manufacturers add taurine to infant feeding formulae (91, 92).

3.4.3 Potential effects of taurine

A review of the literature indicates that many of the putative functions of taurine appear to be physiologically beneficial (Table 3.3). However, there are some limited data to suggest that, under certain conditions, exposure of cells or human embryos to very high concentrations of taurine may be harmful (94, 95). It is unlikely that these findings will have any relevance to humans consuming taurine by the oral route.

A search of the literature shows little evidence to suggest that taurine is a risk to human health. However, there are no published studies of the effects of high intakes of taurine in healthy adults, and no studies at all in children or adolescents. The available published toxicological data for humans are summarised in Table 3.3. These studies have been carried out in adults who were undergoing experimental treatment for defined medical disorders.

Table 3.2 Putative physiological functions of taurine [adapted from Huxtable (91) and Bkaily et al. (93)]

System	Action
Cardiovascular	Antiarrhythmic properties Hypotensive action Modulation of calcium channel action Retardation of lesion development in calcium overload cardiomyopathy Increase resistance of platelets to aggregation Positive inotropic effect in heart muscle Protection against calcium overload in hypoxic injury
Central nervous system	Anti-convulsant properties Modulator of neuronal excitability Maintenance of cerebellar function Thermoregulation Anti-aggressive actions Central regulation of cardiorespiratory responses Alteration to sleeping duration Resistance to anoxia/hypoxia Altered motor behaviour Anti-tremor actions Suppression of eating and drinking
Retina	Maintenance of structure and functions
Liver	Bile salt synthesis
Reproductive system	Sperm motility
Muscle	Membrane stability
Others	Modulator of neurotransmitters and hormones Osmoregulation Stimulation of glycolysis and glycogenesis Antioxidant effects Attenuation of hypercholesterolaemia Cell proliferation and viability Conjugation of xenobiotics prior to excretion

There are some data to suggest that taurine may mitigate against some of the adverse consequences of ethanol consumption, and as such, may possibly encourage greater alcohol intake (100).

Taurine, when consumed with alcohol, has been shown to reduce sleep-time in mice (101-103). However, there are no studies of the effects of ethanol with concomitant taurine intake on sleep time in human subjects. Changes in locomotor activity following alcohol consumption and supplementation with taurine have also been demonstrated in laboratory animals (104, 105).

Alcohol has a negative effect on taurine homeostasis in humans. Chronic alcohol abusers were reported to have significant increases in plasma taurine concentration seven days following withdrawal from alcohol. Furthermore, an oral dose of ethanol (0.8 $g.kg^{-1}$ body mass) decreased plasma taurine content 90 minutes after administration (106).

Table 3.3 Summary of taurine toxicity studies in humans [adapted from the ANZFA Full Assessment Report and Regulation Impact Assessment. Application A349 Formulated Caffeinated Beverages (11)]

Reference	Dose	Toxicological endpoint
Ikeda (1977) (96)	3000 mg per day (3 x 1000 mg per day) for 7 days in patients undergoing alcohol withdrawal	Fewer psychotic episodes in patients who were supplemented with taurine compared with non-supplemented controls. No evidence of adverse effects
Mantovani and DeVivo (1977) (97)	Single doses of 375 mg per day to 8000 mg per day in epileptic adults	No evidence of adverse effects
Franconi et al. (1985) (98)	1500 mg per day for 90 days in adults with and without insulin dependent diabetes mellitus	No evidence of adverse effects
Kendler (1989) (99)	3000 mg or 6000 mg per day for 6 weeks in adult patients with mild hypertension	Decreased blood pressure in hypertensives No evidence of adverse effects

3.4.4 Taurine – summary

Taurine is an amino acid and its main function in the human body is in the synthesis of bile salts. In addition, taurine can conjugate with various xenobiotics and aid in their excretion. While some animals, such as the cat, require taurine in the diet, humans synthesise adequate supplies of taurine and do not rely on dietary sources.

Taurine has been shown to have beneficial health effects, including decreasing blood pressure. A thorough search of the literature revealed no published studies of any negative physiological effects of high intakes of taurine in healthy adults.

There are no studies of the effects of taurine supplementation in adult humans and, apart from some papers discussing the effects of the consumption of stimulant drinks (3), there are few studies on the interactions of taurine with other ingredients contained in stimulant drinks (such as caffeine and glucuronolactone) or with substances such as alcohol or drugs. While it is not possible to extrapolate results of animal studies to the human condition, the interactions of taurine and alcohol are particularly pertinent in light of the evidence that stimulant drinks are regularly consumed with alcohol (Chapters 5 and 6). Further investigations in humans are required.

3.5 Glucuronolactone

3.5.1 Introduction

Glucuronolactone is a naturally occurring metabolite formed from glucose. Not all stimulant drinks contain glucuronolactone (Table 2.1), however, the concentration when present ranges from 250 to 2500 $mg.l^{-1}$.

3.5.2 Sources of glucuronolactone

Glucuronolactone is only found naturally in a small number of foods, of which wine is the richest natural source. It has been reported, based on USA estimates, that consumers of two 250 ml cans of stimulant drinks containing 2400 $mg.l^{-1}$ could exceed glucuronolactone intake from other food sources by up to 500-fold (7).

At physiological pH, glucuronolactone is in equilibrium with glucuronic acid, its immediate precursor. Animals, including rats and mice, which synthesise vitamin C, do so by converting glucuronic acid, either to gulonic acid or to glucuronolactone, then to gulonolactone, and finally to ascorbic acid. These animals can also convert orally administered glucuronolactone to vitamin C (107). As humans do not possess the metabolic pathway to synthesise vitamin C, rats and mice are unsuitable models for the study of the effects of glucuronolactone in man.

3.5.3 Potential effects of glucuronolactone

There has been little research examining the effects of glucuronolactone in humans. The available data indicate that when glucuronolactone is administered orally to humans it is rapidly absorbed, metabolised and excreted as glucaric acid, xylitol and L-xylulose (108).

A number of animal studies using rat, mouse and dog models have examined the metabolism of glucuronolactone. However, given that the metabolic pathway of glucaric acid in these animals is markedly different from that in humans, the relevance of such studies to human glucuronolactone metabolism is unknown.

Some toxicity studies have been carried out in animal models. The SCF report in 1999 concluded the following:

> "*The available toxicity studies are extremely limited. Acute toxicity studies have been carried out in rat, mouse, dog, rabbit and cat by oral, intravenous, intraperitoneal and subcutaneous routes. It* [glucuronolactone] *is of low acute toxicity, with the oral route being the least toxic*" (7).

The effect of glucuronolactone supplementation on rat longevity has been examined (109). The study was designed to test the hypothesis that, as an inhibitor of ß-glucuronidase, glucuronolactone would increase longevity by increasing the rate of excretion of xenobiotics as glucuronides. Administration of glucuronolactone in drinking water had no effect on fluid intake, bodyweight, time of death, or cause of death as determined by autopsy.

The effect of glucuronolactone on the biochemical changes produced in rats during exercise has also been examined (110). The study concluded that glucuronolactone inhibited the synthesis of a number of undesirable metabolites formed as a result of intensive exercise. It also prevented a decrease in blood sugar levels and in hepatic glycogen while increasing the length of time that the rats exercised before exhaustion.

3.5.4 Glucuronolactone - summary

The intake of glucuronolactone from consumption of some stimulant drinks may be much greater than that from the rest of the diet and there appears to be little or no information available for risk assessment of glucuronolactone at these levels in humans. Furthermore, the only study in which high levels of glucuronolactone have been added to the diet is in the rat model. Since rats and mice metabolise glucuronolactone differently from humans, toxicity studies using a more suitable model, such as the guinea pig, are warranted.

There is no information available on the possible interaction of glucuronolactone and alcohol metabolism.

‘There is little evidence to suggest that taurine is a risk to human health. However, there are no published studies of high intakes of taurine in healthy adults, and no studies at all in children or adolescents’.

‘Stimulant drinks are associated, and actively promoted, in sporting contexts. They are not, however, suitable for use as rehydration drinks in association with sport or exercise.’

Chapter 4
Effects of the Combined Ingredients of Stimulant Drinks

4.1 Introduction

Extensive research has been carried out on the health effects of some of the individual ingredients of stimulant drink products, such as caffeine. However, an examination of the literature reveals limited studies of the combined effects of these ingredients, or their combined effects under the circumstances in which they are consumed. Of the studies that have been conducted, the performance effects only of consumption of stimulant drinks have been examined (3). Qualitative research conducted for the purposes of this report confirms that the public has a number of concerns regarding the possible adverse health effects of stimulant drinks (Chapter 5).

4.2 Physiological Effects of Stimulant Drinks under the Circumstances in which they are Consumed

4.2.1 Sport

Stimulant drinks are promoted in such a way as to suggest that they may be beneficial to individuals partaking in active pursuits. Certain stimulant drink products are advertised overtly in sporting environments or with sporting overtures (Chapter 7).

The main ingredients in stimulant drinks purported to influence body physiology during sport are caffeine and carbohydrate.

4.2.1.1 Caffeine during exercise

The use of caffeine in sport is a contentious issue. IOC considers that a urinary concentration of caffeine of 12 $mg.l^{-1}$ in urine represents a positive drug test. However, caffeine is shown to have performance-enhancing effects at concentrations that would result in urinary excretion below 12 $mg.l^{-1}$ as set by the IOC (111).

Caffeine is reported to be most beneficial in endurance-type exercise activities (i.e. activities lasting more than 30 minutes). The physiological bases of the performance-enhancing effects of caffeine are not known. Many theories have been put forward including, a possible increase in circulating adrenaline and/or sympathetic nervous activity. One theory proposes that caffeine influences adipose tissue metabolism. This results in an increase in the plasma concentration and subsequent uptake by, and oxidation of, free fatty acids leading to a reduction in the rate of glycogen use in skeletal muscle. Another putative mechanism for caffeine action is the creation of a more favourable intracellular ionic environment facilitating the development of a contractile force in muscle (111).

A sports person using caffeine as an ergogenic aid would typically consumer 4 – 5 $mg.kg^{-1}$ body mass of caffeine (approximately 350 mg of caffeine, equivalent to 4 cans of a typical stimulant drink) 60 – 90 minutes prior to the event. This allows time for the caffeine to be absorbed into the circulation and reach an effective concentration in the blood. At this level of intake, caffeine acts as a diuretic. Adequate fluid intake is recommended to offset potential dehydration (112).

Caffeine-induced diuresis during exercise may result in excessive fluid and electrolyte loss, a decrease in plasma volume and reduced ability to thermoregulate leading to a higher body temperature (112). There are, however, some reports which suggest that urine volume, sweat loss, plasma volume, nor core temperature is altered during exercise following caffeine ingestion (113, 114), although these results remain unconfirmed.

Given the limited information on the diuretic effects of stimulant drinks, it is the view of the Committee that in the immediate period following physical exercise, caffeine-containing stimulant drinks are not suitable as an oral rehydration aid.

4.2.1.2 Carbohydrate during exercise

It has been established that the ingestion of a carbohydrate-containing beverage during exercise can maintain blood glucose levels, and the required carbohydrate oxidation, to sustain high-intensity exercise performance (112).

Pre-exercise consumption of a fluid beverage designed to enhance sports performance is not straightforward. Taken 40 minutes prior to exercise, the ingestion of a beverage containing 40 g of a simple carbohydrate (250 ml of stimulant drink contains approximately 30 g of carbohydrate, Table 2.1), invokes a rapid decrease in blood glucose to hypoglycaemic levels and a higher rate of glycogen utilisation during exercise, thereby decreasing the exercise output. The same quantity of carbohydrate beverage consumed only five minutes prior to exercise has little, if any, effect on blood glucose or glycogen utilisation and increases the total amount of work performed (115).

Carbohydrate feeding during exercise is acknowledged to be beneficial to sports performance (116). The consumption of a stimulant drink could provide a readily available source of energy intake in the form of carbohydrate (400 kJ per 250 ml serving of a typical stimulant drink) during exercise. However, it is important to note that high carbohydrate beverages, such as stimulant drinks, are hypertonic to blood plasma and the majority of body fluids and will thereby decrease the rate of gastric emptying and induce a net secretion of water from the body into the upper part of the small intestine prior to absorption. This removal of body water is, in effect, a form of dehydration and the resultant increase in intestinal water may lead to gastrointestinal disturbance and discomfort (112). In general, isotonic or sports beverages contain a carbohydrate concentration isotonic with respect to blood plasma and do not elicit these effects and are, therefore, promoted as effective modes of carbohydrate delivery.

In recovery from exercise, there is a two-phase restoration of body glycogen stores. Glycogen resynthesis occurs most rapidly within the first six hours, provided carbohydrate is consumed at a rate of 1 $g.kg^{-1}$ body mass every two hours during this period. If the replenishment of body glycogen post-exercise were the intended use for stimulant drinks, for an adult person weighing 75 kg, this would be equivalent to the consumption of approximately 750 ml of a stimulant drink (equivalent to three 250 ml cans) every two hours (112). However, as noted in section 4.2.1.1, the large intake of caffeine contained in a typical stimulant drink (equivalent to approximately 3.2 $mg.kg^{-1}$ body mass every two hours) would probably have a negative effect on the restoration of fluid balance and therefore the use of stimulant drinks for this purpose would not be recommended (112).

4.2.1.3 Interaction between caffeine and carbohydrate upon exercise performance

Reviews of the effect of caffeine upon exercise performance show the performance-enhancing effect of caffeine to be highly variable (111, 117). However, a limited number of studies have evaluated the interaction between caffeine and carbohydrate or the performance-enhancing effect of a caffeine-containing carbohydrate beverage. In one study, the addition of caffeine to a carbohydrate-containing solution was found to have a positive effect on performance during a high intensity cycle exercise lasting approximately one hour (118). These data reveal that, when combined with carbohydrate, relatively low doses of caffeine can enhance endurance-exercise performance.

4.2.1.4 Stimulant drinks and exercise

The effect of a stimulant drink on performance in endurance athletes has been examined in a number of limited small-scale studies, many of which have received endorsement from the manufacturer of a stimulant drink product. These studies suggest an improved performance following consumption of stimulant drinks (119, 120).

In one randomised crossover study, subjects were given either a drink containing: carbohydrate and caffeine, but without taurine and glucuronolactone;

carbohydrate but without taurine, glucuronolactone, or caffeine; or carbohydrate with taurine, glucuronolactone and caffeine (119). The results showed a significant increase in performance during exercise in the group receiving the taurine containing drink. The recipients of the taurine containing drinks also demonstrated lower heart rates and catecholamine levels resulting in prolonged exercise endurance, which was observed up to 24 hours later (119).

Another study investigated the parameters of cardiac contractility in 13 endurance-trained athletes following consumption of a stimulant drink containing: carbohydrate, caffeine and taurine; carbohydrate and caffeine but without taurine; and a placebo containing carbohydrate, but without caffeine and taurine (120). The results demonstrated an effect of the stimulant drink on cardiac parameters after exercise and the authors suggested that the observed effects might explain the improved performance and lower heart rate observed in previous studies (120).

4.2.2 Social context

Quantitative and qualitative analyses (Chapters 6 and 7) indicate that stimulant drinks are widely consumed in social settings such as in public houses and clubs, both on their own but mainly with alcohol.

4.2.2.1 Alcohol

The physiological and pharmacological effects of combined caffeine and alcohol were previously discussed in section 3.2.6 of this report.

There is considerable concern that the consumption of alcohol and stimulant drinks may cause transient behavioural effects, including increased aggression, as well as increasing the ability of individuals to drink alcohol for longer periods of time (Chapter 5). The latter effect in itself is a cause of concern as this may result in individuals consuming larger quantities of alcohol. A search of the literature revealed no information with regard to any published reports of the health effects of the concomitant consumption of stimulant drinks and alcohol.

The above concerns are supported by findings from the qualitative analysis discussed in more detail in Chapter 5. This analysis revealed that parents of consumers perceived that stimulant drinks encouraged greater consumption of alcohol. In recent years, the increase in street violence has been associated with an increased consumption of alcohol. These concerns have led to the establishment of an inquiry within the Department of Justice, Equality and Law Reform in the Republic of Ireland. The Commission on Liquor Licensing is currently continuing with its deliberations (121).

In summer 2001, the Swedish National Food Authority recommended that stimulant drinks should not be consumed with alcohol. This recommendation followed the death of a young woman from arrhythmia who had, reportedly, consumed a number of stimulant drinks with alcohol (122). The Swedish authorities are currently carrying out a further examination of the effects of stimulant drinks and alcohol.

4.2.2.2 Recreational drugs

Stimulant drinks may be used in the 'club' scene where drugs, including 'recreational' drugs (Ecstasy (MDMA) and cocaine) may also be used. Thus, the Committee considered it necessary to investigate any link between stimulant drinks and recreational drugs. The interaction of caffeine and drugs, including recreational drugs, has been previously discussed in section 3.2.6.

While it may not be possible to directly extrapolate research on animals to humans, the evidence shows enhanced toxicity of MDMA when co-administered with caffeine (81). This may give cause for further concern where stimulant drinks are being consumed with drugs of abuse, especially amphetamine-like drugs.

4.3 Behavioural/Performance Effects of Stimulant Drinks

As already mentioned, there are little published data in the literature on the behavioural and performance effects of stimulant drinks.

In a study of the effect of a stimulant drink on cognitive performance in humans, no effect on reaction time in males was observed while females exhibited a small improvement in reaction time following ingestion of the stimulant drink (250 ml or one can) compared with a placebo (123).
It has also been reported that a stimulant drink significantly improved concentration, reaction time, memory, mood, as well as aerobic and anaerobic endurance (124).

The effect of a stimulant drink on driving performance has been investigated (125, 126).
In the latter study, the researchers examined reaction time and sleepiness in 12 sleep-deprived individuals participating in a simulated highway driving experiment. Among the control subjects, sleepiness was particularly evident 30 – 60 minutes into a two-hour drive. However, subjects who had consumed the drink (500 ml, equivalent to two cans), showed a significant reduction in lane drift and also demonstrated improved reaction time (126).

In 2001, 'mania' associated with a stimulant drink was reported in a letter to the Canadian Journal of Psychiatry (127). In this letter, the authors suggested that stimulant drinks might be associated with pathological mood and behavioural changes in vulnerable patients such as those with bipolar illnesses. These observations followed a report of increased euphoria, hyperactivity and insomnia in a patient suffering from bipolar disorder who had consumed three cans of a stimulant drink.

4.4 Acute Physiological Effects of Stimulant Drinks

There is particular concern that some individuals who may have increased sensitivity to the ingredients of stimulant drinks, particularly caffeine, may have an acute physiological response on consuming the products.

While there are no reports in the literature regarding the adverse physiological effects of the combined ingredients of stimulant drinks, one recent study examined the effect of a stimulant drink on blood pressure and arterial stiffness in a laboratory setting (128). The stimulant drink (500 ml, equivalent to two cans) was administered to eight healthy volunteers and blood pressure and heart rate were monitored over the course of a two-hour period. By observing arterial stiffness via pulse wave velocity, the authors suggested that the stimulant drink had a dual action on the cardiovascular system, with taurine having a vasodilatory effect in addition to the known vasoconstrictor effect of caffeine. They concluded from their data that the stimulant drink had acute cardiovascular effects.

While this is the only study in the literature that specifically looks at the possible adverse health effects of a stimulant drink, the study design did not provide for a control or placebo being incorporated into the research. In considering the physiological effects of stimulant drinks, cognisance must be given to the potential adverse effects of the individual ingredients as discussed in Chapter 3.

4.5 Summary

Peer reviewed studies on the physiological and behavioural effects of the combined ingredients of stimulant drinks are very limited and these areas require further study. Qualitative research suggests that consumption of these products is associated with effects such as disorientation, sleeplessness and increased heart rate.

While the consumption of stimulant drinks on their own is an issue, the context or circumstances under which they are consumed is also relevant.

Stimulant drinks are associated, and actively promoted, in sporting contexts. Caffeine can enhance performance in certain sports. However, stimulant drinks are not suitable for use as rehydration drinks in association with sport or exercise. Unlike isotonic sports drinks, stimulant drinks do not meet the recommended compositional requirements (with respect to osmolarity and concentrations of caffeine, carbohydrate and electrolytes). Little is known about the possible adverse effects on exercise performance and fluid balance during sport and exercise occurring from the interaction of the principal ingredients contained in stimulant drinks and further research is necessary.

Results of qualitative and quantitative analyses indicate that stimulant drinks are widely consumed as mixers for alcoholic beverages. There is little published information on the possible adverse health effect of stimulant drinks with alcohol, although there is concern that increased alcohol intake, in combination with stimulant drinks, may have behavioural effects. As they are regularly used in social settings, the possible adverse effects of the interaction of stimulant drinks with recreational drugs (e.g. Ecstasy) must also be considered.

‘The majority of participants in the groups perceived that the primary mode of consumption of stimulant drinks was with alcohol.’

Chapter 5
Consumer Perceptions

5.1 Introduction

In order to address consumer health concerns and perceptions with regard to stimulant drinks, a qualitative study of the attitudes of the public in relation to stimulant drinks was undertaken. The results of this analysis were then set in a social context of general lifestyle and drinking behaviour. A summary of the study is outlined below and the full text of the qualitative study can be obtained on the FSPB website at:
URL:*http://www.safefoodonline.com/publications/pubs.html*

5.2 Methodology

Focus groups were used in the research. Research took place in November 2001 and due to time restrictions all sessions were conducted in Dublin. Three groups of people were identified as being central to this issue:

- parents of young adults in the core target market (aged 18 - 24 years) who still resided in the parental home. Fathers and mothers of the economic groupings, ABC1, and mothers, CD2, were interviewed.
- consumers in the core target market (aged 18 – 24 years), ABC1 males and C1C2 females.
- young consumers under the age of the core target market (aged 12 – 15 years) were also included. In this case, five groups were interviewed: ABC1 males aged 12 & 13 years; C2D females aged 13 years; ABC1 males aged 14 & 15 years; C2D females aged 12 & 13 years and ABC1 females aged 15 years*.

5.3 Results

5.3.1 Concerns of parents of consumers

Parents acknowledged that their adult children have a short-term focus, living for today and not planning for the future, simultaneously spending their earnings on their social life.

Parents were aware of stimulant drinks and specific brands and generally held a negative view of them. The majority of parents had concerns about perceived health issues pertaining to stimulant drinks and had heard, and were able to recount, many anecdotes.

The main parental concern was the consumption of stimulant drinks with alcohol. Parents believed that stimulant drinks were not 'safe' when consumed with alcohol because they 'stimulated' the drinker unlike other available mixers, and also allowed for further alcohol consumption. Parents believed that stimulant drinks adversely affected how the alcohol was assimilated by the drinker, resulting in individuals who became drunk in a 'different way' to the norm.

Some parents expressed concern that consumption of stimulant drinks could lead to violence, while other parents stated that inability to sleep following consumption of stimulant drinks was a matter for concern.

5.3.2 Concerns of young adult consumers, 18 – 24 years

Among this age group, there is a strong drinking culture across gender and class. Drinking to excess, to the point of becoming drunk with reduced control, is at least a weekly event.

* *Social class definitions are based on the occupation of the main income earner in a household and are defined as follows:*
Grade A: Upper middle class, e.g. medical doctor, bank manager, university professor
Grade B: Middle class, e.g. college lecturer, pharmacist
Grade C1: Lower middle class, e.g. bank clerk, Garda sergeant
Grade C2: Skilled working class, e.g. carpenter, electrician
Grade D: Other working class, e.g. fisherman, milkman
Grade F: Farmer

The consumption of stimulant drinks had a stronger bias in the male group, who saw it as a socially acceptable way to drink vodka. None claimed it as their main drink, and most respondents claimed to drink it late into a drinking session rather than at the beginning. Most claimed to drink less stimulant drinks now than they had one year or eighteen months ago.

All participants in this age group expressed some level of concern about stimulant drinks. Consumers enjoyed the stimulatory effect of stimulant drinks particularly with alcohol. However, their enjoyment of the combination was less than that with other alcohol combinations. Their reported ability to enjoy stimulant drinks was affected by the background concerns of their being slightly dangerous and this was likely to curtail excessive consumption.

Consumers also expressed concern in relation to the caffeine content of the drinks. Some consumers reported the inability to sleep following consumption of stimulant drinks and this was seen as a negative attribute.

5.3.3 Concerns of young consumers

There were marked differences in the behaviour of the groups within this category according to age, gender and social class profiles, particularly in relation to personal freedom, alcohol consumption and stimulant drinks.

All young consumers were aware of stimulant drinks and a particular brand was mentioned frequently. Almost all of the groups reported having tried stimulant drinks. Young consumers perceived stimulant drinks to fill a gap between soft drinks and alcohol and found it attractive because they considered them to be slightly 'illicit' due to the stories they had heard and its close association with adult drinking.

5.4 Summary

The majority of participants in the groups perceived that the primary mode of consumption of stimulant drinks was with alcohol. However, both parents and consumers of stimulant drinks believed that the use of stimulant drinks with alcohol was no longer the 'trendy' drink that it had once been, although there remained a core group of consumers of stimulant drinks with alcohol. This group was male who tended to see stimulant drinks as a more credible mixer for vodka and other spirits.

The main concerns *vis à vis* stimulant drinks were its consumption with alcohol, the perceived 'high' caffeine content, and the sense of ambiguity and uncertainty about what the other ingredients were and how they affected the body. The uncertainty over what these ingredients were, or their effects, was also raised. Anecdotes also played a large part in moulding opinions and beliefs surrounding the drinks.

Parents were more actively concerned than consumers, the latter acknowledging the risks but continuing to drink the product. In general, there was a sense that stimulant drinks were no longer the 'must have' drink of the majority of young adults and with that, a perception that any health risks had diminished.

‘Parents were more actively concerned than consumers, the latter acknowledging the risks but continuing to drink the product.’

‘The average number of cans consumed by ‘ever’ consumers in a single session was three.’

Chapter 6
Studies of Consumption Levels and of Behaviour and Attitudes to Stimulant Drinks

6.1 Introduction

Results from the qualitative research into consumer perceptions indicated that stimulant drinks are widely consumed, mainly with alcohol, and by young males in particular. The Committee considered it necessary to establish the consumption patterns and levels of peak consumption of stimulant drinks being consumed on the island of Ireland before any further assessment could be made of the health effects of the drinks. To this end, a quantitative study was commissioned to establish consumption levels and intake patterns of stimulant drinks on the island.

6.2 Background

6.2.1 International studies

Quantitative analyses of the consumption patterns of stimulant drinks have been previously carried out. These include market research by *Red Bull* GmbH in Austria and independent research studies in Germany and Australia. Results from these analyses suggest that the consumption of stimulant drinks is prevalent among young people.

The German survey conducted in 1994, interviewed 1265 children and young adults between the ages of 10 and 19 years (129). Results indicated that 40% of children aged 10 – 13 years had tasted stimulant drinks, with 23% drinking on average one can (250 ml) of a stimulant drink per week. A survey conducted in Austria in 1999 on behalf of *Red Bull* GmbH, reported that 45% of respondents (15 - 50 years) had consumed one or more cans of Red Bull during the previous week (3). Use of stimulant drinks was higher in the younger age group (15 – 24 years) compared with the older group (25 – 50 years).

In Australia, 381 children and young adults between 8 and 18 years were surveyed (130). Twenty seven percent of males and 12% of females in the 8 – 13 year old category reported having tasted stimulant drinks. While these studies did not report any reasons for concern about the use of stimulant drinks nor about their health or behavioural effects, the Australian study noted that "healthcare professionals should be aware that children as young as 8 years consume these products".

None of the above surveys investigated the circumstances under which stimulant drinks were actually consumed, or the maximum number of stimulant drinks consumed on one occasion.

6.2.2 Consumption on the island of Ireland

The North/South Ireland Food Consumption Survey conducted 1997–2000 is an analysis of the food intake levels and consumption habits of the population on the island of Ireland (14). The survey used a 7-day estimated food record/diary in which all foods and drinks consumed by the respondents during the period were recorded.

Of 1379 individuals aged 18 – 64 years surveyed, only 19 respondents reported consuming stimulant drinks. Of those 19 subjects, 14 were male and 5 were female, and, with the exception of one male subject, all were aged 19 – 31 years (14). The median daily intake of the consumers was 0.29 cans per day. There was a large range of intake. The 5th percentile for consumers only was 0.04 cans per day, whereas the 95th percentile was one can per day. Although the weekly consumption figures appear relatively modest, they mask the fact that some subjects may have consumed large amounts over relatively short periods of time.

6.3 Survey of the Consumption patterns of Stimulant Drinks on the Island of Ireland

Against the above background, the Committee considered it necessary to establish current consumption patterns of stimulant drinks on the

island of Ireland and particularly the consumption behaviour of young children. The overall aim of the survey commissioned by the FSPB was to establish patterns of consumption of stimulant drinks in a representative sample of the population of Ireland, north and south, between the ages of 11 and 35 years.

The specific objectives of the research were to provide information on the frequency and pattern of use of stimulant drinks, the purpose of use, the environment of use and the relationship of stimulant drinks with alcohol.

An appropriate questionnaire was devised in conjunction with Lansdowne Market Research (Appendix I). A summary of the study is outlined below and the full text of the qualitative study can be obtained on the FSPB website at: URL:*http://www.safefoodonline.com/publications/pubs.html.*

6.3.1 Methodology

The survey was conducted as part of the Lansdowne Market Research Omnibus Questionnaire, which is run all year round on a fortnightly cycle. The Omnibus Survey involves face-to-face interview of 1200 participants in the Republic of Ireland and 1100 in Northern Ireland, aged 15 – 64 years (16 – 64 years in Northern Ireland).

In order to obtain consumption data on stimulant drinks among children, booster samples of 200 children in the Republic of Ireland (11 – 14 years) and 200 children in Northern Ireland (11 –15 years) were included. Participants in the Omnibus Survey over the age of 35 years were not included in the stimulant drinks survey.

Owing to self-imposed restrictions within the market research industry, questions with regard to alcohol and alcohol consumption were only asked of those respondents over the age of 18 years.

The fieldwork for the survey was conducted in July 2001.

6.3.2 Results

6.3.2.1 Overall demographics of survey

A total of 1260 individuals were surveyed regarding their stimulant drink consumption and respondents were equally distributed among social class and gender. Details of the demographics of the survey respondents are shown in Appendices II and III.

6.3.2.2 Frequency of drinking

The number of respondents who claimed to have 'ever'* consumed or were 'regular'* consumers of stimulant drinks was quite a small number compared with those who had ever or regularly consumed soft or 'fizzy' drinks (Tables 6.1 and 6.2).

When asked, 51% of respondents in Northern Ireland reported having 'ever' consumed stimulant drinks, while 10% of respondents reported drinking stimulant drinks on a regular basis. These figures were 37% and 11%, respectively, for the Republic of Ireland.

* *'Ever' drinking and 'regular' drinking was self-defined by respondents. 'Ever' drinking consumers were those who had ever tasted or consumed stimulant drinks but did not consider themselves to be regular consumers. 'Regular' consumers described individuals who consumed stimulant drinks frequently.*

Table 6.1 Whether respondents had 'ever' consumed a number of specified drinks

	'Ever' Drinkers			
	Republic of Ireland (n = 625)		Northern Ireland (n = 635)	
Type of drink	***n***	***%***	***n***	***%***
Fizzy drinks	556	89	616	97
Energy drinks	425	68	502	79
Spirits	425	68	298	47
Flavoured drinks (bottle)	375	60	495	78
Coffee	350	56	381	60
Beer	338	54	324	51
Wine	250	40	279	44
Stimulant drinks	***231***	***37***	***324***	***51***

Table 6.2 Whether respondents 'regularly' consumed a number of specified drinks

	'Ever' Drinkers			
	Republic of Ireland (n = 625)		Northern Ireland (n = 635)	
Type of drink	***n***	***%***	***n***	***%***
Fizzy drinks	431	69	476	75
Beer	238	38	152	24
Coffee	200	32	190	30
Energy drinks	181	29	146	23
Flavoured drinks (bottle)	169	27	216	34
Wine	88	14	83	13
Spirits	69	11	76	12
Stimulant drinks	***69***	***11***	***63***	***10***

6.3.2.3 Prevalence of regular consumers of stimulant drinks by sex, age and social class

In Northern Ireland, 13% of males and 7% of females reported being regular consumers. In the Republic of Ireland, these figures were 14% and 7% for males and females, respectively (Table 6.3).

There was no clear difference in the ages of consumers between Northern Ireland and the Republic of Ireland, although consumers in the Republic of Ireland, tended to start younger and consumption was highest in the 19 – 24 years age group. In both jurisdictions there were no social class differences in consumption patterns (Table 6.3).

6.3.2.4 When respondents started to drink stimulant drinks

In Northern Ireland, the majority of consumers of stimulant drinks (both 'regular' and 'ever' consumers) reported having started to consume stimulant drinks approximately 1 - 2 years ago (i.e. 1999 – 2000), with less than 10% having started to consume the drinks within the six months prior to the survey (Figures 6.1 and 6.2). Similarly, in the Republic of Ireland most respondents reported starting to drink stimulant drinks one to two years ago, although 13% of 'regular' drinkers reported having started within the month prior to the survey.

These results coincide with the introduction of stimulant drinks onto the market on the island of Ireland.

6.3.2.5 Settings in which stimulant drinks were consumed

'Pubs and clubs' were the most important drinking locations for regular stimulant drink consumers in both Northern Ireland and in the Republic of Ireland (Figure 6.3). When asked, 80% of 19 – 24 year olds who had ever consumed stimulant drinks, had done so in a 'pub or club' setting. For respondents in the 11 – 18 year old category, 'with friends' was the most likely setting in which they had ever consumed stimulant drinks.

Table 6.3 Distribution of regular consumers of stimulant drinks by age, sex and social class

	Sex		Age (years)					Social Class		
	Male %	Female %	11-12 %	13-14 %	15-18 %	19-24 %	25-35 %	ABC1 %	C2DE %	F %
Northern Ireland n = 63	13	7	4	2	14	9	6	11	9	9
Republic of Ireland n = 69	14	7	10	6	13	16	8	11	10	13

Figure 6.1 When 'ever' consumers began drinking stimulant drinks

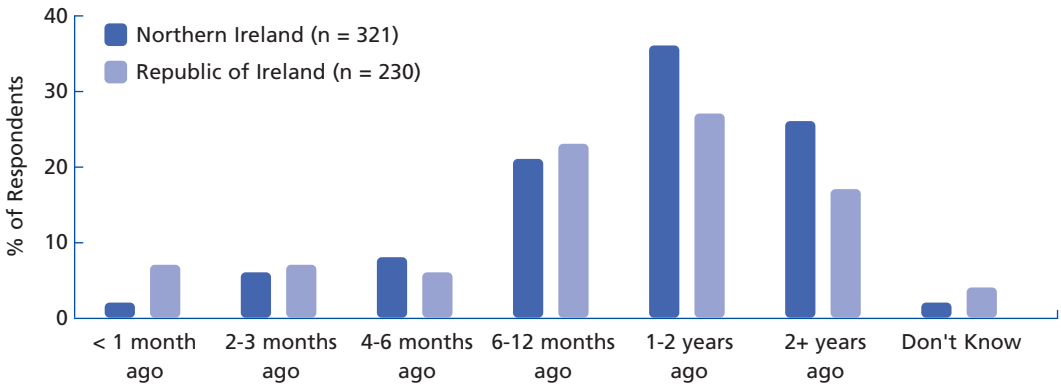


Figure 6.2 When 'regular' consumers began drinking stimulant drinks

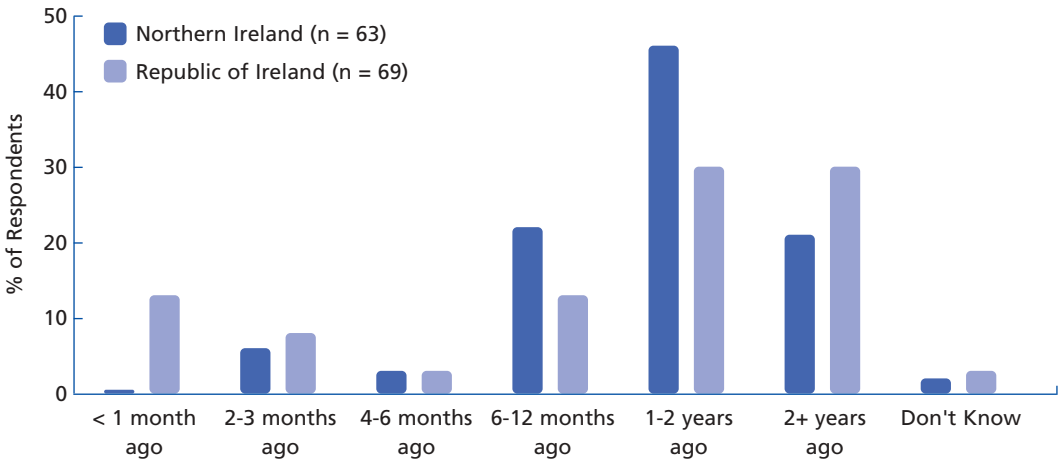
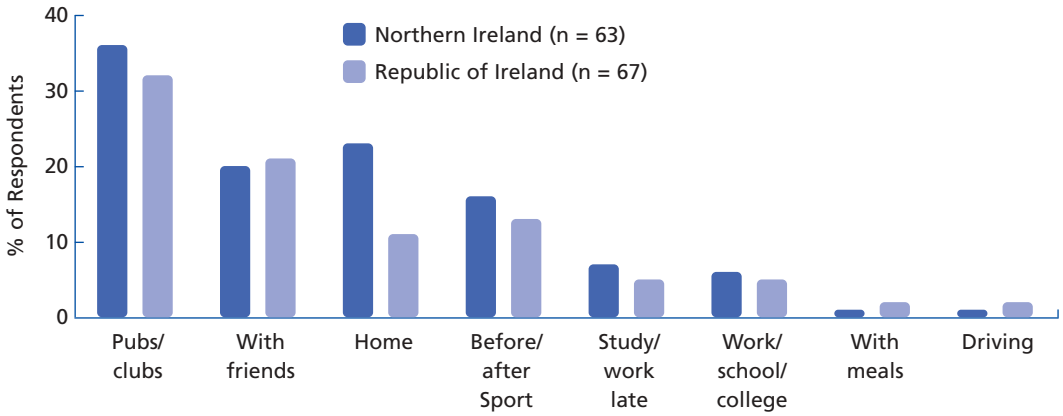


Figure 6.3 Settings in which stimulant drinks were regularly consumed



'Before and after sport' was also a common setting for the consumption of stimulant drinks, particularly with males. However, surprisingly fewer respondents reported the use of stimulant drinks to stimulate them while studying or working late, one of the 'functional' uses of the products promoted by the manufacturers (3).

When the drinking occasions of those respondents who reported ever consuming stimulant drinks were examined in detail, it was established that there was no difference between male and female drinkers of stimulant drinks in the contexts where they consumed the drinks. The only exceptions were sport in both Northern Ireland and the Republic of Ireland, and work/school/college in the Republic of Ireland where more males than females reported drinking stimulant drinks in these settings.

When the time of drinking of stimulant drinks was investigated, 75% and 65% of regular consumers reported drinking the drinks most often between 5 pm and midnight in the Republic of Ireland and Northern Ireland, respectively (Table 6.4). This result corresponds with a 'pub or club' setting for the consumption of stimulant drinks. More respondents in Northern Ireland reported consuming stimulant drinks earlier in the day and this may be associated with the higher use of stimulant drinks for their 'functional' properties within this population.

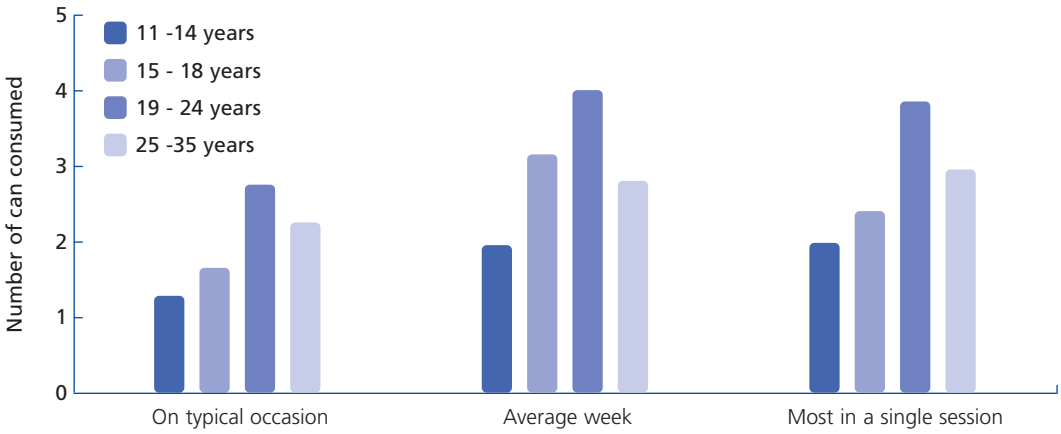
Table 6.4: Times at which regular drinkers consumed stimulant drinks

	% Regular Drinkers	
Time	**Northern Ireland (n = 63)**	**Republic of Ireland (n = 69)**
7 am – midday	13	5
After midday – 5 pm	30	28
After 5 pm – midnight	65	75
After midnight – 7am	22	20

6.3.2.6 Consumption levels of stimulant drinks

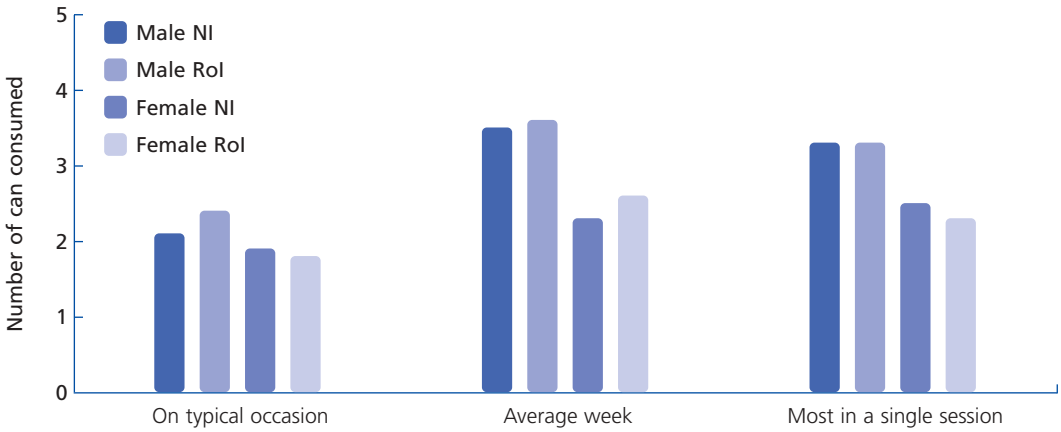
The levels of consumption of stimulant drinks were examined in the survey. The weekly consumption was approximately three cans (each can containing 250 ml) among consumers who had ever consumed stimulant drinks (Figure 6.4). However, when data from the highest consumers (95th percentile) was examined, results indicated that up to eight cans were consumed by some individuals in a week. Similarly, in a single session the average number of stimulant drinks consumed was approximately three cans and among the highest consumers rose to eight cans. This indicates that some individuals are consuming up to 640 mg caffeine in a single sitting. It should also be noted that in the younger age group (11 – 14 years), approximately two cans of stimulant drinks were consumed in a single session (Figure 6.4). These points gives rise to concern regarding the acute effects of stimulant drinks among adults and children.

Figure 6.4 The average number of cans of stimulant drinks consumed within each age group by 'ever' consumers (both north and south, n = 551)



When the age ranges of stimulant drink consumers were examined, it was shown that all age ranges had consumed stimulant drinks, however, the peak consumers fell into the 19 – 24 years age category (Figure 6.5). This confirmed the findings of the qualitative research.

Figure 6.5 The average number of cans of stimulant drinks consumed by male and female 'ever' consumers (both north and south, n = 551)



There was little difference between the reported consumption levels of respondents in Northern Ireland and the Republic of Ireland who had ever consumed stimulant drinks (Figure 6.5). Generally, females tended to consume less stimulant drinks than males, and males in the Republic of Ireland consumed slightly more than their Northern Ireland contemporaries.

6.3.2.7 Consumption of stimulant drinks with alcohol

Stimulant drink consumption was strongly related to alcohol consumption in both the Republic of Ireland and Northern Ireland (Table 6.5).

Table 6.5 Regular stimulant drink consumers (18 – 35 years) who reported consuming stimulant drinks with alcohol

	'Regular' (%)		'Ever' (%)	
	NI (n = 49)	RoI (n = 41)	NI (n = 49)	RoI (n = 41)
With vodka	47	61	71	71
With other alcoholic drinks	2	2	18	7
Between alcoholic drinks	0	5	10	12
On their own	49	32	69	66

Among those who reported ever having consumed stimulant drinks, 84% of all respondents had consumed the drinks with alcohol. Among regular drinkers, 56% of respondents consumed stimulant drinks with alcohol.

Equal numbers of males and females reported regularly consuming stimulant drinks on their own in the Republic of Ireland, while in Northern Ireland, more males regularly consumed stimulant drinks on their own. In Northern Ireland, more females than males regularly consumed stimulant drinks with vodka, while the opposite was the case in the Republic (Table 6.6).

Table 6.6 Regular stimulant drink consumers (18 – 35 years) by sex, who reported drinking stimulant drinks with alcohol

	Northern Ireland (%)		Republic of Ireland (%)	
	Male	Female	Male	Female
With vodka	35	53	61	52
On their own	54	36	51	54

6.3.2.8 Attitudes and behaviour towards stimulant drinks

When respondents were asked to assign attributes and perceptions to stimulant drinks, results were broadly similar in Northern Ireland and the Republic of Ireland (Table 6.7). However, there were differences between how regular consumers and all respondents (including 'ever' and 'regular' consumers, and non-consumers of stimulant drinks) categorised the drinks (Table 6.7).

A large number of all respondents to the survey considered stimulant drinks to be 'unsafe' in large quantities. Attributes related to their 'functional' uses were considered as less important. Regular consumers, while also acknowledging that the drinks were potentially 'not safe' in large quantities, considered their 'popularity and trendy status' ahead of other attributes. Regular consumers were also more likely to categorise stimulant drinks as a drink to 'perk you up' and 'boost awareness and concentration' than all respondents.

Figure 6.7 Attributes assigned by respondants

Attribute	All respondents, % (n = 1260)	Regular stimulant drinks consumers, (n = 132)
Too much…not good	68	78
Fashionable/trendy drink	54	80
Drink mainly for youths	50	72
Becoming more popular	49	84
Mainly drunk with alcohol	47	73
Boosts concentration/awareness	42	69
Drink to perk you up	39	74
Good hangover cure	27	50
A sports drink	14	27
Drink for any occasion	10	20
Goes well with food	5	7

Respondents were further asked about their attitudes towards stimulant drinks. Again results were similar in Northern Ireland and the Republic of Ireland (Table 6.8). However, respondents in the Republic of Ireland gave more consideration to the consumption of stimulant drinks with alcohol than respondents in Northern Ireland. These results support the findings in section 6.3.2.7.

Table 6.8 Agreement with statements (all consumers)

	Agree, %		Disagree, %	
	RoI (n = 625)	NI (n = 635)	RoI (n = 625)	NI (n = 635)
People drink them to perk themselves up if they are tired	80	78	5	3
People drink them on big nights out	78	67	10	8
People drink them to perk themselves up if they have too much to drink	69	56	13	10
People drink them with alcohol to enable them to drink more in an evening	59	43	23	22
People can drink more if they drink a stimulant drink during the night	50	25	28	30
It is a drink for any occasion	41	41	42	28

6.4 Summary

While 51% of respondents in Northern Ireland and 37% in the Republic of Ireland reported having ever consumed stimulant drinks, only 10% in both jurisdictions considered themselves to be regular consumers. Analysis of the results identified males between the ages of 19 and 24 as being the peak consumers.

The average number of cans consumed by 'ever' consumers in a single session was approximately three, while three was also the average weekly consumption of 'ever' consumers. However, there are individuals who consume up to eight cans in one session, and for these individuals, this exposure to very high caffeine concentrations may pose a health risk, particularly if they suffer from an underlying medical condition. Little is known about the consequences of exposure of these individuals to the high levels of taurine and glucuronolactone to which they would also be subjected.

The Committee consider that the context in which stimulant drinks are consumed as central to any study of the health effects of the drinks. When respondents were asked about the settings in which they consumed stimulant drinks, 'pubs and clubs' were the venues of choice. Settings that are associated with the functional use of the products, such as 'studying' and 'working and driving', were less significant.

On being asked in more detail regarding the consumption of stimulant drinks with alcohol, 84% of respondents reported having ever consumed stimulant drinks with alcohol, while 56% reported consuming the drinks with alcohol regularly.

While an equal number of females in Northern Ireland and the Republic of Ireland reported regularly consuming stimulant drinks with alcohol (53%), more males in the Republic of Ireland were regular consumers of stimulant drinks with alcohol compared with their contemporaries in Northern Ireland (61% and 35%, respectively). These results confirm the qualitative results discussed in Chapter 5.

The attitudes and behaviour of respondents to stimulant drinks were addressed during the course of the consumer survey. Attitudes are similar in the Republic of Ireland and Northern Ireland, although respondents in the latter perceive a greater role for stimulant drinks with alcohol.

‘Stimulant drinks are marketed with claims such as ‘vitalises body and mind’, ‘improves psychological performance’ and ‘the ultimate high’.

Chapter 7
Marketing of Stimulant Drinks

7.1 Introduction

Stimulant drinks are marketed with claims such as 'vitalises body and mind', 'improves psychological performance' and 'the ultimate high'. While no specific health or nutritional claims are used in the promotion of these products, concern has been expressed with regard to some of the advertising methods, marketing materials and sales promotion techniques that are employed in the promotion of stimulant drinks.

The Committee therefore considered that some of the marketing approaches adopted by stimulant drink companies should be examined. To this end, the Committee commissioned an assessment of the marketing of stimulant drinks in Ireland, specifically:

- an analysis of the marketing material supporting stimulant drinks in Ireland
- analysis of the distribution channels used by the manufacturers of stimulant drinks
- the preparation of a report on the scope, scale, content and inferred objectives of marketing activity supporting stimulant drinks in Ireland.

This analysis of the market was carried out in March – April of 2001. A summary of the analytical results may be found in the following section, and a copy of the full document is available for consultation on the FSPB website: URL:*http://www.safefoodonline.com/publications/pubs.html.*

7.2 Market Review of Stimulant Drinks on the Island of Ireland

7.2.1 The stimulant drink market on the island of Ireland

Analysis of the stimulant drink market on the island of Ireland indicated that *Red Bull* is the market leader with in excess of 87% share of the market (3). Other products of any significance were *V* and *Shark*. While *Red Bull* GmbH considers the range of *Lucozade* energy drinks to be its most significant and direct competitor (3), these products were not considered in the analysis as they do not fit the definition of stimulant drinks as developed by the Committee in so far as they do not contain the principal ingredients of stimulant drinks, i.e. caffeine, taurine and glucuronolactone.

Due to the fact that *Red Bull* is the dominant player in the stimulant drink market on the island of Ireland, the marketing analysis focuses on the marketing activity of *Red Bull* GmbH.

Market analysis indicates that the target group for stimulant drinks is defined as adults aged between 16 and 39 years, with a core group of consumers aged between 18 and 24 years. A consumption survey carried out on behalf of *Red Bull* GmbH in July 2000 in the Republic of Ireland showed the highest consumption levels amongst males aged 20 – 24 years and amongst D/E social class (3). On the basis of this study, it is estimated that the average consumption of stimulant drinks by consumers within the core market (20 – 24 years) is 19 cans (4.75 l) per month (3).

Sales *per capita* of *Red Bull* on the island of Ireland are higher than in most of the other 52 countries in which the stimulant drink is distributed. Examination of the market suggests that the reason for this could relate to the high levels of alcohol consumption, in particular, the consumption of vodka, rather than its penetration as a 'functional energy drink'.

Results of the consumption survey conducted on behalf of *Red Bull* GmbH indicate that stimulant drinks are heavily used as mixers with vodka, with 25% of males and 32% of females claiming to 'always' drink *Red Bull* as a mixer. These results are confirmed by the qualitative and quantitative analyses discussed in Chapters 5 and 6.

7.2.2 Distribution of *Red Bull* on the island of Ireland

In the survey conducted on behalf of *Red Bull* GmbH, 72% of participants claimed to drink *Red Bull* with alcohol (3). A review of the distribution chain of stimulant drinks indicated that 65% of *Red Bull* distribution in the Republic of Ireland is through the licensed trade, while in Northern Ireland, this channel represents 45% of total sales.

Red Bull GmbH denies the active promotion of its product with alcohol (3) and it sees the long-term success of the product being driven by its 'functional' properties, and not as a mixer with alcohol. However, the marketing review suggests that it continues to sell its product predominantly into the licensed trade in the Republic of Ireland. Indeed their marketing material is ambiguous in relation to alcohol. In one of its brochures it states:

> "*Red Bull does not contain alcohol, but there is no reason why it shouldn't. Adding alcohol to Red Bull does not change Red Bull's properties*".

7.2.3 Marketing strategies

The analysis of the marketing activity of *Red Bull* GmbH suggests that the company is concerned with the promotion of its product as a 'functional' drink. There are three core strategies employed by *Red Bull* GmbH in all markets, namely advertising, sampling and sponsorship.

7.2.3.1 Advertising

Red Bull GmbH uses television, radio and cinema, but not print or outdoor advertising, although point-of-sale literature is available. Television and cinema advertising is cartoon based, and is used in all markets where *Red Bull* is distributed throughout the world.

7.2.3.2 Sampling

Examination of the market indicates that *Red Bull* GmbH strongly support the use of product sampling in the promotion of the drink. This is based on the premise that if a potential consumer experiences the product in the 'right' situation (i.e. when they need energy), they will become a repeat purchaser. As of April 2001, there were ten sampling teams in the Republic of Ireland and four in Northern Ireland. These teams target individuals such as taxi drivers, nurses and late night workers.

In addition to the sampling teams, *Red Bull* GmbH employs student brand managers. In April 2001, there were six student brand managers on campuses in the Republic of Ireland. According to *Red Bull* GmbH, the role of the student brand manager is to represent the brand on campus, to educate students about the benefits of the product and to encourage trial and future purchase.

'Fact brochures' are available to support the sampling teams and the student brand manager. *Red Bull* GmbH produces these brochures with the objective to 'communicate' the functional aspects of its product. The fact brochures include:

- "*Your Personal Trainer Comes in a Can*" aimed at sports/active people
- "*Wakey Wakey Alive Very Alive*" aimed at drivers.

However, the marketing review observed that in addition to the above, some of the verbal messages being given by the sampling staff may be over-claiming for the product. (Claims such as "*It breaks down things that are clogged in your body and flushes them out. It's like an inner cleanser*…and… *protects against gall bladder disease and facial twitches …and can also help epilepsy.*")

7.2.3.3 Sponsorship

Sport is the main focus of the sponsorship programme and the emphasis is on emerging and established extreme sports. *Red Bull* is seen to be associated with 'extreme' sports in all its markets. Analysis indicates that the strategy adopted is designed to support both the 'functionality' positioning of the product and the 'personality' of the brand.

7.3 Regulation of the advertising of stimulant drinks

7.3.1 Advertising regulation in the Republic of Ireland

In the Republic of Ireland, the Advertising Standards Authority for Ireland (ASAI) is a self-regulatory body established by the advertising industry to ensure that advertisers comply with the requirements of the Code of Advertising Standards and of Sales Promotion Practices as published by the ASAI. While there are no specific provisions or references in the Codes with regard to the advertising of soft drinks, including stimulant drinks, all products are assessed in light of an advertisement's probable effect given the context. In this regard, particular attention is paid to the characteristics of the likely audience, the media used, the location and context of the advertisement and the nature of the advertised product (131).

There have been a number of complaints lodged with the ASAI regarding the promotional campaigns used by *Red Bull* GmbH. One complaint concerned a television advertisement for *Red Bull* featuring cartoon characters. The complainant suggested that the product was a high caffeine drink that the advertiser, in its own product information, stated was unsuitable for children. The complainant believed that this advertisement posed unnecessary risks to children's health, particularly in the absence of legislation that would restrict access to the product. The complaint was not upheld by the ASAI as the advertisements used were shown after the 9 pm water shed and the cartoon characters used were found to be neither specifically designed for children nor familiar to children in general.

Another complaint was received by the ASAI regarding the claims made by *Red Bull* GmbH in a booklet widely available throughout the country. The claims include:

- "*Red Bull keeps your eyes wide open and on the road*"
- "*You've got better things to do than sleep*"
- "*Red Bull does not contain alcohol, but there is no reason why it shouldn't. Adding alcohol to Red Bull does not change Red Bull's properties*".

The complainant objected to the booklet on the basis that the claims were offensive and gave exceptionally irresponsible advice in a situation of general concern about road safety. To date no decision has been taken on this complaint although such promotional material, known as point-of-sale, falls outside the remit of the ASAI.

7.3.2 Advertising regulation in the UK

In the UK, the Advertising Standards Authority (ASA) performs a similar role to that of the ASAI in Ireland. In 1997, an objection to advertisements for *Red Bull* was lodged. In its advertising, *Red Bull* GmbH claimed that its product:

- "*improves concentration*"
- "*improves reaction time*"
- "*improves endurance*"

The complainant challenged whether the advertisers could substantiate these claims.

In January 2001, the ASA found in favour of the complainant on the basis that at the time of the original complaint, there was insufficient scientific evidence to support the claims made by *Red Bull* GmbH (132). While *Red Bull* GmbH had subsequently provided scientific evidence to support its claims, the ASA noted that this evidence related to a caffeine concentration much higher than that present in a single can (250 ml) of *Red Bull* as implicated in its advertising. The ASA recommended that in the future *Red Bull* GmbH should submit all advertisements to the Committee of Advertising Practice for prior approval.

7.4 Summary

The marketing review indicates that sales of stimulant drinks on the island of Ireland have peaked and that current levels of sales figures are now running at approximately 20% below the levels of 2000. Recent trends suggest that the use of stimulant drinks such as *Red Bull* as a mixer with alcohol is beginning to be replaced by other more 'trendy' products on the market (e.g. *Bacardi Breezer, Smirnoff Ice*). However, stimulant drinks still have a strong and loyal consumer base and there are indications that, in spite of the manufacturers' claims, large quantities continue to be consumed with alcohol.

The analysis of the marketing activity of stimulant drinks highlights two main areas of concern:

- some of the verbal messages being given by the sampling staff may be over-claiming for the product. (Claims such as "*It breaks down things that are clogged in your body and flushes them out. It's like an inner cleanser*…and… *protects against gall bladder disease and facial twitches …and can also help epilepsy.*")
- some of the promotional brochures encourage people to drink *Red Bull* rather than to sleep. Even allowing for an element of permissible advertising licence, it is not clear whether the brochures are intended to be taken literally or not. However, as written material they have the capacity to be taken to mean exactly what they say, and these inferences could be injurious to health.

‘Market analysis indicates that the target group for stimulant drinks is defined as adults aged between 16 and 39 years, with a core group of consumers aged between 18 and 24 years.’

‘It is recommended that stimulant drinks not be consumed in association with sport and exercise as a thirst quencher.’

Chapter 8 Recommendations

8.1 Introduction

In reviewing the adverse health effects of stimulant drinks, the Committee was constrained by the limited amount of comprehensive information, risk assessment data and peer reviewed scientific research in this area. In light of this limited information and in order to protect public health, the Committee has adopted a precautionary approach to its review and makes the following recommendations.

8.2 Labelling

There is currently no specific legislation governing stimulant drinks within the EU although, owing to domestic legislation, stimulant drinks are not sold in a number of countries.

In February 2002, EU Member States agreed changes to the labelling regulations. These changes will require drinks with caffeine contents greater than 150 mg per l to be labelled 'high caffeine content' and the amount of caffeine present must be given. The new rules must come into effect by July 1st 2004.

The Committee welcomes the new ruling on caffeine labelling in the EU, i.e. that drink products with caffeine contents greater than 150 mg per l should be labelled 'high caffeine content' and that the amount of caffeine present in the product be given. This ruling be implemented as soon as is practicable.

The Committee also recommends that stimulant drinks should be labelled with an indication that they are unsuitable for children (under 16 years), pregnant women and individuals sensitive to caffeine.

8.3 Groups for Special Consideration

The Committee reviewed the current knowledge with regard to the individual ingredients of stimulant drinks. The Committee gave close consideration to the use of stimulant drinks by individuals who may be at increased risk due to the high caffeine nature of these products, specifically pregnant women, caffeine-sensitive individuals and children.

In the context of advice to pregnant women to limit caffeine intake owing to the possible adverse effects of high caffeine intake on pregnancy outcome, stimulant drinks should be classified with other beverages of high caffeine content.

Consumption of stimulant drinks by children under 16 years should be discouraged on the basis of possible transient behavioural effects of high caffeine intake, such as increased arousal, irritability, nervousness or anxiety.

8.4 Circumstances under which Stimulant Drinks are Consumed

The use of stimulant drinks during sport and exercise was a concern for the Committee, particularly as it was under such circumstances that the present review was commissioned.

It is recommended that stimulant drinks not be consumed in association with sport and exercise as a thirst quencher, and that the products should carry a clear statement on the label that they are unsuitable rehydration agents for use in sport and during exercise.

The effect of stimulant drinks in combination with alcohol and other stimulants was also reviewed. Given the limited information available, the main areas of concern regarding stimulant drinks and

alcohol consumption are the dehydration effects and the increased consumption of alcohol. Results of qualitative and quantitative research indicate that stimulant drinks are commonly consumed with alcohol, particularly vodka.

Consumers should be advised that caution be exercised in the consumption of stimulant drinks with alcohol and the products should carry a clear statement on the label to this effect.

8.5 Marketing

Market analysis reveals that the sale and consumption of stimulant drinks on the island of Ireland has declined in the past two years. However, a core market group remains, specifically male aged 19 – 24 years.

The Committee has a number of concerns about the marketing and promotion of stimulant drinks including:

- misleading claims
- suggestion that stimulant drinks reduce the requirement for sleep
- lack of recommended upper consumption limits
- ambiguous information on the consumption of stimulant drinks with alcohol
- promotion of stimulant drinks consumption in association with sport.

It is recommended that the industry regulators and relevant authorities address such practices.

8.6 Further Research

The Committee recognises that in order to undertake a full risk assessment of the ingredients of stimulant drinks and their interactions, extensive research would need to be conducted. Such research would require toxicological investigations that would best be carried out at an international level and concerted international research should be undertaken.

It is therefore recommended that further research be carried out to:

- ***monitor patterns of stimulant drink consumption***
- ***establish an upper safe level for daily intake of glucuronolactone and taurine in humans***
- ***investigate possible adverse effects of interactions between stimulant drink ingredients such as caffeine and taurine, between such ingredients and alcohol, and under conditions of exercise and consequent dehydration.***

Appendix I

Stimulant Drink Survey Questionnaire

Ask all aged 15-35 only

Showcard '1'

Q.1 Which of the following types of drink have you **ever drunk?**

Q.2 Which of the following types of drink do you drink **regularly?**

Q.3 Which of the following types of drink do you drink **most often?**

Single Code Only

	Q.1 Ever	Q.2 Regularly	Q.3 Most Often
Fizzy drinks (e.g. Coke/7UP/Fanta etc)	1	1	1
Energy drinks (e.g. Lucozade Energy/Finches Fuel/Gatorade)	2	2	2
Stimulant Drinks (e.g. Red Bull, V, Red Lion, Shark etc)	3	3	3
Bottled/Flavoured Water	4	4	4
Beer	5	5	5
Wine	6	6	6
Spirits (e.g. Vodka, Whiskey)	7	7	7
Coffee	8	8	8

Ask all ever drinking stimulant drinks (Code 3 at Q.1) Others go to Q.13.

Showcard '2'

Q.4 How long ago did you start to drink stimulant drinks like Red Bull, Red Lion or V?

1 month or less	1
2-3 months ago	2
4-6 months ago	3
6 months to 1 year ago	4
Between 1 and 2 years ago	5
More than 2 years ago	6

Showcard '3'

Q.5 On which, if any, of these occasions do you **ever drink** Stimulant Drinks such as Red Bull, Red Lion or V?

Q.6 On which, if any, of these occasions do you **regularly** drink Stimulant Drinks such as Red Bull, Red Lion, or V?

Q.7 On which, if any, of these occasions do you drink Stimulant Drinks such as Red Bull, Red Lion or V **most often?**

	Q.5 Ever	Q.6 Regularly	Q.7 Most Often
At home	1	1	1
In pubs/clubs	2	2	2
When out with friends	3	3	3
With Meals	4	4	4
While studying/working late	5	5	5
At work/school/college	6	6	6
Before sport	7	7	7
After sport	8	8	8
When driving	9	9	9

Showcard '4'

Q.8a At which of these times do you **ever drink** stimulant drinks such as Red Bull, Red Lion or V?

Q.8b At which of these times do you **regularly** drink stimulant drinks such as Red Bull, Red Lion or V?

Q.8c At which of these times / occasions do you drink stimulant drinks such as Red Bull, Red Lion or V **most often?**

	Q.8a Ever	Q.8b Regularly	Q.8c Most Often
7am – mid-day	1	1	1
After mid-day to 5pm	2	2	2
After 5pm to midnight	3	3	3
After midnight to 7am	4	4	4

Q.9 When drinking stimulant drinks **(On most often occasion Q7),** how many cans on average do you drink in one session?

Q.10 How many cans of stimulant drinks would you drink in an average week?

Q.11 What is the most number of cans you have drunk in one session?

Showcard '5'

Q.12a When drinking stimulant drinks like Red Bull, please tell me which of the following **ever** applies to you.

Q.12b Which applies **most often**

	Ever	Most Often
I drink it on its own without mixing	1	1
I drink it with Vodka	2	2
I drink it with Gin	3	3
I drink it with Rum	4	4
I drink it with other alcoholic drinks	5	5
I drink it in between alcoholic drinks	6	6

Ask all

Showcard '6'

Q.13 Please tell me which, if any, of the following statements apply to these types of soft drink, you may mention as many or as few as you like.

Read out ⇨	Fizzy Drinks (e.g Coke/ 7Up)	Energy Drinks	Stimulant Drinks
It's a drink that boosts concentration and alertness	1	1	1
It's a drink for any occasion	2	2	2
It's a drink to perk you up	3	3	3
It's a sports drink	4	4	4
It's a drink mainly drunk with alcohol	5	5	5
It's a drink mainly for drinking in pubs	6	6	6
It's a drink that goes well with food	7	7	7
It's a good hangover cure	8	8	8
Too much of it would not be good for you	9	9	9
It's a drink that is becoming more popular	1	1	1
It's a fashionable/trendy drink	2	2	2

Showcard '7'

Q.14 I am now going to read out some comments that people have made about stimulant drinks like Red Bull, Red Lion, V etc. Please tell me to what extent you agree or disagree with each of these statements?

Read Out	Agree Strongly	Agree	Neither Agree nor Disagree	Disagree	Disagree Strongly	Don't Know
People drink them with alcohol to enable them to drink more in an evening	1	2	3	4	5	6
People drink them on a big night out	1	2	3	4	5	6
People drink then to perk themselves up if they've had too much to drink	1	2	3	4	5	6
People drink them to perk themselves if they are tired	1	2	3	4	5	6
People can drink more if they drink Red Bull during the night	1	2	3	4	5	6
It is a drink for any occasion	1	2	3	4	5	6

Appendix II

Table I Demographics of respondents in the Republic of Ireland

	Sex			Age					Social Class		
	Total	Male	Female	11-12	13-14	15-18	19-24	25-35	ABC1	C2DE	F
Total (n)	625	313	312	51	54	141	131	248	261	310	54
Sex											
Male (n)	313	313		30	25	67	72	119	134	154	25
Male (%)	*50*	*100*		*59*	*46*	*48*	*55*	*48*	*51*	*50*	*46*
Female (n)	312		312	21	29	74	59	129	127	156	29
Female (%)	*50*		*100*	*41*	*54*	*52*	*45*	*52*	*49*	*50*	*54*

Appendix III

Table II Demographics of respondents in Northern Ireland

	Sex			Age					Social Class		
	Total	Male	Female	11-12	13-14	15-18	19-24	25-35	ABC1	C2	DE
Total (n)	635	306	329	49	60	109	147	270	259	151	225
Sex											
Male (n)	306	306		22	33	55	76	120	125	76	105
Male (%)	*48*	*100*		*45*	*55*	*50*	*52*	*44*	*48*	*50*	*47*
Female (n)	329		329	27	27	54	71	150	134	75	120
Female (%)	*52*		*100*	*55*	*45*	*50*	*48*	*56*	*52*	*50*	*53*

Glossary

Alkaloids: Naturally occurring nitrogen containing compounds that have pharmacological actions in man and other animals.

Ambulatory Blood Pressure: Normal blood pressure when standing.

Analgesic: A substance used in medicine to relive pain.

Aortic Wave Form: A measure of pressure in the heart shown diagrammatically as a wave.

Arrhythmia: An abnormal heart rhythm.

Arterial Stiffness: The stiffening of the arteries which is thought to contribute to the increased incidence of cardiovascular disease with age.

Blood Pressure: The pressure of the blood within the arteries. It is produced primarily by the contraction of the heart muscle. Two numbers record its measurement. The first (systolic pressure) is measured after the heart contracts and is the highest. The second (diastolic pressure) is measured before the heart contracts and is the lowest.

Cardio Vascular Disease (CVD): A disease relating to, or involving the heart, and blood vessels.

Cardio Vascular System: The circulatory system comprising the heart and blood vessels. The system carries nutrients and oxygen to the tissues of the body and removes carbon dioxide and other wastes from them.

Congenital Malformations: A physical defect present in a baby at birth, irrespective of whether the defect is caused by a genetic factor or by prenatal events that are not genetic.

Diuresis: Increased formation and excretion of urine.

Dopamine: Neurotransmitter found in the brain that is a precursor of adrenaline and noradrenaline.

Dopaminergic: Dopamine-induced effects.

Electrolyte Loss: The loss of salts from the body, usually sodium and potassium.

Ephedrine: A substance that stimulates contraction of the smooth muscle of the capillaries and arteries and causes a secondary release of noradrenaline. It causes increases in blood pressure and it is used when blood pressure drops e.g. during anesthesia.

Epidemiological Studies: The assessing of specific characteristics of large groups of people in order to identify which factors may influence the development of diseases.

Epinephrine: A hormone secreted by the adrenal glands, especially in times of stress or in response to fright or shock. Its main actions are to increase blood pressure and mobilize tissue reserves of glucose.

Ergogenic Aids: Compounds that have been promoted as helping to improve performance in a variety of ways such as altering body composition or by enhancing energy efficiency, energy control or energy production.

Glycaemic Index: The increase in blood glucose after a test dose of a carbohydrate, relative to that in response to an equivalent amount of glucose.

Half Life: The period over which the concentration of a specified chemical or drug takes to fall to half its original concentration in the specified fluid or blood.

Heart Disease: Group of symptoms arising from the failure of the coronary arteries to supply sufficient blood to heart muscles.

Homeostasis: A tendency of biological systems to maintain stability while continually adjusting to conditions which are optional for survival.

Hypercholesterolaemic: Abnormally high concentrations of cholesterol in the blood. Normal total plasma cholesterol is below 5.2mmol/l. Raised levels of cholesterol are generally considered to be a sign of high risk of atherosclerosis and heart disease.

Hypertonic: A solution more concentrated than body fluids.

Intraperitoneal: Within the peritoneal cavity. The area that contains the abdominal organs.

Isotonic Drinks: Drinks with the same osmotic pressure as body fluids.

Meta Analysis: A review of the results of past studies done on a particular subject which draws conclusions based on this combined analysis.

Mitral Valve: A valve within the heart found between the upper and lower cambers of the left side. This valve opens and closes as blood flows through the heart.

Mitral Valve Prolapse: Drooping down or abnormal bulging of the mitral valve during the contraction of the heart.

Myocardial Infarction: The changes that occur to the heart muscles due to sudden (acute) deprivation of circulating blood.

Natriuresis: The excretion of sodium salts in the urine.

Ossification: The process of creating bone, that is i.e. transforming cartilage (or fibrous tissue) into bone.

Placebo: An inert, harmless treatment (such as a sugar pill) given to the control group so that both control and experimental groups receive what appears to be identical treatment during the study.

Platelet Aggregation: The clumping together of the irregular, disc-shaped element in the blood that assists in blood clotting.

Pre-Term Birth: Birth before 37 weeks of gestation.

Psychoactive: Substances that alter mood, cognition or behaviour.

Psychomotor: Pertaining to motor effects of cerebral or psychic activity. Movement produced by action of the mind or will.

Pulse Wave Velocity: Pulse wave describes the waveform of the pressure formed by blood as it runs through the blood vessels. It varies because of the contraction of the heart, reaching a peak equivalent to systolic measurements of blood pressure and a trough equivalent to the diastolic measurement of blood pressure. Pulse wave velocity refers to the speed of the pulse wave and is thought to be a reliable index of the assessment of the degree of atherosclerosis.

Sudden Adult Death Syndrome: The term given to the sudden death generally of young adults from lesser-known heart conditions. Usually, atherosclerosis of the heart is not the cause. More often these young victims have a thickened muscle (hypertrophic cariomyopathy) without accompanying high blood pressure.

Tachycardia: Rapid heartbeat, as occurs after exercise. It may also occur without undue exertion as a result of anxiety.

Vasoconstrictor: Constriction of the blood vessels.

Vasodilatory: Dilation of the blood vessels caused by a rise in body temperature.

Xenobioctics: Substances foreign to the body, including drugs and some food additives.

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Notes

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