Chapter 5 Alcohol and individuals

Although the use of alcohol brings with it a number of pleasures, with most people expecting more positive than negative outcomes from drinking when asked, alcohol increases the risk of a wide range of social harms, generally in a dose dependent manner - i.e. the higher the alcohol consumption, the greater the risk. Harms done by someone else's drinking range from social nuisances such as being kept awake at night through to more serious consequences such as marital harm, child abuse, crime, violence and homicide. Generally the higher the level of alcohol consumption, the more serious is the crime or injury. The volume of alcohol consumption, the frequency of drinking and the frequency and volume of episodic heavy drinking all independently increase the risk of violence, with often, but not always, episodic heavy drinking mediating the impact of volume of consumption on harm.

Apart from being a drug of dependence, alcohol is a cause of some 60 different types of diseases and conditions, including injuries, mental and behavioural disorders, gastrointestinal conditions, cancers, cardiovascular diseases, immunological disorders, lung diseases, skeletal and muscular diseases, reproductive disorders and pre-natal harm, including an increased risk of prematurity and low birth weight. For most conditions, alcohol increases the risk in a dose dependent manner, with the higher the alcohol consumption, the greater the risk. For some conditions, such as cardiomyopathy, acute respiratory distress syndrome and muscle damage, harm appears only to result from a sustained level of high alcohol consumption, but even at high levels, alcohol increases the risk and severity of these conditions in a dose dependent manner. The frequency and volume of episodic heavy drinking are of particular importance for increasing the risk of injuries and certain cardiovascular diseases (coronary heart disease and stroke).

A small dose of alcohol consumption reduces the risk of heart disease, although the exact size of the reduction in risk and the level of alcohol consumption at which the greatest reduction occurs are still debated. Better quality studies that account for other influences find less of a risk and find that the reduced risk occurs at a lower level of alcohol consumption. Most of the reduction in risk can be achieved by an average of 10g of alcohol (one drink) every other day. Beyond 20g of alcohol (two drinks) a day - the level of alcohol consumption with the lowest risk - the risk of coronary heart disease increases. In very old age, it seems that the reduction in risk is less. It is alcohol that mainly reduces the risk of heart disease rather than any specific beverage type. There is evidence that alcohol in low doses might reduce the risk of vascular-caused dementia, gallstones and diabetes, although these findings are not consistent across all studies.

The risk of death from alcohol is a balance between the risk of diseases and injuries that alcohol increases and the risk of heart disease (which mostly occurs at older age) that, in small amounts, alcohol decreases. This balance shows that, at least in the United Kingdom, the level of alcohol consumption with the lowest risk of death is zero or near zero for women under the age of 65 years, and less than 5g of alcohol a day for women aged 65 years or older. For men, the level of alcohol consumption with the lowest risk of death is zero under 35 years of age, about 5g a day in middle age, and less than 10g a day when aged 65 years or older (and probably returning towards zero in very old age).

There are health benefits to the heavier drinker from reducing or stopping alcohol consumption. Even for chronic diseases, such as liver cirrhosis and depression, reducing or stopping alcohol consumption is associated with rapid improvements in health.

INTRODUCTION

The World Health Organization's comparative risk assessment study describes the relationship between alcohol consumption and health and social outcomes as complex and multidimensional, Figure 5.1 (Rehm *et al.* 2004). Alcohol can impact on health through three intermediate and linked variables, direct biochemical effects, intoxication and episodic heavy drinking, and dependence.

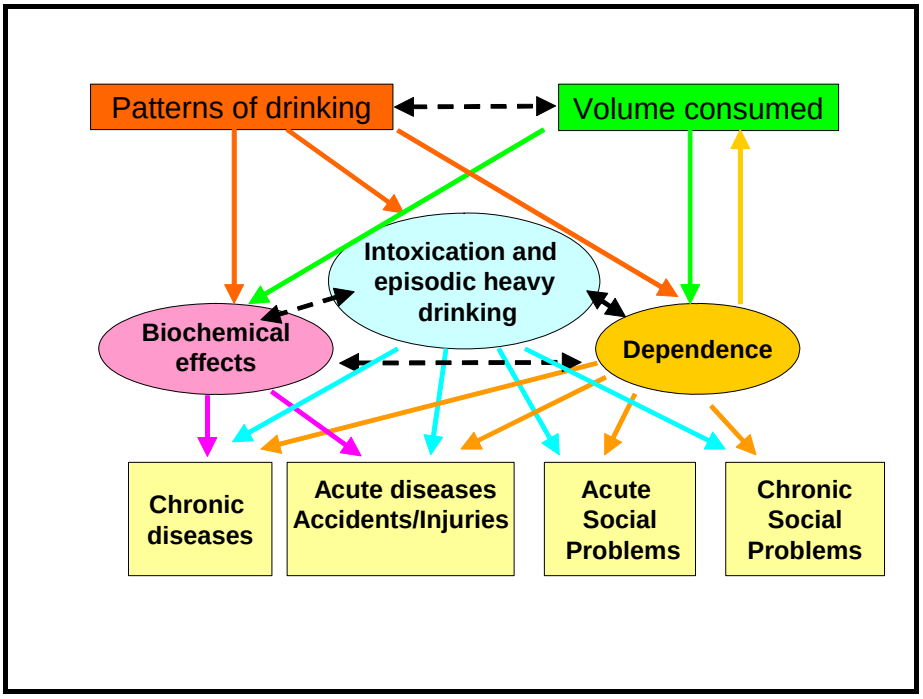

Figure 5.1. The relationship between alcohol consumption, intermediate variables and alcohol related outcomes. Source (modified): Rehm *et al.* 2004.

The direct **biochemical effects** of alcohol can influence a number of diseases of both short and long term duration, and with both positive and negative consequences. Beneficial effects include a reduced risk of coronary heart disease by, for example, alcohol's effect in raising levels of high density lipoprotein cholesterol (Klatsky 1999). Harmful effects include an increased risk of liver cirrhosis by, amongst other means, alcohol's effect when metabolized in producing carbon centred free radicals (Albano and Clot 1996).

Intoxication is a state of functional impairment in psychological and psychomotor performance induced by the presence of alcohol in the body (World Health Organization 1992) that is mostly dose-related (Eckardt *et al.* 1998) and involves multiple body functions. It can lead to unintentional injuries and short term social consequences such as violence and crime, and can also lead to long term social consequences – for example when an intoxicated person causes an intentional injury to another person, leading to a prison sentence. Episodic heavy drinking can be a cause of many major conditions with short and long term chronic consequences, including cardiac arrhythmias and strokes.

Alcohol dependence, a condition in its own right, is defined as a cluster of physiological, behavioural, and cognitive phenomena in which the use of alcohol takes on a much higher priority for a given individual than other behaviours that once had greater value (World Health Organization 1992). Alcohol dependence is thus a powerful mechanism sustaining alcohol consumption and mediating its impact on both short and long term diseases and social harms.

The measurement of alcohol consumption and the epidemiology of risk

In most studies relating alcohol consumption to risk, the measurement of alcohol consumption typically depends on self-report. This can bring a number of problems, since self-reported alcohol consumption is affected by mis-classification in both random and non-random ways (Duffy 1992). It is possible that, due to underreporting of alcohol consumption, the level of risk associated with a particular amount of alcohol consumption will correspond to a greater amount of alcohol consumption and the plotted risk curves are too steep. However, this might be balanced by the fact that it is uncommon for studies to measure consumption at more than one point in the lifetime (Grønbæk *et al.* 2004). Alcohol consumption usually decreases with age – this means the level of risk will correspond to a lower amount of alcohol consumption, and the risk curves will be too shallow. This has been shown in regular heavy drinkers for several outcomes (having coronary heart disease, a stroke, or dying), with a much higher risk when it is based on average alcohol intake over a twenty year period compared to measuring only the level of consumption at the beginning of the period (Emberson *et al.* 2005) (see Figure 5.8 below.) Unfortunately, current biomarkers of alcohol use presently available are not yet sufficiently reliable to account for lifetime consumption (Swift 2003). The length of follow-up also needs to be considered in estimating the true risk. The Copenhagen City Heart Study found that the apparent protective effect of low alcohol consumption on coronary heart disease became less during prolonged follow-up, whereas high alcohol consumption became associated with higher risk of death from cancer with longer follow-up (Nielsen et al 2005).

Patterns of drinking

Increasingly epidemiological studies have taken into account drinking patterns, which include all aspects of alcohol use that are not covered by the term 'volume of drinking' (Rehm *et al.* 1996). Such aspects include temporal variations in drinking, heavy drinking occasions, settings, activities or circumstances associated with drinking and types of beverage consumed (see also Chapter 4). The volume of alcohol consumption has been the usual measure linking alcohol to disease, working mainly through direct biochemical effects or through alcohol dependence to produce long-term consequences. However, the same overall average volume of alcohol can be consumed in small quantities regularly or in large quantities on few occasions, and both volume and patterns appear to work as independent risks for certain conditions, with patterns also sometimes mediating the effect of volume on harm. As will be shown throughout this chapter, patterns of drinking are not only important for some acute health outcomes such as injuries (Greenfield 2001; Rossow *et al.* 2001), but also for some chronic diseases such as coronary heart disease (Britton and McKee 2000; Chadwick and Goode 1998; Puddey *et al.* 1999; Trevisan *et al.* 2001a 2001b).

This does not mean that the volume of drinking is no longer important when episodic

heavy drinking has been taken into account (Rehm *et al.* 2003). Rather, it seems that drinking patterns, including episodic heavy drinking, modify rather than explain the health effects of alcohol. This is well illustrated in a study of alcohol-related aggression in young American men and women (aged between 17 and 21 years), who were asked how often they had 'gotten into an argument or fight' during or after drinking in the previous 12 months, and who were asked about their drinking frequency, their drinking volume and their episodic heavy drinking, defined as the number of days in which five or more drinks had been consumed on the same occasion during the past 30 days (Wells *et al.* 2005). It is clear that drinking frequency, drinking volume and episodic heavy drinking are all related. The more there is episodic heavy drinking, the greater the frequency of drinking and the greater the overall volume of alcohol consumed. The study found that drinking frequency, drinking volume and episodic heavy drinking were all independently associated with an increased risk of fights after drinking. When these three drinking variables were analyzed together, looking at the interactions between them to see which was most important, drinking frequency and drinking volume confounded the relationship between episodic heavy drinking and aggression (in other words, a considerable proportion of the independent relationship between episodic heavy drinking and aggression was due to the frequency and volume of drinking). When all three drinking variables were considered together, only the frequency of drinking remained statistically significant in its relationship with aggression. Thus, whilst both volume of drinking and drinking patterns are important (Room 2005), there is not always a simple relationship between a pattern of episodic heavy drinking and harm.

Causality and attribution

The World Health Organization's Comparative Risk Assessment emphasized that in determining causality and attribution, both reliable outcome measurements and causal pathways are needed (Rehm *et al.* 2004). Sufficient evidence of causality includes outcomes for which the evidence indicates that an association (positive or negative) exists between alcohol consumption and the disease or injury and that chance, confounding variables and other bias can with reasonable confidence be ruled out as factors in this association. Using criteria for establishing causality in epidemiology (Hill 1965; Rothman and Greenland 1998), most weight is usually placed on the following four criteria:

1. consistency across several studies;
2. established experimental biochemical evidence of mediating processes, or at least physiological plausibility;
3. strength of the association (effect size); and
4. temporality (i.e. cause before effect).

"*Alcohol: no ordinary commodity*" stressed that to varying degrees, different health and social outcomes have both an objective element and an element that is a matter of social definition (Babor *et al.* 2003). Even at the one end of the continuum, where the fact of death can be measured objectively and reliably, national recording and coding practices often vary from one country to another (Ramstedt 2002). Further, alcohol's involvement in a death may be missed by those certifying the death, or may be deliberately not mentioned to protect the reputation of the deceased. A study of death recording in 12 cities in 10 countries found that, after supplementing data from the death certificate with data from hospital records and interviews with attending physicians and family members, the net number of deaths assigned to the disease category "liver cirrhosis with mention of alcoholism" rose by 135%, with the majority

of the new cases being recoded from categories of cirrhosis without mention of alcohol (Puffer and Griffith 1967). Similarly, in Canada, it has been estimated that 65% of recorded deaths from non-alcoholic cirrhosis of the liver are in fact due to alcohol (Ramstedt 2003).

For health problems that do not result in death, social definition plays an even larger part (Room *et al.* 2001). While internationally comparable statistics by causes of death have long been available (World Health Organization 1992), there are no cross-nationally comparable data on disabilities (Goerdt *et al.* 1996; Rehm and Gmel 2000; World Health Organization 2001), which can lead to difficulties in overall attribution, since alcohol is more related to disability than to mortality (Murray and Lopez 1996). For social problems, as the term itself implies, the element of social definition becomes more prominent and the way social matters are thought about in a given society changes over time. For this reason the role of alcohol as a causal factor in disease is presently more clearly understood scientifically than the role of alcohol in the causation of social harm.

Alcohol's causal role in social and health problems is usually contributory, being only one of several factors responsible for the problem. For health outcomes, epidemiological definitions stress not only consistent relations but also biological pathways (Rothman and Greenland 1998). Thus, the consistent relationship between alcohol and lung cancer found in many epidemiological studies, even after adjustment for smoking (English *et al.* 1995; Prescott *et al.* 1999; Freudenheim *et al.* 2005), is not usually included as an alcohol-attributable disease because no biological pathway has yet been identified, and because the higher incidence of lung cancer in drinkers may be due to smoking (Bandera *et al.* 2001).

While the causal status of the relationship between alcohol and health outcomes often depends on the plausibility of potential biological pathways, the causal status of the relationships between alcohol and social harm cannot usually be determined this way. An exception is aggressive behaviour, where biological pathways have been identified alongside non-biological mediating factors that determine whether violence occurs on a given drinking occasion (see below). A causal link between alcohol intoxication and aggression is supported by epidemiological (Collins and Schlenger 1988; Wiley and Weisner 1995) and experimental research (Bushman and Cooper 1990; Bushman 1997), as well as by research indicating specific biological mechanisms linking alcohol to aggressive behaviour (Peterson *et al.* 1990; Pihl *et al.* 1993; Sayette *et al.* 1993).

ALCOHOL AND SOCIAL WELL-BEING

Alcohol and social pleasure

The use of alcohol brings with it a number of pleasures (Peele and Grant 1999; Peele and Brodsky 2000). The notion that a low consumption of alcohol is good for health is possibly as old as the history of alcohol itself (Thom 2001) and is embedded in folk wisdom (Cherrington 1925), as discussed in Chapter 2. When respondents in general populations are asked their expectations about the effects of alcohol, more positive than negative sensations and experiences are usually mentioned. (e.g., taste, relaxation, sociability, and subjective health) (Grønbæk *et al.* 1999; Poikolainen and Vartiainen 1999; Heath 2000; Guallar-Castillon *et al.* 2001), with little mention of harm (Mäkelä and Mustonen 1988; Mäkelä and Simpura 1985; Nyström 1992).

Alcohol plays a role in everyday social life, marking such events as births, weddings and deaths, as well as marking the transition from work to play and easing social intercourse (see Chapter 2). Throughout history and in many different cultures, alcohol is a common means for friends and companions to enhance the enjoyment of each other's company and generally have fun (Heath 1995).

The benefits to those who drink during social occasions are greatly influenced by culture, the setting in which drinking occurs, and people's expectations about alcohol's effects. So strong are these beliefs about alcohol that people become observably more sociable when they think that they have consumed alcohol but actually have not (Darkes and Goldman 1993). That alcohol improves the drinker's mood in the short term is an important reason why many people drink (Hull and Stone 2004). There is, indeed, a large amount of evidence that the immediate effects of alcohol include increased enjoyment, euphoria, happiness and the general expression of positive moods, feelings that are experienced more strongly in groups than when drinking alone (Pliner and Cappell 1974), and very much influenced by expectations (Brown *et al.* 1980; Hull *et al.* 1983). In the few studies available of people who reported receiving psychological benefits from alcohol use, the number of benefits reported correlated with how much alcohol they drank as well as with how often they drank heavily (Mäkelä and Mustonen 1988). Of course, the heavier drinkers in the study were also more likely to report problems from use, and the ratio of benefits to problems tended to decline for the heaviest drinkers. Further, drinkers' expectancies of positive outcomes from drinking are associated with increased drinking levels (Bot *et al.* 2005).

Although stress reduction, mood elevation, increased sociability, and relaxation are the most commonly reported psychosocial benefits of drinking alcohol (Hull and Bond 1986; Baum-Baicker 1987), the effectiveness of alcohol use relative to other means for reducing stress-related diseases has not been studied. However, there is extensive evidence indicating that individuals who suffer psychological distress and rely on alcohol to relieve their stress are more likely to become dependent on alcohol (Kessler *et al.* 1996 1997; Book and Randall 2002). In any one year, over one in eight individuals with an anxiety disorder also suffer from an alcohol use disorder (Grant *et al.* 2004). Alcohol is also commonly seen as aiding sleep – but while it may induce sleep, it also leads to increased wakefulness and arousal several hours later, and aggravates sleep disorders (Castaneda *et al.* 1998).

Alcohol and social harms

Social harms from other people's drinking are common, and include being kept awake at night by drunk people, being harassed in public places and in private parties, being afraid of drunk people in public areas, and being physically hurt or having property damaged, child neglect and failure of others to fulfil social roles.

Alcohol and its negative social consequences

The risk of the most commonly experienced negative social consequences of alcohol – such as getting into a fight, harming home life, marriage, work, studies, friendships or social life – increases proportionally to the amount of alcohol consumed, with the slope of the curve varying across countries, Figure 5.2. An eight year follow up study from Switzerland found that both a daily consumption of more than 40g of alcohol and weekly heavy drinking occasions (50g of alcohol or more per occasion) were associated with at least one of six negative social consequences (Rehm and Gmel

1999). In this study, episodic heavy drinking appeared to increase the risk of social consequences, independent of the overall volume of consumption.

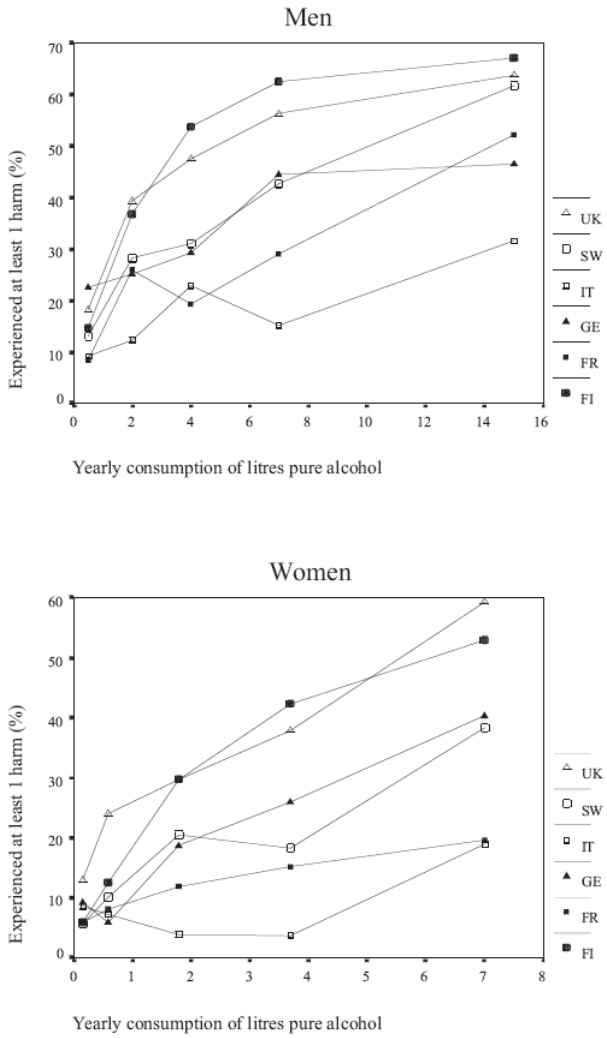

Figure 5.2 Increasing the risk of at least one negative social consequence (getting into a fight, harming home life, marriage, work, studies, friendships or social life) by yearly alcohol consumption for selected European countries. UK United Kingdom, SW Sweden, IT Italy, GE Germany, FR France, FI Finland. Source: Norström (2001).

Social harms from other people's drinking are also common, being more common for less severe consequences (such as being kept awake at night by drunk people) than for being harassed in public places, being harassed in private parties, being insulted and being afraid of drunk people in public areas, as well as more severe types of consequences (such as being physically hurt or property damage) (Rossow and Hauge 2004). Studies show that a small proportion of the population are harmed repeatedly and in various ways, with younger people, women, those who report a higher annual alcohol intake, more frequent episodes of intoxication and more frequent visits to public drinking places being more likely to have received harm from someone else's drinking (Rossow 1996; Mäkelä *et al.* 1999). The drinking behaviour of the typical victim of social harms from others' drinking very much resembles the drinking behaviour of those who experience various kinds of alcohol-related social harms from their own drinking (Hauge and Irgens-Jensen 1986; Room *et al.* 1995; Midanik 1999; Mustonen and Mäkelä 1999; Rehm and Gmel 1999). The harm done

by alcohol to people other than the drinker (which could be termed environmental alcohol damage) is summarized in Box 5.1.

Box 5.1 The harm done by alcohol to people other than the drinker

CONDITION	*SUMMARY OF FINDINGS*
Negative social consequences	Social harms from other people's drinking are more common for less severe consequences (such as being kept awake at night by drunk people) than for more severe ones (such as being afraid of drunk people in public areas). Negative social consequences to others have higher rates in the population than social consequences to the drinker.
Violence and crime	There is a relationship between alcohol consumption and the risk of involvement in violence (including homicide), which is stronger for episodic heavy drinking than for overall consumption. There are also relationships between greater alcohol use and sexual violence (particularly violence against strangers) and domestic violence (although this is attenuated when other factors are taken into account). Generally the higher the level of alcohol consumption, the more serious the violence.
Marital harm	Beyond a strong association between heavy drinking and marital breakdown, a few well-designed studies have demonstrated a significantly increased risk of separation or divorce among married heavy drinkers.
Child abuse	A large number of studies, not always of good methodology, have reported a variety of childhood adversities to be more prevalent among children of heavy drinkers than others.
Work related harm	When compared to lighter drinking, higher alcohol use results in lowered productivity and increased injury to others.
Drinking and driving	The risk of crashes and injuries to others from drinking increases with both the volume of alcohol consumption and the number of heavy drinking occasions.
Pre-natal conditions	Alcohol shows reproductive toxicity. Prenatal exposure to alcohol can be associated with a distinctive pattern of intellectual deficits that become apparent later in childhood. Even though the volume of drinking may be low, drinking several drinks at a time during pregnancy can increase the risk of spontaneous abortion, low birth weight, prematurity and intra-uterine growth retardation and may reduce milk production in breastfeeding mothers.

Violence A substantial proportion of incidents of aggression and violent crime involves one or more participants who have been drinking (Murdoch, Pihl and Ross 1990; Budd 2003; Pernanen 1991; Collins 1993; Wells, Graham and West 2000; Pernanen *et al.* 2002; Allen *et al.* 2003), with 25%-85% of violent crimes relating to alcohol, the proportion varying across countries and cultures (see Chapter 6). There is a relationship between alcohol consumption and the risk of involvement in violence, including homicide, which is stronger for intoxication than for overall consumption (Rossow 2000; Wells *et al.* 2000). A large number of studies have demonstrated a significantly increased risk of involvement in violence among heavy drinkers, who are also more likely to be the recipients of violence (Rossow *et al.* 2001; Greenfield and Henneberg 2001).

Alcohol and violence

There is a relationship between alcohol consumption and the risk of involvement in violence, which is stronger for intoxication than for overall consumption. Generally the higher the level of alcohol consumption, the more serious is the violence. Caution should be used in extrapolating these findings across all cultures, since many of the studies originate from a restricted range of cultures.

Episodic heavy drinking, frequency of drinking and drinking volume are all independently associated with the risk of aggression (Wechsler *et al.* 1994; Wechsler *et al.* 1995; Wechsler *et al.* 1998; Komro *et al.* 1999; Bonomo *et al.* 2001; Swahn 2001; Richardson and Budd 2003; Swahn and Donovan 2004; Wells *et al.* 2005), with frequency of drinking appearing to be the most important (Wells *et al.* 2005). Drinking volume was associated with alcohol-related aggression in a general population sample, without any evidence of a threshold effect, even when high-quantity drinking was controlled (Room, Bondy and Ferris 1995).

Alcohol is related to aggression in both men and women, with some evidence that alcohol has a greater effect on male aggression than on female aggression (Giancola *et al.* 2002), although one study found similar or slightly increased risks of aggression for women compared with men at the same level of alcohol consumption variables (Wells *et al.* 2005). In this study, aggression was more related to drinking in public places for women, but not for men, when controlling for the drinking variables.

There is an overall relationship between greater alcohol use and criminal and domestic violence, with particularly strong evidence from studies of domestic and sexual violence (Mirrlees-Black 1999; Abbey *et al.* 2001; Caetano *et al.* 2001; Brecklin and Ullman 2002; White and Chen 2002; Lipsey *et al.* 1997; Greenfeld 1998). The relationship is attenuated when other characteristics, such as culture, gender, age, social class, criminal status, childhood abuse, and use of other drugs in addition to alcohol are taken into account. Generally the higher the level of alcohol consumption, the more serious is the violence (Gerson and Preston 1979; Martin and Bachman 1997; Sharps *et al.* 2001). Studies from the United Kingdom (Mirrlees-Black 1999) and Ireland (Watson and Parsons 2005) indicate that one third of intimate partner violence occurs when the perpetrator is under the influence of alcohol. Violence against strangers is more likely to involve alcohol than is violence against intimate partners (Abbey *et al.* 2001; Testa and Parks 1996).

High blood alcohol levels or high levels of consumption are commonly reported not only in the perpetrators of violence, but also in the recipients (Makkai 1997; Mirrlees-Black 1999; Brecklin and Ullman 2002). Alcohol-related sexual assaults by strangers seem to be more likely to occur the greater the alcohol consumption of the recipient, whereas the risk of alcohol-related sexual assaults by partners or spouses seems to be independent of the alcohol consumption of the recipient (Kaufman Kantor and Asdigian 1997; Chermack *et al.* 2001). Many recipients develop drinking problems as a response to sexual violence (Darves-Bornoz *et al.* 1998).

Alcohol as a cause of violence Aside from epidemiological and experimental research relating intoxication and violence (Graham and West 2001; Haines and Graham 2005), there is also research indicating specific biological mechanisms that link alcohol to aggressive behaviour (Bushman 1997; Lipsey *et al.* 1997; Leonard 2005), which are moderated by situational and cultural factors (Wells and Graham

2003). The pharmacological effects of alcohol include increased emotional lability and focus on the present (Graham, West and Wells 2000), decreased awareness of internal cues or less self-awareness (Hull 1981), decreased ability to consider consequences (Hull and Bond 1986; Pihl, Peterson and Lau 1993; Ito, Miller and Pollock 1996) or reduced ability to solve problems (Sayette, Wilson and Elias 1993), and impaired self-regulation and self-control (Hull and Stone 2004). However, these biological pathways are mediated by people's expectations about how people act after drinking (including how acceptable it is to act drunkenly and how accepted certain behaviours are when drunk), in what has been termed 'drunken comportment' (see Chapter 2). How this affects the role of alcohol as a cause of crime across Europe is discussed in Chapter 6.

Alcohol also appears to interact with personality characteristics and other factors related to a personal propensity for violence, such as impulsivity (Zhang *et al.* 1997, Lang and Martin 1993). Injuries from violence may also be more closely linked to alcohol dependence than other types of alcohol-related injury (Cherpitel 1997). In addition to alcohol consumption and drinking pattern, the social context of drinking is also important for alcohol related aggression (Eckardt *et al.* 1998; Fagan 1990; Martin 1992; Collins and Messerschmidt 1993; Graham *et al.* 1998; Parker and Auerhahn 1998), especially for young people whose drinking behaviour is influenced strongly by peers (Hansen 1997). A meta-analysis found that the effects of alcohol were greater in situations characterized by greater anxiety, inhibition conflict and frustration, while differences between sober and intoxicated persons were smaller in situations involving high provocation or self-focused attention (Ito *et al.* 1996). Further, given sufficient disincentives for aggression the effects of alcohol on aggression can be reduced or even eliminated altogether (Hoaken *et al.* 1998; Jeavons and Taylor 1985).

Public drinking establishments are high-risk locations for alcohol-related aggression (Pernanen 1991; Stockwell *et al.* 1993; Archer, Holloway and McLouglin 1995; Rossow 1996; Leonard, Quigley and Collins 2002). However, drinking contexts by themselves do not explain the relationship between alcohol and aggression, since the impact of alcohol also acts independently of the context or setting in which drinking is taking place (Wells *et al.* 2005). The environment for alcohol-related aggression is also not independent of drinking. Although a few incidents that occur in bars involve interpersonal conflict between friends or couples that might have occurred in another setting, almost all incidents of aggression that occur in bars are unplanned, emerge from the social interaction in the bar (Graham and Wells 2001) and often involve strangers. The Comparative Risk Assessment study of the World Health Organization concluded that it seems reasonable to assume that almost all incidents of violence occurring in bars and other environments where drinking is the main activity should be considered attributable to alcohol, either directly through the pharmacological effects of alcohol or indirectly through the social norms related to drinking (Rehm *et al.* 2004).

Marital harm and violence A large number of cross-sectional studies have demonstrated a significant positive association between heavy drinking and the risk of marital breakdown (Leonard and Rothbard 1999), but only a few well-designed studies have demonstrated a significantly increased risk of separation or divorce among married heavy drinkers as compared to others (Fu and Goodman 2000). A large number of cross-sectional studies (Lipsey *et al.* 1997; Leonard 2005) and a few longitudinal studies on alcohol consumption and marital aggression have shown that husbands' heavy drinking increases the risk of marital violence (Quigley and Leonard 1999), in a dose dependent manner (Kaufman Kantor and Straus 1987). Testa *et al.* (2003) reported that episodes of violence in which the husband was drinking involved

more acts of violence and were more likely to involve severe violence compared to sober violence episodes. It also seems that treatment for alcohol dependence reduces intimate partner violence (O'Farrell and Choquette 1991; O'Farrell *et al.* 1999; O'Farrell *et al.* 2000; O'Farrell *et al.* 2003; Stuart *et al.* 2003). Thus, it seems reasonable to conclude that alcohol can be a contributing cause of violence (Leonard 2005). Women with alcohol-related problems often have marital problems (Blankfield and Maritz 1990), and are less confident about resolving marital disagreement (Kelly *et al.* 2000). Women who are alcohol-dependent report high rates of aggression in their spouses (Miller *et al.* 1989, Miller and Downs 1993) and women who are in receipt of alcohol related violence tend to drink more (Olenick and Chalmers 1991).

Child abuse Parental drinking can affect the environment in which a child grows up through financial strain, poor parenting, marital conflicts and negative role models (Gmel and Rehm 2003). A large number of studies have reported a variety of childhood mental and behavioural disorders to be more prevalent among children of heavy drinkers than others, although many of these studies have been criticized for inadequate methodology (Miller *et al.* 1997; Rossow 2000; Widom and Hiller-Sturmhofel 2001). A few recent reports from well-designed studies have shown a higher risk of child abuse in families with heavy drinking parents (Rossow 2000). Systematic reviews have suggested that alcohol is a cause of child abuse in 16% of cases (English *et al.* 1995; Ridolofo and Stevenson 2001).

Reduced work performance Studies analyzing absenteeism rates of people at all levels of alcohol consumption have yielded mixed results (Gmel and Rehm 2003). Some have found no association between absenteeism and drinking. For example, Ames *et al.* (1997) found no significant association between absenteeism and the drinker's usual volume of consumption or frequency of heavy drinking occasions (which they defined as occasions during the past year when a person had 10 or more drinks). Moreover, though drinking at the workplace and hangovers at work were related to other negative consequences, such as workplace injuries, they were not related to absenteeism. A longitudinal study in the UK found that male abstainers had an increased risk of sickness absence compared with lighter drinkers (Marmot *et al.* 1993). A J-shaped relationship has been found in other studies for sickness absence (Vahtera *et al.* 2002), as well as for unemployment (Mullahy and Sindelar 1996) and earnings (Hamilton and Hamilton 1997), although it is not clear in all these studies the extent to which characteristics of the non-drinkers explain the findings, or the extent to which the absenteeism simply reflects a higher extent of health problems in the abstainers as opposed to the light drinkers.

On the other hand, harmful alcohol use and episodic heavy drinking increase the risk of arriving to work late and leaving work early or disciplinary suspension, resulting in loss of productivity; turnover due to premature death; disciplinary problems or low productivity from the use of alcohol; inappropriate behaviour (such as behaviour resulting in disciplinary procedures); theft and other crime; and poor co-worker relations and low company morale (Marmot *et al.* 1993; Rehm and Rossow 2001; Gmel and Rehm 2003). One study conducted at 114 work sites (Mangione *et al.* 1999) showed an almost linear relationship between increasing average consumption and a summary measure of job performance, finding the strongest associations between consumption and getting to work late, leaving early, and doing less work, and only a weak association with missing days of work. Thus, alcohol consumption may have more effect on productivity on the job than on the number of workdays missed.

ALCOHOL AND THE RISK OF ILL-HEALTH

Alcohol is a toxic substance related to more than 60 different disorders with short and long term consequences (Gutjahr *et al.* 2001; English *et al.* 1995; Ridolfo and Stevenson 2001; Room *et al.* 2005). Table 5.1, which is reproduced from the Comparative Risk Assessment, summarizes the relationship between alcohol consumption and risk of ill-health for some more important conditions. For many conditions there is an increasing risk with increasing levels of alcohol consumption, with no evidence of a threshold effect (Anderson *et al.* 1993; Anderson 1995; Anderson 2003; Rehm *et al.* 2003), and with the slopes of the risks varying by gender (Corrao *et al.* 1999; Corrao *et al.* 2004). Box 5.2 summarizes the harms done by alcohol to the individual drinker.

Table 5.1. Relative risks for selected conditions (taken from Comparative Risk Assessment)

	Women			Men		
	Alcohol consumption, g/day					
	0-19	20-39	40+	0-39	40-59	60+
Neuro-psychiatric conditions						
Epilepsy	1.3	7.2	7.5	1.2	7.5	6.8
Gastrointestinal conditions						
Cirrhosis of the liver	1.3	9.5	13.0	1.3	9.1	13.0
Oesophageal varices[1]	1.3	9.5	9.5	1.3	9.5	9.5
Acute and chronic pancreatitis	1.3	1.8	1.8	1.3	1.8	3.2
Metabolic and endocrine conditions						
Diabetes mellitus	0.9	0.9	1.1	1.0	0.6	0.7
Malignant neoplasms						
Mouth and oropharynx cancers	1.5	2.0	5.4	1. 5	1.9	5.4
Oesophageal cancer	1.8	2.4	4.4	1.8	2.4	4.4
Laryngeal cancer	1.8	3.9	4.9	1.8	3.9	4.9
Liver cancer	1.5	3.0	3.6	1.5	3.0	3.6
Breast cancer	1.1	1.4	1.6			
Other neoplasms	1.1	1.3	1.7	1.1	1.3	1.7
Cardiovascular (CVD) diseases						
Hypertensive disease	1.4	2.0	2.0	1.4	2.0	4.1
Coronary heart disease	0.8	0.8	1.1	0.8	0.8	1.0
Ischaemic stroke	0.5	0.6	1.1	0.9	1.3	1.7
Haemorrhagic stroke	0.6	0.7	8.0	1.3	2.2	2.4
Cardiac arrhythmias	1.5	2.2	2.2	1.5	2.2	2.2
Conditions arising during the perinatal period						
Spontaneous abortion	1.2	1.8	1.8			
Low birth weight[2]	1.0	1.4	1.4	1.0	1.4	1.4
Prematurity[2]	0.9	1.4	1.4	0.9	1.4	1.4
Intrauterine growth retardation[2]	1.0	1.7	1.7	1.0	1.7	1.7

[1]Alcohol-related oesophageal varices only occur in the presence of liver cirrhosis
[2]Relative risk refers to drinking of mother
Source: Rehm *et al.* (2004)

Box 5.2 The harm done by alcohol to the individual drinker		
	Condition	**Summary of findings**
Social well being	**Negative social consequences**	For getting into a fight, harming home life, marriage, work, studies, friendships or social life, the risk of harm increases proportional to the amount of alcohol consumed.
	Reduced work performance	Higher alcohol use results in reduced employment and increased unemployment and reduced productivity.
Intentional and unintentional injuries	**Violence**	There is a relationship between alcohol consumption and the risk of involvement in violence, which is stronger for episodic heavy drinking than for overall consumption. The higher the alcohol consumption, the more severe the violence.
	Drinking and driving	The risk of drinking and driving increases with both the amount of alcohol consumed and the frequency of high volume drinking occasions. There is a 38% increased risk of accidents at a blood alcohol concentration level of 0.5g/L.
	Injuries	There is a relationship between the use of alcohol and the risk of fatal and non-fatal accidents and injuries. People who usually drink alcohol at lower levels, but who engage periodically in drinking large quantities of alcohol, are at particular risk. Alcohol increases the risk of attendance at hospital emergency rooms in a dose dependent manner.
	Suicide	There is a direct relationship between alcohol consumption and the risk of suicide and attempted suicide, which is stronger for episodic heavy drinking than for overall consumption.
Neuropsychiatric conditions	**Anxiety and sleep disorders**	Over one in eight of individuals with an anxiety disorder also suffer from an alcohol use disorder. Alcohol aggravates sleep disorders.
	Depression	Alcohol use disorders are a risk factor for depressive disorders in a dose dependent manner, often preceding the depressive disorder, and with improvement of the depressive disorder following abstinence from alcohol.
	Alcohol dependence	The risk of alcohol dependence begins at low levels of drinking and increases directly with both the volume of alcohol consumed and a pattern of drinking larger amounts on an occasion. Young adults are particularly at risk.
	Nerve damage	Clinical studies find that between one quarter and one third of alcohol dependent patients have damage to the peripheral nerves of the body, with the risk and severity of damage increasing with

		lifetime use of alcohol.
	Brain damage	Heavy alcohol consumption accelerates shrinkage of the brain, which in turn leads to cognitive decline. There appears to be a continuum of brain damage in individuals with long-term alcohol dependence.
	Cognitive impairment and dementia	Heavy alcohol consumption increases the risk of cognitive impairment in a dose dependent manner.
Gastrointestinal, metabolic and endocrine conditions	**Liver cirrhosis**	Alcohol increases the risk of liver cirrhosis in a dose dependent manner. At any given level of alcohol consumption, women have a higher likelihood of developing liver cirrhosis than men.
	Pancreatitis	Alcohol increases the risk of acute and chronic pancreatitis in a dose dependent manner.
	Type II diabetes	Although low doses decrease the risk compared with abstainers (see Box 5.3), higher doses increase the risk.
	Overweight	Alcohol contains 7.1 kcal/g and is a risk factor for weight gain. In very heavy drinkers alcohol can replace calories due to meal skipping and lead to malnutrition.
	Gout	Alcohol increases the risk of high blood levels of uric acid and gout in a dose dependent manner.
Cancers	**Gastrointestinal tract**	Alcohol increases the risk of cancers of the mouth, oesophagus (gullet) and larynx (upper airway), and to a lesser extent, cancers of the stomach, colon and rectum in a linear relationship.
	Liver	Alcohol increases the risk of cancer of the liver in an exponential relationship.
	Breast	Alcohol increases the risk of female breast cancer in a dose dependent manner.
Cardiovascular diseases	**Hypertension**	Alcohol raises blood pressure and increases the risk of hypertension, in a dose dependent manner.
	Stroke	Alcohol increases the risk of haemorrhagic stroke with a dose-response relationship. The relationship with ischaemic stoke is J-shaped, with low doses reducing the risk (see Box 5.3) and higher doses increasing the risk. Episodic heavy drinking is an important risk factor for both ischaemic and haemorrhagic stroke, and is particularly important as a cause of stroke in adolescents and young people.
	Irregularities in heart rhythms	Episodic heavy drinking increases the risk of heart arrthymias and sudden coronary death, even in people without any evidence of pre-existing heart disease

	Coronary heart disease (CHD)	Although light drinking reduces the risk of CHD, beyond 20g a day (the level of alcohol consumption with the lowest risk, see Box 5.3), the risk of heart disease increases, being more than the risk of an abstainer after 80g a day. The reduced risk is much less in very old age, where over-reporting of CHD on death certificates also occurs.
	Cardiomyopathy	Over a sustained period of time, a high level of alcohol consumption, in a dose dependent manner, increases the risk of damage to the heart muscles (cardiomyopathy).
Immune system		Alcohol can interfere with the normal functions of the immune system, causing increased susceptibility to certain infectious diseases, including pneumonia, tuberculosis and possibly HIV.
Lung diseases		People with alcohol dependence have a two- to four- fold increased risk of acute respiratory distress syndrome (ARDS) in the presence of sepsis or trauma.
Post-operative complications		Alcohol increases the risk of post-operative complications and risk of admittance to intensive care in a dose dependent manner.
Skeletal conditions		There appears to be a dose-dependent relationship between alcohol consumption and risk of fracture in both men and women that is stronger for men than for women. (See also Box 5.3). In high doses, although in a dose dependent manner, alcohol is a cause of muscle disease.
Reproductive conditions		Alcohol can impair fertility in both men and women.
Total mortality		It has been estimated, at least in the UK, that in younger people (women under the age of 45 years and men under the age of 35 years), any level of alcohol consumption increases the overall risk of death in a dose dependent manner.

Alcohol increases the risk of disorders through both short term, and often brief and intense exposure such as episodic heavy drinking (or binge drinking), described as the *acute effects* of alcohol, and through prolonged or long term exposure, described as the *chronic effects* of alcohol (Last 2001). The disorders include those of sudden onset, whose duration is often brief, described as *acute consequences*, and those which last a long time, described as *chronic consequences* (Last 2001). Intentional and unintentional injuries largely result from acute exposure, as do certain other conditions with long term consequences, such as cardiac arrhythmias and ischaemic stroke. Other conditions, such as cirrhosis of the liver and cancers, result from long term exposure. It is important to note that there can be considerable overlap between acute and chronic exposure and between acute and chronic outcomes for individuals and for certain conditions. Thus an individual with alcohol-related osteoporosis (weakening of the bones) and muscle disease with decreased muscle strength, both

of which result from long term exposure, can be at increased risk of a bone fracture following an alcohol-caused fall. Further a fracture can have both short term consequences (completely and normally heals) and long term consequences, such as bone infection or disability resulting form the fracture. In this section, we have described the conditions in order of the importance of their contribution to alcohol-related disability adjusted life years (see Chapter 6), pointing out when exposure is generally acute or chronic. We have also mentioned some conditions, such as schizophrenia, which are not believed to be caused by alcohol, but which can be affected by alcohol, including treatment outcomes.

Unintentional and intentional injuries

Drinking and driving The risk of drinking and driving increases with both the amount of alcohol consumed and the frequency of high volume drinking occasions (Midanik *et al.* 1996), and blood alcohol concentration levels (Blomberg *et al.* 2002; Hingson and Winter 2003). A review of 112 studies provided strong evidence that impairment in driving skills begins with any departure from a zero blood alcohol concentration level (BAC) (Moskowitz and Fiorentino 2000). Comparison of blood alcohol concentrations (BACs) of drivers in accidents with the BACs of drivers not involved in accidents find that male and female drivers at all ages who had BACs between 0.2g/l and 0.49g/l had at least a three times greater risk of dying in a single vehicle crash. The risk increased to at least 6 times with a BAC between 0.5g/L and 0.79g/L and 11 times with a BAC between 0.8g/l and 0.99 g/L (Zador *et al.* 2000). The risks are greater for serious and fatal crashes, for single-vehicle crashes, and for younger people. Even relatively low doses of alcohol consumption (20g of alcohol) can impair driving in the presence of relative sleep deprivation (Horne *et al.* 2005). The use of alcohol increases both the possibility of being admitted to hospital from drink-drive injuries, and the severity of the injuries (Borges *et al.* 1998).

Injuries There is a relationship between the use of alcohol, largely in the short term, and the risk of fatal and non-fatal accidents and injuries (Cherpitel *et al.* 1995; Brismar and Bergman 1998; Smith *et al.* 1999; Macdonald *et al.* 2005). In an Australian study, the risk of sustaining an injury after consuming more than 60g of alcohol in a 6-hour period was ten times greater for women and two times greater for men (McLeod *et al.* 1999). In a Finnish study, an increasing volume of alcohol consumption increased the risk of fatal injury (Paljärvi *et al.* 2005). When analyzing drinking occasions, drinking at the level of one to two drinks on an occasion, regardless of frequency, did not increase the risk of fatal injury. Drinking four or more drinks at a time increased the risk of fatal injury, with the risk increasing with the frequency of drinking four or more times on an occasion, and with no evidence that tolerance to alcohol lowered the risk of fatal injuries among frequent heavy drinkers. Other studies have found that people who usually drink alcohol at lower levels, but who engage periodically in drinking large quantities of alcohol, are at particular risk (Watt *et al.* 2004). Alcohol increases the risk of attendance at hospital emergency rooms in a dose dependent manner (Cherpitel 1993; Cherpitel *et al.* 2003; Borges *et al.* 2004; Cherpitel *et al.* 2005); between 20% and 80% of emergency room admissions can be alcohol-related (Hingson and Howland 1987).

Alcohol and injuries

There is a relationship between the use of alcohol and the risk of fatal and non-fatal accidents and injuries. People who usually drink alcohol at lower levels, but who engage periodically in drinking large quantities of alcohol, are at particular risk.

Alcohol alters the treatment course of injured patients and can lead to surgical complications (Smith *et al.* 1999) and a greater likelihood of death (Li *et al.* 1994).

Suicide Heavy drinking is a major risk factor for suicide and suicidal behaviour among both young people and adults (Lesage *et al.* 1994, Andrews and Lesinsohn 1992; Beautrais 1998). There is a direct relationship between alcohol consumption and the risk of suicide and attempted suicide, which is stronger for intoxication than for overall consumption (Rossow 1996).

Neuropsychiatric conditions

Depression There is a linear relationship between alcohol consumption and symptoms of depression and anxiety, with increasing prevalence of symptoms with greater consumption (Alati *et al.* 2005).

A number of studies have consistently shown that people with depression and mood disorders are at increased risk of alcohol dependence and vice versa (Regier *et al.* 1990; Merikangas *et al.* 1998; Swendsen *et al.* 1998; Kringlen *et al.* 2001; de Graaf *et al.* 2002; Petrakis *et al.* 2002; Sonne and Brady 2002; Farrell *et al.* 2001; Farrell *et al.* 1998; Jacobi *et al.* 2004; Bijl *et al.* 1998; Pirkola *et al.* 2005). Alcohol-dependent individuals demonstrate a two- to three-fold increase in risk of depressive disorders (Hilarski and Wodarki 2001; Schuckit 1996; Swendson *et al.* 1998), and there is evidence for a continuum in the magnitude of co-morbidity as a function of level of alcohol use (Kessler *et al.* 1996; Merikangas *et al.* 1998; Rodgers *et al.* 2000). For example, one American study found that in any one year, 12% of individuals with unipolar depression were dependent on alcohol (Grant *et al.* 2004), see Table 5.2. Conversely, 28% of people dependent on alcohol had a major depressive disorder, Table 5.3. Similarly, the German Health Interview and Examination Survey found that whereas 56% of people diagnosed with DSM-IV “alcohol abuse and dependence” had one psychiatric diagnosis, 22% had two, 8% three, and 14% four or more diagnoses (Jacobi *et al.* 2004).

Alcohol and depression

Alcohol-dependent individuals demonstrate a two- to three-fold increase in risk of depressive disorders, with a greater risk the greater the level of alcohol consumption. In a substantial number of cases, alcohol use disorders precede the onset of depression.

Although depression may precede heavy alcohol consumption or alcohol use disorders, there is substantial co-morbidity where the onset of alcohol use disorders precedes the onset of depressive disorders (Merikangas *et al.* 1998; Kessler *et al.* 1996; Rehm *et al.* 2004). Furthermore, many depressive syndromes markedly improve within days or weeks of abstinence (Brown and Schuckit 1988; Dackis *et al.* 1986; Davidson 1995; Gibson and Becker 1973, Penick *et al.* 1988; Pettinati *et al.* 1982; Willenbring 1986). There are several plausible biological mechanisms by which alcohol dependence may cause depressive disorders (Markou *et al.* 1998).

Table 5.2 The risk of alcohol dependence in people with mood disorders (US data)[1].

Comorbid Mood Disorders* and Substance Abuse

	Any substance abuse or dependence (%)	Alcohol dependence (%)	Alcohol abuse (%)
Any Mood Disorder	32.0	4.9	6.9
Any Bipolar Disorder	56.1	27.6	16.1
Bipolar I	60.7	31.5	14.7
Bipolar II	48.1	20.8	18.4
Unipolar Depression	27.2	11.6	5.0

NOTES: *Mood disorders include depression and bipolar disorder.
Bipolar disorder, or manic depression, is characterized by extreme mood swings.
Bipolar I disorder is the most severe bipolar disorder.
Bipolar II disorder is less severe.
Unipolar depression is depression without manic episodes.
SOURCE: Data reported in the table are based on findings of the Epidemiologic Catchment Area study (Regier et al. 1990).

[1]The categories alcohol dependence and alcohol abuse are mutually exclusive.

Table 5.3 The risk of mood disorders in people with alcohol dependence (US data).

Prevalence of Psychiatric Disorders in People with Alcohol Abuse and Alcohol Dependence

	Alcohol abuse		Alcohol dependence	
Comorbid Disorder	1-year rate (%)	Odds ratio	1-year rate (%)	Odds ratio
National Comorbidity Survey[1]				
Mood disorders	12.3	1.1	29.2	3.6*
Major depressive disorder	11.3	1.1	27.9	3.9*
Bipolar disorder	0.3	0.7	1.9	6.3*
Anxiety disorders	29.1	1.7	36.9	2.6*
GAD	1.4	0.4	11.6	4.6*
Panic disorder	1.3	0.5	3.9	1.7
PTSD	5.6	1.5	7.7	2.2*
Epidemiologic Catchment Area[2] study	Lifetime rate (%)	Odds ratio	Lifetime rate (%)	Odds ratio
Schizophrenia	9.7	1.9	24	3.8

NOTES: *Odds ratio was significantly different from 1 at 0.05 level. The odds ratio represents the increased chance that someone with alcohol abuse or dependence will have the comorbid psychiatric disorder (e.g., a person with alcohol dependence is 3.6 times more likely to also have a mood disorder compared to a person without alcohol dependence).
The 1-year rate of a disorder reflects the percentage of people who met the criteria for the disorder during the year prior to the survey.
The lifetime rate reflects the percentage of people who met the criteria for the disorder at any time in their lifetime.
SOURCES: [1]Kessler et al. 1996. [2]Regier et al. 1990.

Alcohol dependence No matter how drinking is measured (Grant and Harford 1990; Muthen *et al.* 1992; Dawson and Archer 1993; Hall *et al.* 1993; Caetano and Tam 1995; Midanik *et al.* 1996; Caetano *et al.* 1997), the risk of alcohol dependence increases with both the volume of alcohol consumption and a pattern of drinking larger amounts on an occasion (Caetano *et al.* 1997; Caetano and Cunradi 2002). Both the UK based OPCS national psychiatric morbidity survey (Farrell *et al.* 2001) and the US based NHIS-88 survey (Caetano *et al.* 1997) found that the risk of alcohol dependence increased linearly with the volume of alcohol consumption, with a pattern of drinking that included the consumption of five or more drinks per day considerably increasing the risk in the US study.

The association between alcohol consumption and dependence should not be seen as flowing in one direction only, i.e. from drinking to alcohol dependence. One of the characteristics of alcohol dependence is self-perpetuation. Once installed, dependence itself influences both the pattern and volumes of alcohol consumption, which in turn leads to the maintenance of dependence.

Alcohol dependence is particularly common amongst young adults (Farrell *et al.* 2001; Caetano 1999; Caetano and Cunradi 2002), with frequent drinking at ages 14-15 years predicting alcohol dependence at age 20-21 years (Bonomo *et al.* 2004). There is a progression from alcohol use through harmful use to alcohol dependence (Ridenour *et al.* 2003), and an increasing risk of dependence with duration of exposure to alcohol. One half of people who eventually become dependent do so within ten years of the first use of alcohol (Wagner and Anthony 2002), although the most severe forms of alcohol dependence are rare before the age of 30 years (Coulthard *et al.* 2002).

The two factors that contribute to the development of alcohol dependence are psychological reinforcement and biological adaptation within the brain (World Health Organization 2004; Spanagel and Heilg 2005).

Nerve damage (peripheral neuropathy) Clinical studies find that between one quarter and one third of alcohol dependent patients have damage to those nerves of the body dealing both with the senses and movement, and in particular those supplying the legs (Monforte *et al.* 1995). The risk and the severity of the damage increase as lifetime use of alcohol increases. The effect is independent of malnutrition, but the extent to which malnutrition worsens the damage is unclear. The extent to which alcohol in lower doses increases the risk of peripheral neuropathy is not known.

Cognitive impairment, dementia, and brain damage Alcohol consumption has both immediate and long-term effects on the brain and neuropsychological functioning. The relationship between heavy alcohol consumption and cognitive impairment is well established (Williams and Skinner 1990). People drinking 70 to 84 grams of alcohol per day over an extended period of time show some cognitive inefficiencies; people drinking 98 to 126 grams of alcohol per day show mild cognitive deficits; and 140 grams or more per day results in moderate cognitive deficits similar to those found in people with diagnosed alcohol dependence (Parsons and Nixon 1998).

There is some evidence that amongst men and women aged between 20 and 64 years that abstainers have poorer cognitive function than light drinkers (up to 20g alcohol per day for men and 10g alcohol per day for women) (Rodgers *et al.* 2005), but this seems largely but not completely due to selection effects and poorer physical functioning in the abstainers as opposed to the lighter drinkers (Anstey *et al.* 2005).

There is some indication that light alcohol consumption may reduce cognitive impairment (Ganguli *et al.* 2005) and the risk for vascular-caused dementia in older people, whereas the effects on Alzheimer's disease and cognition remain uncertain, with some studies finding a relationship (Stampfer *et al.* 2005) and others not (Gunzerath *et al.* 2004). Frequent alcohol drinking in middle aged people was associated with cognitive impairment and harmful effects on the brain in later life in one Finnish study, which was more pronounced if there was a genetic susceptibility to dementia (Antilla *et al.* 2004).

Heavy drinking accelerates shrinkage of the brain, which in turn leads to cognitive decline (Rourke and Loberg 1996; Oscar-Berman and Marinkovic 2003). During adolescence, alcohol can lead to structural changes in the hippocampus (a part of the brain involved in the learning process) (De Bellis *et al.* 2000) and at high levels can permanently impair brain development (Spear 2002). There appears to be a spectrum of brain damage in individuals with long-term alcohol dependence, ranging from moderate deficits to the severe psychosis of Wernicke-Korsakoff syndrome, which causes confusion, disordered gait, double vision and inability to retain new information.

Alcohol consumption and ***tobacco use*** are closely linked behaviours. Thus, not only are people who drink alcohol more likely to smoke (and vice versa) but also people who drink larger amounts of alcohol tend to smoke more cigarettes. Smoking rates among people with alcohol dependence have been estimated to be as high as 90 percent. Similarly, smokers are far more likely to consume alcohol than are non-smokers, and smokers who are dependent on nicotine have a 2.7 times greater risk of becoming alcohol dependent than non-smokers (see Drobes 2002 and John *et al.* 2004).

Although not considered to be caused by alcohol, not only is hazardous and harmful alcohol use more common among people with a diagnosis of ***schizophrenia*** (Hulse *et al.* 2000), but there is also evidence that even low levels of alcohol consumption can worsen the symptoms of this condition as well as interfere with the effectiveness of some standard medications (Castaneda *et al.* 1998). Furthermore, improved treatment outcomes have been achieved when harmful alcohol use and the schizophrenia have been treated in an integrated fashion (Mueser and Kavanagh 2001). The co-occurrence between alcohol use disorder and schizophrenia maybe be due to biological factors (a common neurological basis that might reinforce the positive effects of alcohol) and psychological and socio-environmental factors (alleviation of the consequences of mental ill-health and the promotion of socialization) (Drake and Muser 2002).

Gastrointestinal conditions

Long term exposure of alcohol increases the risk of liver cirrhosis (Figure 5.3), and acute and chronic pancreatitis (Corrao *et al.* 1999). For men who die between the ages of 35 and 69 years, the risk of death from liver cirrhosis increases from 5 per 100,000 at no alcohol consumption to 41 per 100,000 at 4 or more drinks per day (Thun *et al.* 1997).

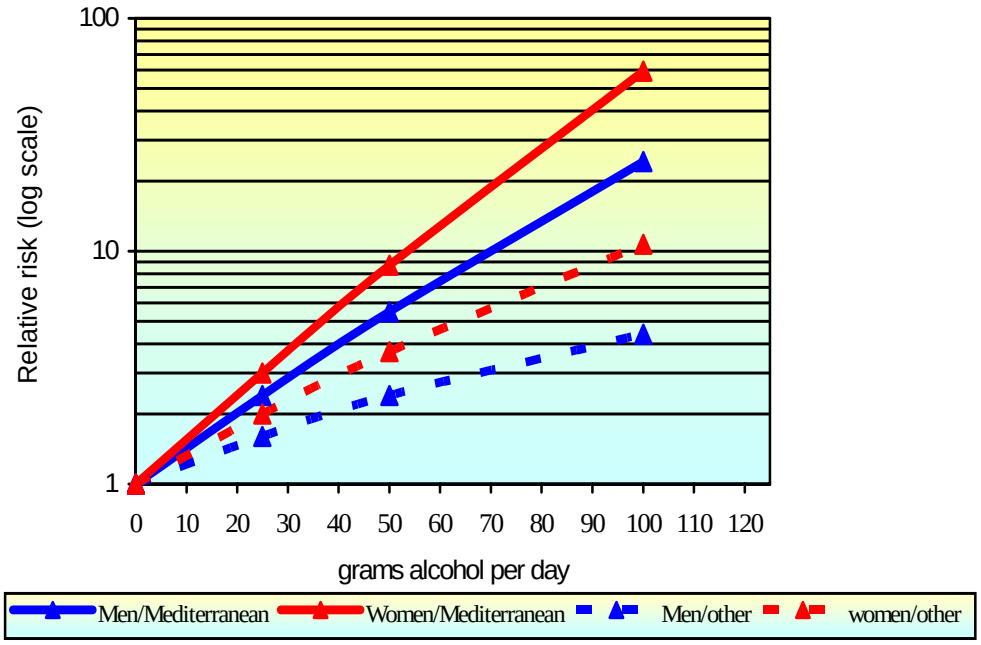

Figure 5.3. Relative risks of liver cirrhosis by alcohol intake for men and women, living in Mediterranean areas and in other areas. Source: Corrao *et al.* (1999).

Although a strong correlation exists between the risk of cirrhosis, the product of daily consumed alcohol in grams and the time of alcohol consumption, only approximately 20% of people with alcohol dependence develop liver cirrhosis (Seitz and Homan 2001). Some studies point to the existence of genetic factors which predispose to alcoholic liver disease. Thus, with respect to alcoholic cirrhosis, the concordance of homozygous (identical) twins was almost 15% compared to 5% for heterozygous (non-identical) twins (Lumeng and Crabb 1994). Polymorphism of ethanol-metabolizing enzymes and/or mutations may also contribute to the risk of alcoholic liver disease. Some studies also show that increased incidence of some HLA-antigens, such as B8, Bw40, B13, A2, DR3 and DR2, are associated with an increased risk of developing alcoholic liver disease (Lumeng and Crabb 1994).

Drinking pattern is also of importance, since periodic drinking of larger quantities of alcohol carries a lower risk compared to continuous drinking for a longer period of time. There is an interaction with hepatitis C infection, with infection increasing the risk of liver cirrhosis at any given level of alcohol consumption, and increasing the severity of the cirrhosis (Schiff 1997; Schiff and Ozden 2003). There is also an apparent interaction with aliphatic alcohol congeners arising from homemade spirits, which increase the risk of cirrhosis (Szucs *et al.* 2005). At any given level of alcohol consumption, women have a higher likelihood of developing liver cirrhosis than men (Mann *et al.* 2003) (see Figure 5.3). Some studies have suggested that increased body mass index (BMI) and blood glucose may independently increase the risk of alcoholic liver disease (Naveau *et al*. 1997; Raynard *et al*. 2002). There has also been a suggestion that wine drinkers have a lower risk of alcohol induced cirrhosis than spirit or beer drinkers (Becket *et al*. 2002).

Gallstones and diabetes

There is some evidence that alcohol might reduce the risk of gallstones, although this finding is not consistent across all studies. Low doses of alcohol decrease the risk of type II diabetes compared with abstainers, but higher doses increase the risk.

There is apparently no association between alcohol consumption and the risk of gastric and duodenal ulcer (Corrao *et al.* 1999; Corrao *et al.* 2004). There is some evidence that alcohol might reduce the risk of gallstones (cholelithiasis) (Leitzmann *et al.* 1998; see Ashley *et al.* 2000; Rehm *et al.* 2003; Rehm *et al.* 2004), although this finding is not consistent across all studies (Sahi *et al.* 1998, Kratzer *et al.* 1997). This is in contrast to the increased risk of developing gallstones in patients with cirrhosis of the liver.

Endocrine and metabolic conditions

Diabetes The relationship with type II diabetes appears to be U- or J-shaped, with low doses decreasing the risk compared with abstainers in both men and women and higher doses increasing the risk (Anbani *et al.* 2000; Rimm *et al.* 1995, Perry *et al.* 1995, Stampfer *et al.* 1988; Hu *et al.* 2001; Rehm *et al.* 2004; Wei *et al.* 2000; Wannamethee *et al.* 2002). Although this finding is not present in all studies (Holbrook *et al.* 1990; Monterrosa *et al.* 1995), it is probably due to alcohol's effect of increasing insulin sensitivity in low doses (10g-20g alcohol a day) (Facchini *et al.* 1994; Flanagan *et al.* 2000).

Weight gain Alcohol represents an important source of energy content of 7.1 kcal/g (Lieber 1988), with every component of the energy-balance equation being affected by the ingestion of alcohol. Moderate amounts of alcohol enhance energy intake due to the caloric content of the alcohol (Rose *et al.* 1995) as well as its appetite-enhancing effects (Siler *et al.* 1998; Forsander 1994). Experimental evidence from several metabolic studies showed an enhancement of a positive fat balance, and thus alcohol being a risk factor for the development of a positive energy balance and weight gain, with the fat being preferentially deposited in the abdominal area (see Suter 2005). In drinkers with alcohol dependence, a larger fraction of the alcohol energy might not be an available source of energy due to the induction of the microsomal ethanol-oxidizing system (Levine *et al.* 2000), and alcohol substituting calorie intake due to meal skipping (Hillers and Massey 1985; Rissanen *et al.* 1987).

Although many epidemiologic studies find a positive relationship between alcohol intake and body weight (Gordon *et al.* 1983; Gordon and Doyle 1986; Rissanen *et al.* 1991; Wannamethee and Shaper 2003) not all do so (Liu *et al.* 1995). This seems largely to be explained by gender, age and ethnic differences (Klatsky *et al.* 1977; Suter *et al.* 1997; Suter 2005). In a study of Swiss restaurant keepers, although abstainers had a higher body weight than moderate alcohol consumers (Meyer *et al.* 1999), limiting the analysis to daily alcohol consumers found a linear increase of the body mass index (BMI) with increasing alcohol intake up to a daily consumption of more than 125g alcohol. Alcohol seems to be particularly important as a risk factor for overweight in drinkers with a high-fat diet and in those who are already overweight (Suter *et al.* 1999).

Gout Alcohol appears to increase the risk of high blood levels of uric acid in a dose dependent manner (Sugie *et al.* 2005), a risk factor for gout, as well as the risk of

gout (an inflammatory arthritis), itself, increasing in a dose dependent manner with alcohol consumption (Choi *et al.* 2004).

Cancers

Alcohol is a carcinogen and long term exposure increases the risk of cancers of the mouth, oesophagus (gullet), larynx (upper airway), liver and female breast, and to a lesser extent, cancers of the stomach, colon and rectum in a linear relationship, Figure 5.4, with no evidence of a threshold effect (Bagnardi *et al.* 2001a; Bagnardi *et al.* 2001b). The mechanisms by which alcohol induces carcinogenesis are hypothesized to include the interaction of cytochrome P-4502E1 (CYP2E1), which metabolizes ethanol to acetaldehyde and is involved in the metabolism of various procarcinogens (Poschl and Seitz 2004). The annual risk of death from alcohol-related cancers (mouth, gullet, throat and liver) increases from 14 per 100,000 for non-dinking middle-aged men to 50 per 100,000 at 4 or more drinks (40g alcohol) a day (Thun *et al.* 1997).

Breast cancer

Alcohol increases the risk of female breast cancer. The cumulative risk by age 80 years increases from 88 per 1000 non-drinking women to 133 per 1000 women who, at baseline, drank 6 drinks (60g) a day.

There is strong evidence that alcohol increases the risk of female breast cancer (one of the most frequent cause of death among younger women) in a dose dependent manner at all ages (Collaborative Group on Hormonal Factors in Breast Cancer 2002). The cumulative risk by age 80 years increases from 88 per 1000 non-drinking women to 133 per 1000 women who, at baseline, drank 6 drinks (60g) a day. It is possible that alcohol increases the risk of breast cancer by increasing sex hormone levels that are known to be a risk factor for beast cancer.

A pooled analysis of original data from nine case controlled studies found that people who drank alcohol had a lower risk for some non-hodgkin lymphomas, but not all (a group of heterogeneous diseases characterized by the malignant transformation of healthy lymphoid cells) (Morton *et al.* 2005). The reduced risk was not related to level of alcohol consumption, and former drinkers had a similar risk to never drinkers. It is unclear the extent to which the findings could be explained by some unidentified confounders.

Also, as noted above, there is a consistent relationship between alcohol and lung cancer (English *et al.* 1995), believed to be mediated by smoking (Bandera *et al.* 2001).

Studies have also considered whether or not alcohol is genotoxic or mutagenic - a substance that can induce permanent changes in the way that cells, tissues, and organs function, which may contribute to the development of cancer. A number of studies have suggested that alcohol has weak genotoxic potential following metabolic changes (Obe and Anderson 1987; Greim 1998). Although the importance of this is not clear (Phillips and Jenkinson 2001), a proposal was considered, but not decided, for the classification of ethanol by the European Chemicals Bureau (1999) of the European Commission as a category 2 mutagen (substances which should be regarded as mutagenic to man) under the Dangerous Substances Directive (67/548/EEC) classification system (Annex VI) (European Commission 2005).

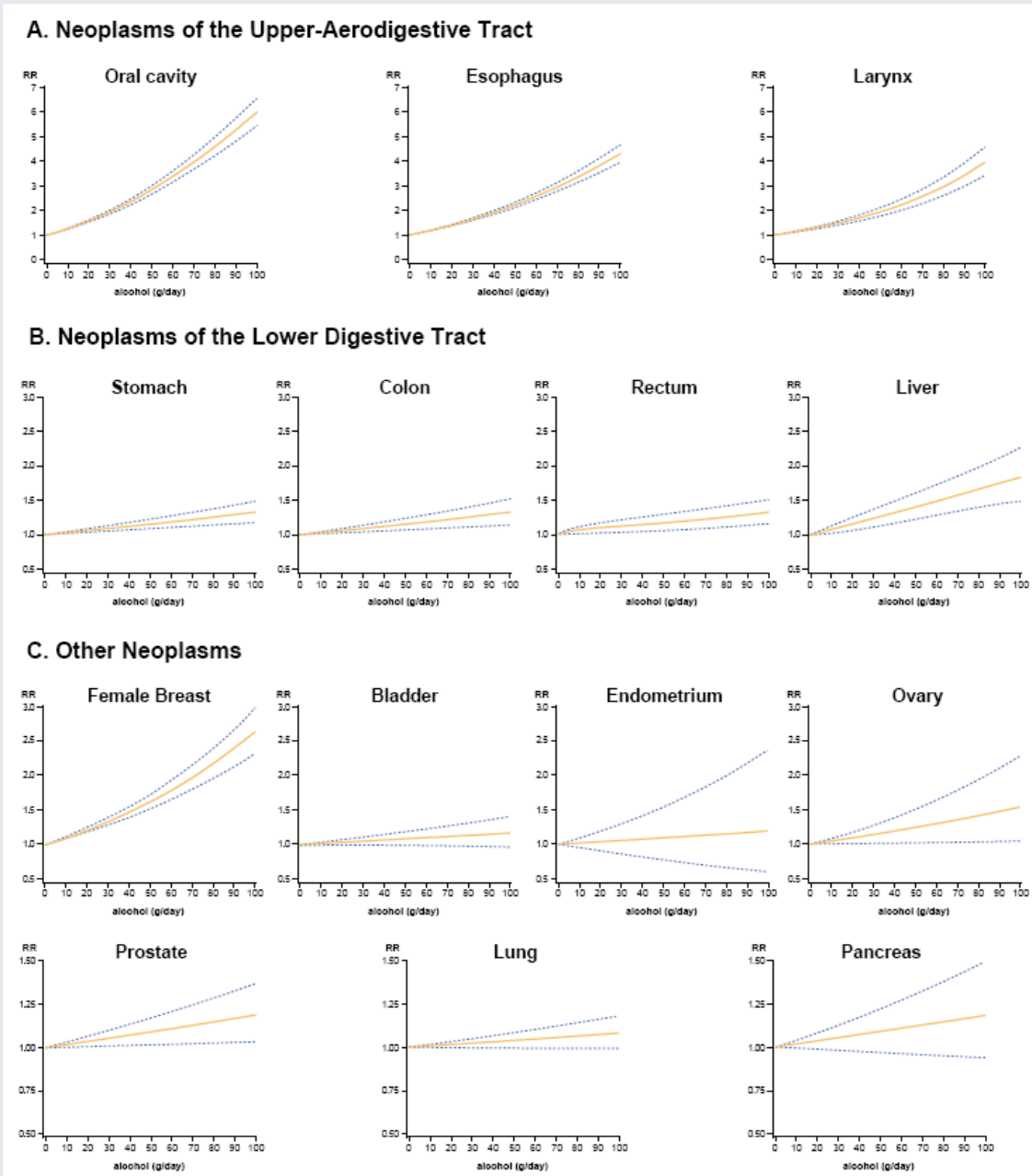

Figure 5.4 Relationship between levels of alcohol consumption and risk for 14 types of cancer. Source: Corrao *et al.* 2004.

Cardiovascular diseases

(For discussion of coronary heart disease, see page 158 below)

Hypertension Alcohol raises blood pressure and increases the risk of hypertension in a dose dependent manner (Beilin *et al.* 1996; Curtis *et al.* 1997; English *et al.* 1995; Grobbee *et al.* 1999; Keil *et al.* 1997; Klatsky 1996;.Klatsky 2001), Figure 5.5.

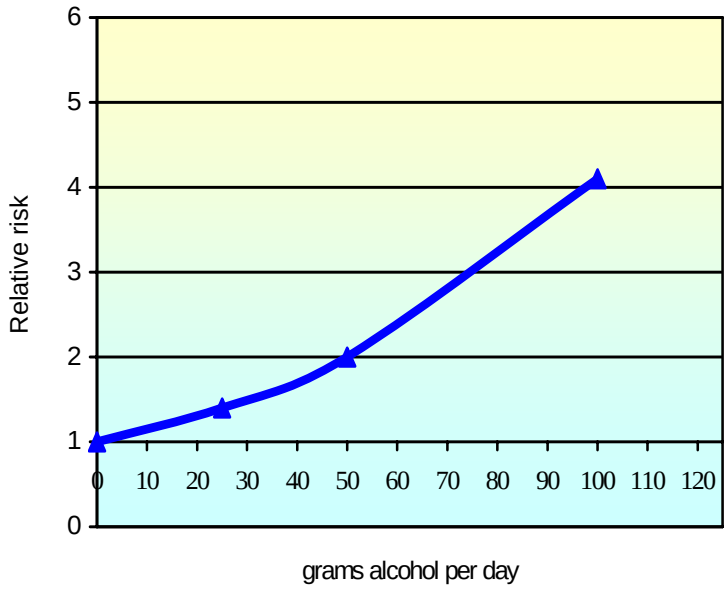

Figure 5.5 Relative risks of hypertension by alcohol intake. Source: Corrao *et al.* (1999).

Stroke There are two main types of stroke: ischaemic stroke which follows a blockage of an artery supplying blood to the brain; and haemorrhagic stroke (also including sub-arachnoid haemorrhage) which follows bleeding from a blood vessel within the brain. Alcohol increases the risk of haemorrhagic stroke (Corrao *et al.* 1999; Reynolds *et al.* 2003), Figure 5.6. Many individual studies have found that light drinking reduces the risk of ischaemic stroke (Beilin *et al.* 1996; Hillbom 1998; Keil *et al.* 1997; Kitamura *et al.* 1998; Knuiman and Vu 1996; Sacco *et al.* 1999; Thun *et al.* 1997; Wannamethee and Shaper 1996). Whereas one systematic review combining all studies found no clear evidence of a protective effect of light to moderate drinking on the risk of either ischaemic stroke or overall stroke (Mazzaglia *et al.* 2001), a more recent review found a clear J-shaped relationship between alcohol consumption and risk of ischaemic stroke, with consumption levels of up to 24g a day reducing the risk, whereas consumption levels of 60 or more grams per day increased the risk (Reynolds *et al.* 2003). The relationship is moderated by a genotype that influences high density lipoprotein cholesterol that is one of the biochemical mediators of the protective effect. In the absence of the genotype there is no statistical relationship between alcohol consumption and risk of ischaemic stroke; whereas in its presence alcohol consumption increases the risk of iscahemic stroke (Mukamal *et al.* 2005).

Episodic heavy drinking is an important risk factor for both ischaemic and haemorrhagic stroke, and is particularly important as a cause of stroke in

adolescents and young people. Up to 1 in 5 of ischaemic strokes in persons less than 40 years of age are alcohol-related, with a particularly strong association among adolescents (Hillbom and Kaste 1982).

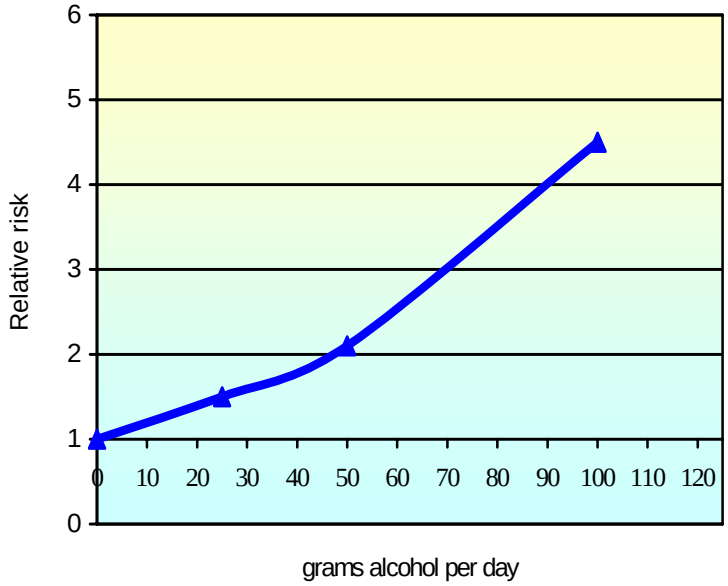

Figure 5.6 Relative risks of haemorrhagic stroke by alcohol intake. Source: Corrao *et al.* (1999).

Irregularities in heart rhythms Episodic heavy drinking increases the risk of heart arrthymias and sudden coronary death, even in people without any evidence of pre-existing heart disease (Robinette *et al.* 1979; Suhonen *et al.* 1987; Wannamethee and Shaper 1992; Mukamal *et al.* 2005). Atrial fibrillation appears the most common form of arrhythmia induced by both consistent heavy alcohol consumption and high volume drinking occasions. It has been estimated that in 15%-30% of patients with atrial fibrillation, the arrhythmia may be alcohol-related, with possibly 5%-10% of all new episodes of atrial fibrillation explained by excess alcohol use (Rich *et al.* 1985).

Heart rhythms

Episodic heavy drinking increases the risk of heart arrthymias and sudden coronary death, even in people without any evidence of pre-existing heart disease.

Cardiomyopathy Over a sustained period of time (five years or more), a high consumption of alcohol (more than 90g a day) can lead to cardiomyopathy, a disease of the heart muscle (Urban-Marquez *et al.* 1989) that leads to an enlarged heart and thinning of the heart muscle (Piano 2002). One third of men with alcohol dependence but with no symptoms of heart disease were found to have a considerably reduced heart function (Urban-Marquez *et al.* 1989), with an increased risk as the level of alcohol consumption rises. The extent to which alcohol in lower doses increases the risk of cardiomyopathy is not known.

Immune system

Alcohol can interfere with the normal functions of various components of the immune system (Nelson and Kolls 2002), and a high level of alcohol consumption can lead to immune deficiency, causing increased susceptibility to certain infectious diseases (US Department of Health and Human Services 2000; Estruch 2001), including pneumonia (Fernandez-Sola *et al.* 1995), tuberculosis (Cook 1998), and possibly HIV (Meyerhoff 2001). Part of the immune deficiency is exacerbated by malnutrition and liver disease (Estruch 2001).

Lung diseases

Acute respiratory distress syndrome (ARDS) is a severe form of lung injury that results from blood infections, trauma, pneumonia and blood transfusions (Guidot and Roman 2002). Clinical studies find that the presence of "alcohol abuse" and alcohol dependence independently increase the risk of ARDS two- to four-fold in patients with sepsis or trauma and may play a role in ARDS in as many as half of all patients with the syndrome (Guidot and Hart 2005). Although alcohol itself does not cause acute lung injury, it renders the lung susceptible to the inflammatory stresses of sepsis and trauma. In the United States, ARDS affects some 75,000 to 150,000 people each year (Guidot and Roman 2002), meaning that ARDS matches cirrhosis in terms of alcohol-related deaths in the United States. The extent to which there is a dose response relationship between lower levels of alcohol consumption and the risk of lung injury is not known.

Post-operative complications

Alcohol increases the risk of post-operative complications for general surgery, including infection, bleeding problems and cardiopulmonary insufficiency requiring intensive care (Tønnesen and Kehlet 1999). A Spanish study found a dose response relationship between alcohol consumption and risk of admittance to intensive care following general surgery (Delgad-Rodriguez *et al.* 2003).

Skeletal conditions

There appears to be a dose-dependent relationship between alcohol consumption and osteoporosis and risk of fracture in both men and women (US Department of Health and Human Services 2000; Preedy *et al.* 2001). It seems that the association between heavy alcohol use and decreased bone mass and increased fracture risk is less prevalent in women than in men (Sampson 2002), and there is even some evidence that women who consume alcohol in small doses generally have a higher bone mass than do women who abstain (Turner and Sibonga 2001; Williams *et al.* 2005), although at higher doses, alcohol reduces bone mass (Kogawa and Wada 2005).

In high doses, although in a dose dependent manner, alcohol is a cause of muscle disease and a decrease in muscle strength. It is probably the most common cause of

muscle disease, affecting between one and two thirds of all people with alcohol dependence (Urban-Marquez *et al.* 1989; Preedy *et al.* 2001).

Reproductive conditions

Alcohol can have negative consequences for both male and female reproduction. Alcohol use affects the endocrine glands and hormones involved in male reproduction and can reduce fertility through sexual dysfunction and impaired sperm production (Emanuele and Emanuele 2001). Alcohol consumption during early adolescence may suppress the secretion of specific female reproductive hormones, thereby delaying puberty and adversely affecting the maturation of the reproductive system (Dees *et al.* 2001). Beyond puberty, alcohol has been found to disrupt normal menstrual cycling, impairing fertility (Emanuele *et al.* 2002). There is also some evidence that alcohol is a risk factor for risky sexual behaviour (Markos 2005).

Pre-natal conditions

Alcohol shows reproductive toxicity. Prenatal exposure to alcohol can be associated with a distinctive pattern of intellectual deficits that become apparent later in childhood, including reductions in general intellectual functioning and academic skills as well as deficits in verbal learning, spatial memory and reasoning, reaction time, balance, and other cognitive and motor skills (Mattson *et al.* 2001; Chen *et al.* 2003; Koditowakko *et al.* 2003). Some deficits, like problems with social functioning, appear to worsen as these individuals reach adolescence and adulthood, possibly leading to an increased rate of mental health disorders (Jacobson and Jacobson 2002). Although these deficits are most severe and have been documented most extensively in children with Foetal Alcohol Syndrome (FAS), children pre-natally exposed to lower levels of alcohol can exhibit similar problems (Gunzerath *et al.* 2004) in a dose dependent manner (Sood *et al.* 2001), exacerbated by episodic heavy drinking (Jacobson and Jacobson 1994; Jacobson *et al.* 1998; Streissguth *et al.* 1993 1994).

Pregnancy

Alcohol, even at low average volumes of consumption, and particularly during the first trimester of pregnancy, can increase the risk of spontaneous abortion, low birth weight, prematurity and intra-uterine growth retardation.

There is some evidence that alcohol even at low average volumes of consumption, and particularly during the first trimester of pregnancy can increase the risk of spontaneous abortion, low birth weight, prematurity and intra-uterine growth retardation (Abel 1997; Bradley *et al.* 1998; Windham *et al.* 1997; Albertsen *et al.* 2004; Rehm *et al.* 2004; Albertsen *et al.* 2004). There is also some evidence that alcohol may reduce milk production in breastfeeding mothers (Mennella 2001; Gunzerath *et al.* 2004).

ALCOHOL AND THE RISK OF HEART DISEASE

J-shaped function Alcohol, in low doses, reduces the risk of coronary heart disease (Gunzerath *et al.* 2004). Objectively defined higher quality studies find less of a protective effect than lower quality studies (Corrao *et al.* 2000). A review of higher

quality studies, found that the risk of coronary heart disease decreased to 80% of the level of non-drinkers at 20 grams (two drinks) of alcohol per day, Figure 5.7. Most of the reduction in risk occurred by the level of one drink every second day. Beyond two drinks a day (the level of alcohol consumption with the lowest risk), the risk of heart disease increases, the risk exceeding that of an abstainer beyond a consumption level of 80g a day.

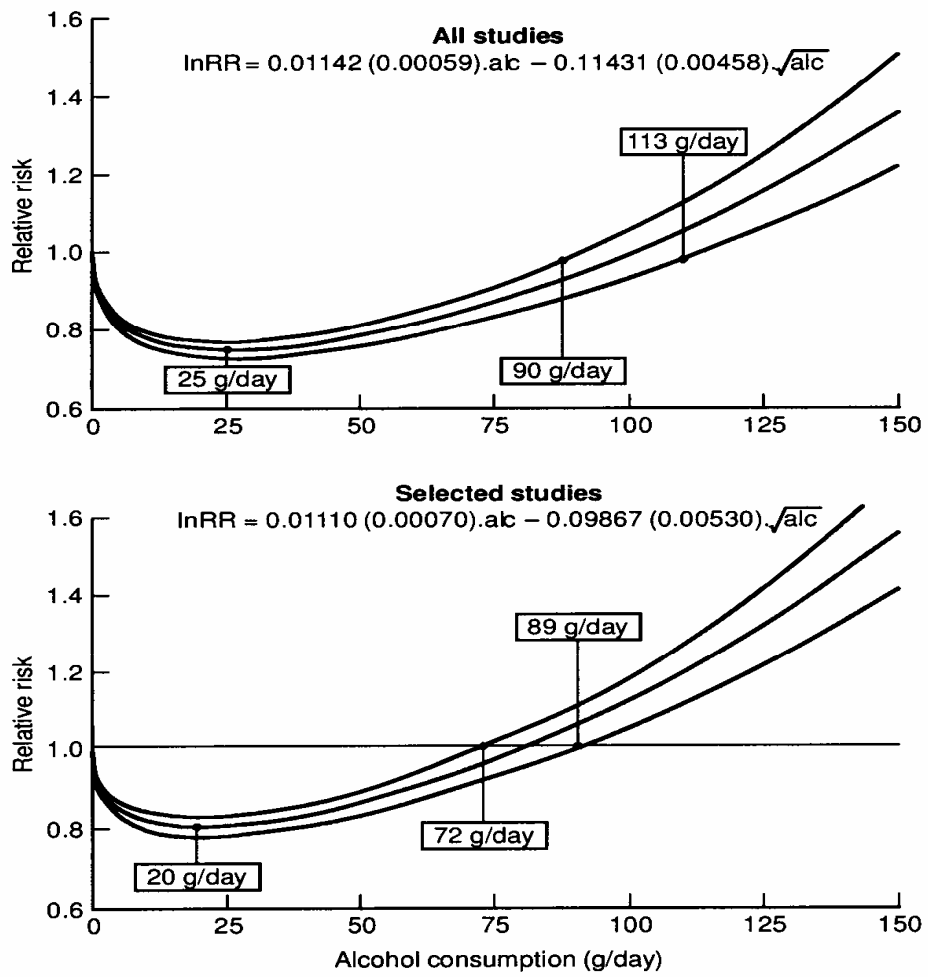

Figure 5.7 Functions (and corresponding 95% confidence intervals) describing the dose-response relationship between reported alcohol consumption and the relative risk of coronary heart disease obtained by pooling all the 51 included studies and the 28 selected cohort studies for which a high quality score was assigned. The fitted models (with standard errors in parentheses) and three critical exposure levels (nadir point, maximum dose showing statistical evidence of protective effect, and minimum dose showing statistical evidence of harmful effect) are reported. *Reproduced from*: Corrao *et al.* (2000).

The protective effect of alcohol is greater for non-fatal heart attacks than for fatal heart attacks, for men than for women and for people studied in Mediterranean countries than in non-Mediterranean countries. Alcohol's effect in reducing the risk is only relevant to middle aged and older adults, who are at increased risk for heart disease. All of the health benefits of alcohol for the individual drinker are summarized in Box 5.3.

Impact of high doses Whereas low doses of alcohol may protect against heart disease, high doses increase the risk, and high volume drinking occasions may precipitate cardiac arrhythmias, myocardial ischaemia or infarction and coronary death (Trevisan *et al.* 2001a; Trevisan *et al.* 2001b; Murray *et al.* 2002; Gmel *et al.* 2003 Britton and Marmot 2004; Trevisan *et al.* 2004).

Coronary heart disease

Alcohol, in low doses, reduces the risk of coronary heart disease, with 80% reduced risk at a consumption of two drinks a day (20g alcohol). Beyond two drinks a day (the level of alcohol consumption with the lowest risk), the risk of heart disease increases, being more than the risk of an abstainer beyond a consumption level of 80g a day.

Biochemical basis The relationship between alcohol consumption and the risk of coronary heart disease is biologically plausible and independent of beverage type (Mukamal *et al.* 2003; Mukamal *et al.* 2005). Alcohol consumption raises levels of high density lipoprotein cholesterol (HDL) (Klatsky 1999). HDL removes fatty deposits in blood vessels and thus is associated with a lower risk of coronary heart disease deaths. Moderate alcohol intake favourably affects blood clotting profiles, reducing the risk of heart disease (McKenzie and Eisenberg 1996; Reeder *et al.* 1996; Gorinstein *et al.* 2003; Imhof and Koenig 2003; Burger *et al.* 2004). Alcohol's impact on coagulation mechanisms is likely to be immediate and, since lipid modification in older age groups produces significant benefit, the impact mediated through elevation of HDL cholesterol can probably be achieved by alcohol consumption in middle age.

The biochemical changes that might reduce the risk of heart disease result equally from beer, wine or spirits and are due to both polyphenols and ethanol (Gorinstein and Trakhtenberg 2003); although red wine has the highest content of polyphenols, the biochemical changes do not result from grape juice or wine from which the alcohol has been removed (Sierksma 2003; Hansen *et al.* 2005). In contrast with these biochemical changes, there is evidence that alcohol consumption, in a dose dependent manner, and episodic heavy drinking increase the risk of calcification of the coronary arteries in young adults (Pletcher *et al.* 2005), a marker of atherosclerosis that is predictive of future heart disease (Pletcher *et al.* 2004).

J-shaped relationship not found in all studies Although the relationship between lower levels of alcohol consumption and reduced risk of coronary heart disease is found in many studies, it is not found in all. A study of a group of employed Scottish men aged over 21 years found no elevated risk for coronary heart disease among abstainers, compared to light and moderate drinkers (Hart *et al.* 1999). Other studies of the general population, where respondents might be expected to have reduced their drinking due to poor health, have found no differences in death rates between light drinkers and abstainers (Fillmore *et al.* 1998a, Fillmore *et al.* 1998b; Leino *et al.* 1998). A meta-analysis of 54 published studies tested the extent to which a systematic misclassification error was committed by including as 'abstainers' many people who had reduced or stopped drinking, a phenomenon associated with ageing and ill health. The studies judged to be error free found no significant all-cause or cardiac protection, suggesting that the cardiac protection afforded by alcohol may have been over-estimated (Fillmore *et al.* 2006).

BOX 5.3 Health benefits of alcohol to the individual drinker		
	Condition	**Summary of findings**
Social well being	***Pleasure***	General population studies have found that alcohol consumption relates to positive sensations and improved subjective health, influenced by culture, the setting in which drinking occurs, and people's expectations about alcohol's effects.
	Work	There is a J-shaped relationship between alcohol consumption and risk of sickness absence, which may reflect a higher extent of health problems in abstainers.
Neuropsychiatric conditions	***Cognitive functioning and dementia***	Light alcohol consumption may reduce the risk for vascular-caused dementia. The effects of alcohol on Alzheimer's disease and cognition remain uncertain, with some studies finding a beneficial effect and others not.
Gastrointestinal, endocrine and metabolic conditions	***Gallstones***	There is some evidence that alcohol might reduce the risk of gallstones, although this finding is not consistent across all studies.
	Type II diabetes	The relationship with type II diabetes appears to be U-shaped, with low doses decreasing the risk compared with abstainers and higher doses increasing the risk. Not all studies find a decreased risk from lighter drinking.
Cardiovascular diseases	***Ischaemic stroke***	There is a J-shaped relationship between alcohol consumption and risk of ischaemic stroke, with low doses of alcohol consumption (up to 24g a day) decreasing the risk.
	Coronary heart disease (CHD)	There is a J-shaped relationship between alcohol consumption and risk of CHD. One meta-analysis has estimated a 20% decreased risk of CHD at reported consumption levels of 20g/day. However, the protective effect appears to be reduced in very old age. Although the relationship between alcohol consumption and the risk of CHD is biologically plausible, concern still remains that the size of the effect may have been overestimated due to alcohol measurement problems and confounders that have not been adequately controlled in all studies.
Skeletal conditions		There is some evidence that women who consume alcohol in small doses generally have a higher bone mass than do women who abstain.
Total mortality		In older people, compared with people who do not drink, small quantities of alcohol reduce the overall risk of dying. In a UK study, the level of alcohol consumption with the lowest risk for total mortality (nadir) occurred at 4 g per day for women aged 65 years and over and 11 g per day for men aged 65 years and over.

Un-healthier lifestyle in abstainers Some studies in England and the United States have found that compared to non-drinkers, light drinkers had generally healthier lifestyles in terms of diet, physical activity and not-smoking (Wannamathee and Shaper 1999; Barefoot *et al.* 2002) and higher incomes (Hamilton and Hamilton 1997; Zarkin *et al.* 1998). It has been suggested that this could have explained the apparent increased risk of heart disease in non-drinkers compared with light drinkers. Although not found in a Finnish study (Poikolainen *et al.* 2005), examples of factors more commonly associated with non-drinking status included being older and non-white, being widowed or never married, having less education and income, lacking access to health care or preventive health services, having co-morbid health conditions such as diabetes and hypertension, having lower levels of mental well-being, being more likely to require medical equipment, having worse general health, and having a higher risk for cardiovascular disease (Naimi *et al.* 2005). For factors in which there were multiple risk categories, there was a graded relationship between increasing levels of risk and an increased likelihood of being a non-drinker.

An Australian study found that non-drinkers had a range of characteristics known to be associated with anxiety, depression and other facets of ill health, such as low status occupations, poor education, current financial hardship, poor social support and recent stressful life events, as well as increased risk of depression, all of which could explain an increased risk of heart disease amongst non-drinkers compared with light drinkers (Rodgers *et al.* 2000; Greenfield *et al.* 2002). One American study found that, whereas alcohol consumption reduced the risk of coronary heart disease in white men, it increased the risk in black men, suggesting that the cardioprotective effect could be explained by consistent confounding of lifestyle characteristics of drinkers (Fuchs *et al.* 2004).

Increased risk based on lifetime consumption The British Regional Heart study has confirmed that as alcohol consumption tends to decrease with age, epidemiological studies based on baseline measurement lead to an underestimation of risk (Emberson *et al.* 2005). Whereas baseline alcohol intake displayed U-shaped relations with cardiovascular disease and all-cause mortality, with light drinkers having the lowest risks and non-drinkers and heavy drinkers having similarly high risks, the nature of these relations changed after adjustment for average intake over the twenty year duration of the study; risks associated with non-drinking were lowered, and risks associated with moderate and heavy drinking increased, Figure 5.8.

Regular heavy drinkers had a 74% higher risk of a major coronary event, a 133% higher risk of stroke, and a 127% higher risk of all-cause mortality than did occasional drinkers (these estimates were 8%, 54%, and 44% before adjustment for intake variation). It is also important to note that the reduction in risk with alcohol consumption may become less and disappear, the longer the time when subjects in studies are followed-up (Nielsen *et al.* 2005).

Reduced protection in very old age Few studies have examined how the relative risk between alcohol consumption and heart disease changes with old age (Grønbæk *et al*. 1998). In general, relative risks for risk factors for coronary heart disease converge towards 1.0 with increasing age (Abbott *et al.* 1997), including alcohol (Abrams *et al.* 1995). The Honolulu heart study found that comparing drinkers with non-drinkers, the relative risk converged towards 1.0, with increasing age, such that there was no evidence for a protective effect in men aged 75 years or older (Abbott *et al.* 2002). Further, in this age group, there is an increased over-recording of coronary heart disease on death certificates. The Framingham Heart Study found that over-recording of heart disease on death certificates increased exponentially

with age, such that at an age of death of 85 years or more, over-recording was estimated to be doubled (Lloyd-Jones *et al.* 1998).

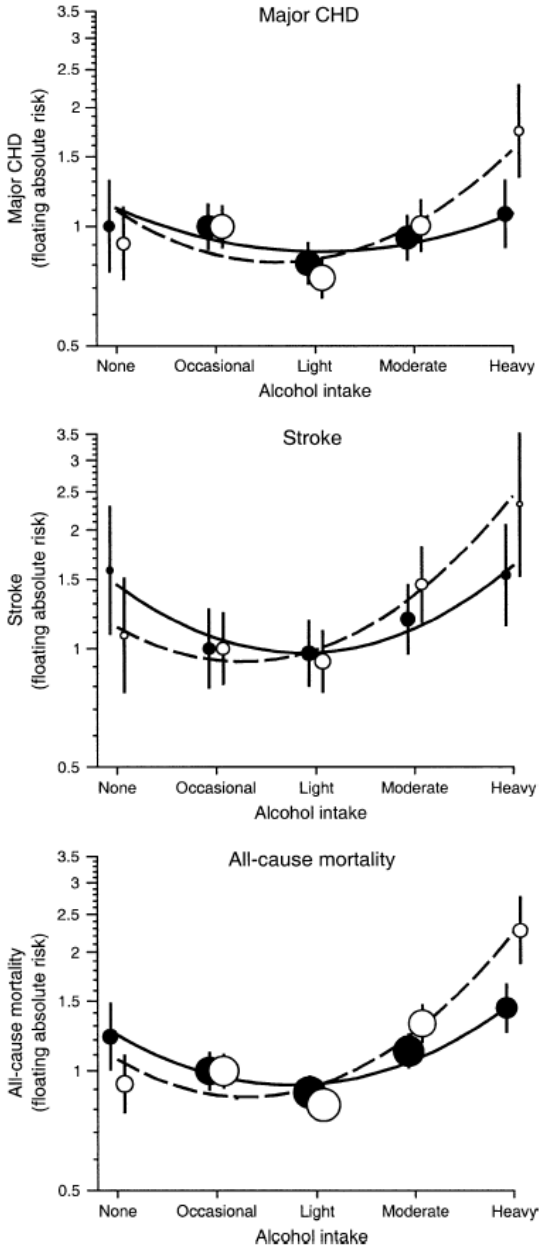

Figure 5.8. Relative hazard of major coronary heart disease (CHD) (coronary death and nonfatal myocardial infarction), stroke, and all cause mortality by alcohol intake, among British Regional Heart Study men originally free from cardiovascular disease followed from 1978/1980 to 1998/2000. The black circles and solid line correspond to baseline alcohol intake levels, and the white circles and dashed line correspond to ''usual'' alcohol intake levels obtained after adjustment for individual variation in alcohol intake. The size of each plotting symbol indicates the amount of statistical information on which each estimate is based. The vertical lines show 95% confidence intervals for the absolute risks. Source: Emberson *et al.* 2005.

IS THERE A RISK FREE LEVEL OF ALCOHOL CONSUMPTION?

The shape of the relationship between alcohol consumption and death depends on both the distribution of the causes of death amongst the population studied, and on the level and patterns of alcohol consumption within the population. At younger ages deaths from accidents and violence (which are increased by alcohol consumption) predominate, while coronary heart disease deaths (which are reduced by alcohol consumption) are rare. The position is reversed at older ages. There is some

evidence that at any given volume of drinking, those drinking higher amounts on a given drinking occasion have a higher risk of death (Tolstrup *et al.* 2004).

The risk of dying

The level of alcohol consumption with the lowest risk of death is zero for women aged less than 45 years and men aged less than 35 years. It is 4 g per day for women aged 65 years and over, and 11 g per day for men aged 65 years and over.

There is a positive, largely linear relationship between alcohol consumption and risk of death in populations or groups with low coronary heart disease rates (which includes younger people everywhere). On the other hand there is a J or, among older populations, a U shaped relationship between alcohol consumption and risk of death in populations with high rates of coronary heart disease. The exact age when the relationship changes from a linear to a J or U shape depends on the distribution of causes of death, but in European countries occurs at an age of death of 50 to 60 years (Rehm and Sempos 1995). The effects of this changing risk curve on overall levels of health in Europe can be seen in Chapter 6.

As with coronary heart disease, the level of consumption in the individual associated with the least risk of death varies from country to country. Thus, studies from southern and central European countries, with higher consumption levels at least until recently, find the level of consumption associated with the lowest rate of death to be higher (Farchi *et al.* 1992; Brenner *et al.* 1997; Keil *et al.* 1997; Renaud *et al.* 1998) than countries with lower alcohol consumption levels (English *et al.* 1995; White 1999).

In the United Kingdom, it has been estimated that the level of alcohol consumption with the lowest risk of death for women is zero aged under 45 years, 3 g per day aged 45 to 64 years and 4 g per day aged 65 years and over, Figure 5.9.

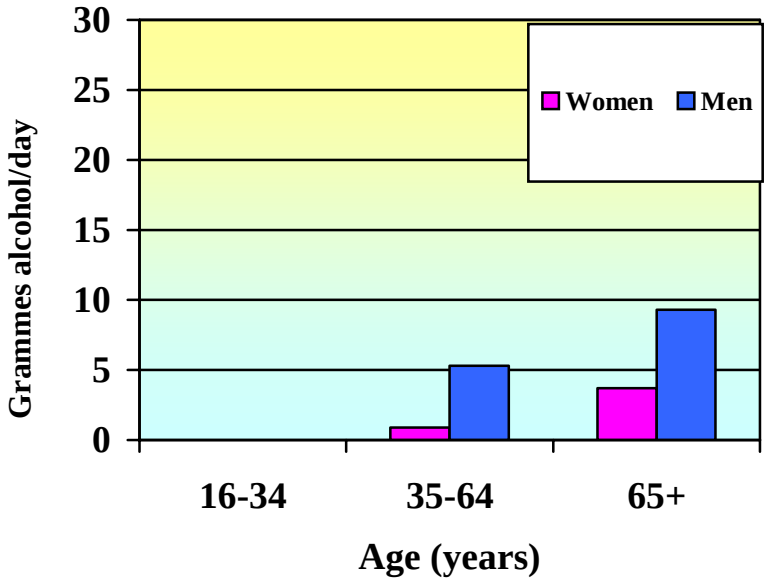

Figure 5.9 Level of alcohol consumption with lowest risk to death (UK estimates). Source: White *et al.* (2002).

Analytical techniques and the J-shaped curve Due to the way that questionnaires ask about alcohol consumption, studies that relate the risk of harm to levels of alcohol consumption summarize alcohol consumption within discrete categories, whereas the distribution between individuals is, in fact, continuous. Categorizing the alcohol intake has several disadvantages: high and low risk individuals could be merged (e.g., for highest alcohol consumption group), and thereby dilute the estimated influence; and the number and placement of category boundaries may affect the estimates and thereby the level of alcohol consumption with the lowest risk of ill-health. A statistical technique called Generalized Additive Models (GAM) can overcome this problem (Hastie and Tibshirani 1990).

When this technique was applied to the results of the Copenhagen Heart Study, it was found that the relationship between alcohol consumption and risk of death was dependent on whether or not non-drinkers (in this study defined as people who drank less than 12g of alcohol a week) were included in the analysis (Johansen *et al.* 2005). A J-shape resulted when non-drinkers were included in the analysis, Figure 5.10 (blue line), with the usual finding that light drinkers have a reduced risk of death over a range of up to one drink a day for women and up to two drinks a day for men. However, if non-drinkers were removed from the analysis, a positive linear relationship was found between alcohol intake and risk of death for both men and women (red line). This analysis suggested that for anyone who drank 12g or more of alcohol per week, there was an increased risk of death, even for low alcohol intake, and there was no evidence of a threshold effect (i.e. there was a straight line relationship, rather than an increased risk only after a certain level of alcohol consumption).

Thus, this study suggests that the J-shaped curve relating alcohol to the risk of death is due to an increased risk in persons who drink less than one drink per week, rather than from a benefit of drinking alcohol; that J-shaped curves overestimate the increased risk of death in drinkers with very low levels of alcohol intake (the first part of the J-shaped curve) compared with those who drink at the level of alcohol consumption with the lowest risk of death; and that J-shaped curves imply that the level of alcohol consumption with the lowest risk of death occurs at too high a level of alcohol consumption.

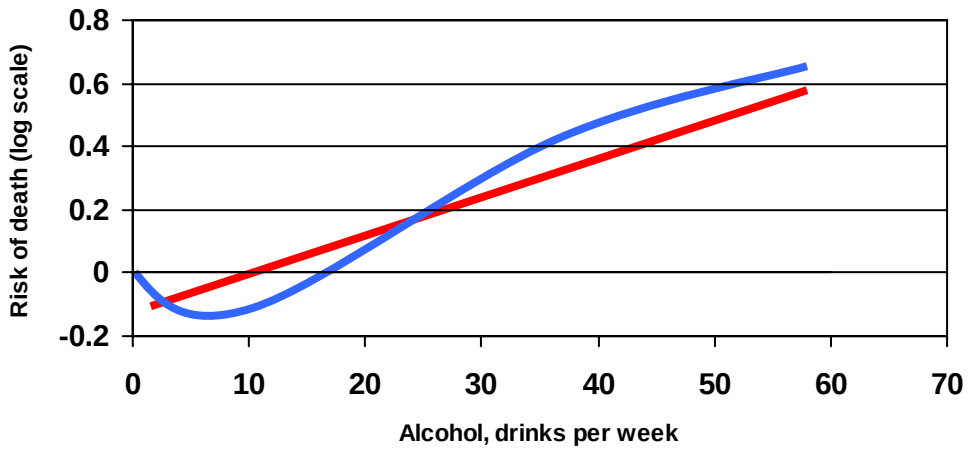

Figure 5.10 Risk of death in men when non-drinkers included in the analysis (blue line) and excluded from analysis (red line). Source: Johansen *et al.* (2005), Copenhagen city heart study. Modelled using General Additive Models.

The impact of alcohol and health across the lifespan is summarized in Box 5.4.

WHAT DETERMINES RISK FOR ALCOHOL-RELATED ILL-HEALTH?

Hippocrates, writing 2500 years ago, advised anyone coming to a new city to enquire whether it was likely to be a healthy or unhealthy place to live, depending on its geography and the behaviour of its inhabitants ("whether they are fond of excessive drinking") (Hippocrates, translated by Lloyd 1978). He continued "as a general rule, the constitutions and the habits of a people follow the nature of the land where they live". The impact of the area and population in which people live is clearly demonstrated by studies of large scale migrations from one culture to another, in which, for example, an increase in risk factors and coronary heart disease is observed when individuals migrate from a low to a high risk culture and assume the lifestyle of the new culture (Kagan *et al.* 1974). In other words, and this applies to many risk factors and conditions (Rose 1992), including suicide (Durkheim, translated by Spaulding and Simpson 1952), the behaviour and health of individuals are profoundly influenced by a society's collective characteristics and social norms. Chapter 6 will show that this also applies to alcohol, where there is a relationship between the overall per capita alcohol consumption and the number of individuals in a population with harmful alcohol use and alcohol use disorders (Skog 1991; Lemmens 2001; Academy of Medical Sciences 2004). The rest of this section will describe other influences that have a direct impact in determining risk for alcohol-related health.

Genetic influences

Genetic background influences the risk of alcohol use disorders. The classic twin study design compares the resemblances for a condition of interest between monozygotic (MZ, identical) twins and dizygotic (DZ, fraternal) twins, in order to determine the extent of genetic influence, or heritability, of the condition. Heritability can be calculated because MZ twins are genetically identical, whereas DZ twins share only half their genes. The method relies on the "equal-environment assumption," that is, that the similarity between the environments of both individuals in a pair of MZ twins is the same as the similarity between the environments of members of pairs of DZ twins, although there is clearly an interaction between genes and the environment (Heath and Nelson 2002).

While twin studies do not identify specific genes influencing a condition, they do provide important information on the condition's genetic impact (more general properties of its inheritance pattern, such as whether genes act independently of one another, or in concert, to influence a condition), which aspects of the condition are most heritable, whether the same genes are influencing the condition in both genders, and whether multiple conditions share any common genetic influences. When data on twins are augmented by data on their family members, the study is termed a twin/family study and can provide more precise information about whether parents transmit a behavioural condition to their offspring genetically or via some aspect of the familial environment (cultural transmission). When detailed data about the environment are collected, twin and twin/family studies can provide information about how environmental factors interact with genetic predisposition to produce a disease.

Box 5.4 Alcohol and health across the lifespan

	Pre-natal	Childhood	Young adulthood	Middle age	Older age
Social consequences			The pleasures from alcohol use occur amongst drinkers		
	The negative social consequences affect all ages				
			Young adults are common perpetrators and are at particular risk		
Injuries	Intentional and unintentional injuries affect all ages				
			Young adults are common perpetrators of intentional injuries and are at particular risk of both intentional and unintentional injuries		
Neuropsychiatric conditions	The consequences of neuropsychiatric conditions affect all ages				
			Although alcohol dependence affects all adult ages, young adults are at increased risk		
				Middle aged and older people are at increased risk from brain damage and cognitive impairment	
Gastrointestinal conditions			Although liver cirrhosis is more common in middle and older age, young adults are also at risk		
Cancers				Cancers are more likely to occur in middle and older age	
Cardiovascular diseases			Hypertension, stroke and irregularities in heart rhythms can affect all adult ages		
			Episodic heavy drinking is an important risk factor for stroke in young adults		
			Coronary heart disease is rare in young adults		
				The reduced risk for coronary heart disease becomes more important in middle age and older adults	In very old adults, the reduced risk seems to disappear
Pre-natal conditions	The consequences of pre-natal alcohol related harm extend across the lifespan				

Some twin and family studies have suggested that the proportion of heritability of alcohol dependence is between 50% and 60% (Cook and Gurling 2001; Dick and Forud 2002; US Department of Health and Human Services 2000). The current literature mostly focuses on alcohol dependence, but there is reason to believe that what is heritable about heavy or problematic drinking reaches more broadly than diagnosable alcohol dependence (Schuckit *et al.* 2004).

Analyses of 987 people from 105 families in the initial sample of the Collaborative Study on the Genetics of Alcoholism (COGA), a large-scale family study designed to identify genes that affect the risk for alcohol dependence and alcohol-related characteristics and behaviours, provided evidence that regions on 3 chromosomes contained genes that increase the risk of alcohol dependence (Reich *et al.* 1998). The strongest evidence was for regions on chromosomes 1 and 7, with more modest evidence for a region on chromosome 2. The replication sample, which comprised 1,295 people from 157 families, confirmed the previous findings, albeit with less statistical support (Foroud *et al.* 2000).

Variants of the genes *ADH2, ADH3 and ALDH2* substantially (although not completely) protect carriers from developing alcohol dependence by making them uncomfortable or ill after drinking alcohol (Reich *et al.* 1998). The genes encode alcohol dehydrogenase and aldehide dehydrogenase respectively, two of the key liver enzymes involved in the metabolism of alcohol to its final end produce acetate.. Analyses of non alcohol dependent sibling pairs in the initial sample of the Collaborative Study on the Genetics of Alcoholism (COGA) produced evidence for a protective region on chromosome 4, in the general vicinity of the alcohol dehydrogenase (*ADH*) genes (Williams *et al.* 1999; Edenberg 2000; Saccone *et al.* 2000).

Other risk factors

At any given level of alcohol consumption, women appear to be at increased risk from the chronic harms done by alcohol, with differing sizes of risk with different illnesses. This is probably due to the fact that women have a lower amount of body water per weight than do men (Swift 2003). Thus, when a woman and a man with the same approximate weight and age consume the same amount of alcohol, the alcohol concentration will be higher in the woman, because the alcohol is dissolved in a smaller volume of body water.

Who is at risk?

Genes, gender, age and socio-economic status affect who is at risk of the harm done by alcohol, with some genes increasing and others decreasing the risk of alcohol use disorders, and, at any given level of alcohol consumption, women, children and adolescents and those with lower socio-economic status being at increased risk.

Consistently across countries and studies, alcohol dependence and alcohol-related mortality is highest in adults with lower socio-economic status (Romelsjo and Lundberg 1996; Leclerc *et al.* 1990; Lundberg and Osterberg 1990; Makela *et al.* 1997; Makela 1999; Loxely *et al.* 2004). There is also an interaction between alcohol consumption and poverty in terms of violent crimes such as homicide, with higher rates when these two risk factors are combined than could be expected

from the addition of both individual risk factors (Parker 1993). In England, for men aged 25–69 years, those in the lowest socio-economic status (SES) category (unskilled labour) had a 15-fold higher risk of alcohol-related mortality than professionals in the highest SES category (Harrison and Gardiner 1999). In Sweden, up to 30% of the differential mortality for middle aged men by socioeconomic group is explained by alcohol consumption (Hemström 2001). These findings match social gradients in health, in which poor social and economic circumstances affect health throughout life (Wilkinson and Marmot 2003). For alcohol, these probably work both ways, with harmful alcohol consumption being a result of, and a way of coping with, harsh economic and social conditions, as well as alcohol dependence leading to downward social mobility.

Children have greater vulnerability to alcohol than adults. As well as usually being physically smaller, they lack experience of drinking and its effects. They have no context or reference point for assessing or regulating their drinking, and, furthermore, they have built no tolerance to alcohol. From mid-adolescence to early adulthood there are major increases in the amount and frequency of alcohol consumption and alcohol-related problems (Wells *et al.* 2004; Bonomo *et al.* 2004). Those with heavier consumption in their mid-teens tend to be those with heavier consumption, alcohol dependence and alcohol related harm, including poorer mental health, poorer education outcome and increased risk of crime in early adulthood (Jefferis *et al.* 2005). Drinking by adolescents and young adults is associated with automobile crash injury and death, suicide and depression, missed classes and decreased academic performance, loss of memory, blackouts, fighting, property damage, peer criticism and broken friendships, date rape, unprotected sexual intercourse that places people at risk for sexually transmitted diseases, HIV infection and unplanned pregnancy (Williams and Knox 1987).

DOES REDUCING ALCOHOL USE IMPROVE HEALTH?

There are health benefits from reducing or stopping alcohol consumption. Part of the harm done by alcohol is immediately reversible; accidents and injuries and the risk of low birth weight and other pre-natal conditions can be completely reversed if alcohol is removed. Young people who cut down on their drinking as they move into early adulthood reduce their risk of alcohol related harm (Toumbouro *et al.* 2004).

Improving health

All acute harms from alcohol can be avoided if alcohol consumption is reduced. Depressive syndromes markedly improve within days to weeks of abstinence. Reductions of alcohol consumption are followed by fairly rapid decreases in liver cirrhosis deaths.

An example of a longer term condition with rapid, sometimes almost immediate remission is depression. Most studies find that many depressive syndromes markedly improve within days to weeks of abstinence (Brown and Schuckit 1988; Dackis *et al.* 1986; Davidson 1995; Gibson and Becker 1973, Penick *et al.* 1988; Pettinati *et al.* 1982; Willenbring 1986).

As described in more detail in Chapter 7, healthcare-based interventions for hazardous and harmful alcohol consumption reduce alcohol consumption, as well as demonstrating reductions in alcohol related problems (Moyer at el 2002) and alcohol-related mortality (Cuijpers *et al.* 2004). The community based Malmö study,

undertaken during the 1970s, demonstrated that under the right conditions, the effects can be dramatic. An intervention for heavy drinkers resulted in half the deaths that occurred in the control group without the intervention at six year follow-up (Kristenson *et al.* 1983).

Some chronic diseases depend on lifetime exposure, and thus risk may be reduced but not completely eliminated by removal of alcohol. On the other hand, population-based studies find that reductions in alcohol consumption in populations are associated with fairly rapid decreases in chronic diseases, such as deaths from liver cirrhosis (Ledermann 1964) (see Chapter 6). Time series analyses have shown that decreases in per capita consumption were associated with considerable concurrent reductions in deaths from liver cirrhosis (e.g. Ramstedt 2001; Skog 1980; and especially Cook and Tauchen 1982).

CONCLUSION

Although alcohol brings with it a number of pleasures, its use is not risk free. The overall amount of alcohol consumed, the frequency of consumption and the frequency and volume of episodic heavy drinking, independently and together, increase a wide range of social, mental and physical harms and illnesses. The risk for these harms is largely dose dependent, with no evidence for a threshold effect. That is, the greater the amount of alcohol consumed, both regularly and on any one occasion, the greater is the risk. For some conditions (acute respiratory distress syndrome, cardiomyopathy, nerve damage and muscle damage), it seems that the risk only increases following heavy and/or sustained alcohol consumption, although even at these higher levels, there is a dose response relationship. For some conditions (particularly injuries and cardiovascular diseases), the risk is largely, but not exclusively, mediated by patterns of episodic heavy drinking.

The harms are partially offset by a number of benefits, primarily a reduction in the risk of coronary heart disease. Thus the overall risk of death is a balance between the harms that alcohol causes, which can be present at all ages, and the benefits from coronary heart disease, which is largely an illness in older age. This means that for women under the age of 45 years and for men under the age of 35 years, the level of alcohol consumption with the lowest risk to death is zero. In very old age, it seems that the reduced risk for coronary heart disease is much less, and it is likely again that any level of alcohol consumption might increase the risk of death.

The harm done by alcohol not only affects the drinker, but also those other than the drinker. Such harms (which could be termed environmental alcohol damage (EAD)), are wide ranging and include violence, homicide, harm to intimate partners and children, other crime, the consequences of road traffic accidents, and harm to the developing baby.

The risk for all types of harms is lessened, and for most conditions, reversed with a reduction of alcohol consumption, both the overall volume of consumption and consumption at any one time.

How the impact of alcohol on the individual summates for Europe as a whole is discussed in the next chapter.

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