

## COMPREHENSIVE REVIEW

# The toxicology of homicide offenders and victims: A review

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### Abstract

**Issues.** The toxicology of homicide offenders and victims, and homicide as a cause of death among psychoactive substance users. **Approach.** Review of the toxicology of homicide, and homicide as a cause of death among psychoactive substance users. **Key Findings.** A half or more of offenders are intoxicated by a psychoactive substance at the time of the homicide, with alcohol the most commonly reported substance. Levels of substances among victims are comparable with those seen among perpetrators. *Among both offenders and victims, levels of substances far exceed population use.* Among substance users, homicide specific mortality rates of substance users far exceed population rates. Reducing rates of alcohol and other drug consumption, at national and individual levels, can be expected to substantially reduce rates of, and risk for, homicide. **Conclusions and Implications.** Psychoactive substances are strongly associated with homicide. One of the major societal benefits that can be derived from active attempts to reduce alcohol and other drug use are reductions in homicide rates. [Darke S. The toxicology of homicide offenders and victims: A review. *Drug Alcohol Rev* 2010;29;202–215]

**Key words:** homicide, toxicology, substance use, mortality, violence.

### Introduction

An association between psychoactive substance use and violence has been long recognised and, in part, contributes to the elevated rates of mortality among substance users [1–3]. Although licit and illicit substance users exhibit elevated rates of death across a range of causes (e.g. disease, suicide, overdose), a *substantial contributor to these elevated rates is death due to homicide, which includes both murder and manslaughter* [1,3]. On the converse side, rates of the commission of crime, and of violent crime in particular, are also substantially higher among substance users, *and the commission of homicide appears to occur at higher rates among substance users* [4–6].

Overall then, substance use appears to be strongly associated with violent death. Although excellent work has been carried out [4–6], to date no review has examined the toxicology of homicide offending and victimisation. The term toxicology refers both to the presence

of psychoactive substances, and to the concentrations of such substances. The current review aimed to examine these relationships. In doing so, the relationship of substances to the commission of homicide and to homicide victimisation were examined. Based on these findings, measures to reduce rates of drug-related homicide are briefly discussed. Searches were conducted in Medline, Psychlit and Embase for English language articles from any country on violence and substance use, the toxicology of homicide offenders/victims and mortality among substance users. Specifically, the current review aimed to:

1. Examine the toxicology of homicide offenders;
2. Examine the toxicology of homicide victims;
3. Examine the *extent of homicide as a cause of death among substance users*;
4. *Briefly examine the possible role of interventions in reducing homicide risk.*

## Substance use and homicide risk

In commencing this review of toxicology, we need to examine first why causal links between substance use and homicide might exist. The key model in this field has been that of Goldstein [7], who proposed three linkages between substance use and violence: (i) the direct psychopharmacological effects of a substance; (ii) 'economic compulsive' violence that arises from attempts to obtain money for drugs (such as robbery); and (iii) 'systemic' violence that results from the dynamics of drug markets (e.g. violence between dealers). For the purposes of this review, these risk factors might be divided broadly into two groups: proximal (pharmacological) and distal (lifestyle-related, including 'economic compulsive' and 'systemic' violence) [5–13]. Proximal factors relate, essentially, to the acute psychotropic effects of particular drugs. We should not, however, assume that all drugs proximally increase the risk of lethal violence, or that those that do are causative for the same reasons [4,14,15]. Most prominently, reflecting the epidemiology of its use, alcohol is the drug most commonly associated with an increased likelihood of committing, and being exposed to, violent acts [13,16–18]. Although the exact aetiology of an association is not the focus of this review, much of the theoretical explanation relates to disinhibition during acute alcohol intoxication [4,5,19]. Alcohol increases emotional lability, reduces self-awareness and decreases the ability to consider the consequences of actions [13]. As such, alcohol-induced disinhibition increases the risk of involvement in violence, whether perpetrating such acts or becoming a victim. An alternate explanation relates to reduced cognitive functioning due to acute intoxication, and of executive processing in particular [15,20]. Reduced executive functioning might result in inappropriate responses to perceived threat and an inability to curtail such responses once initiated.

The other widely used substances that have a potential proximal relationship to violence are the psychostimulants, cocaine and methamphetamine. Regular psychostimulant use is associated with elevated risks of paranoia, agitated delirium and acts of violence [21–24]. There is experimental evidence that chronic psychostimulant use increases aggressive behaviour [25,26], and acute intoxication may enhance or augment aggressive responses [27,28]. The experimental evidence is, however, inconsistent, with some studies reporting no increases in violent behaviours in animals after psychostimulant administration [15,29,30]. Psychostimulant use is also associated with a risk of an acute paranoid schizophreniform psychosis, which can be accompanied by violent behaviours [21–24]. Even in the absence of frank psychosis, paranoid symptoms are remarkably common among psychostimulant users,

and among regular dependent users in particular [22,23].

In contrast to alcohol and the psychostimulants, no obvious proximal pharmacological association exists between opioid use and lethal violence [5]. Opioids are sedatives, and do not directly engender violence (although agitation in the withdrawal stage might well precipitate such behaviours) [5,15]. Despite this, rates of violence are greatly elevated among users of these drugs [31,32]. The risks here appear to relate, however, to distal lifestyle factors, rather than the immediate effects of the drug itself. It should be noted that it is possible that the sedative effects of these drugs, and other drugs, such as benzodiazepines, may raise the risk of becoming a victim of violence, owing to increased vulnerability from intoxication.

Distal factors are essentially substance use lifestyle-related, and refer to factors such as violence resulting from acquisitive crime (Goldstein's 'economic compulsive' violence) and violence surrounding the initiation, maintenance and protection of drug distribution networks (Goldstein's 'systemic' violence) [5–13]. These factors clearly relate to illicit substances in particular. Such drugs are often expensive, and highly sought after by dependent drug users. The scope for violence in circumstances where large amounts of money are involved is large. High levels of crime and sex work carried out to support drug use are well documented [33–35], activities that carry a high trauma risk. Consistent with this, reported rates of serious assault among dependent illicit drug users are high, and far exceed those seen among non-drug users [31,32]. The risk here is continuous, in that market involvement is ongoing, rather than being episodically related to intoxication *per se*.

Although lifestyle factors have been posited primarily in relation to illicit drug use, they also have relevance to alcohol intoxication. Although distribution is legal in western societies, the illegal production and/or smuggling of alcohol might occur to avoid taxation (particularly between countries with land borders), which might lead to economic and systemic violence similar to that seen in relation to illicit drugs. Despite the legality of alcohol, there are proximal risk issues relating to drinking locations. The most salient of these is drinking in bars (public houses) or in clubs in which alcohol is sold, but street-based drinking will also provide a risky environment. Large numbers of intoxicated people, particularly males, creates a circumstance that might engender violence. Indeed, higher densities of liquor outlets have been associated with higher rates of violent crime in surrounding environs [36–38]. Regular drinking at bars thus involves a distal risk for violence. Graham and Homel [39] argued that the environment itself can have an impact on behaviour, with overcrowd-

ing, unsafe glassware, poorly trained and aggressive staff contributing to higher risks of alcohol-related aggression. Lifestyle risks do not, however, solely relate to bars. Rates of alcoholism among the homeless are extremely high and, as noted above, public drinking increases the potential exposure to violence [40].

Finally, we must consider the role of pre-existing comorbid psychopathology. Substance dependence across the board is associated with elevated rates of psychopathology [23,41–44]. This is true whether the primary substance used is a licit drug, such as alcohol or the benzodiazepines, or illicit drugs, such as cannabis, psychostimulants or the opioids. Although much of this pathology relates to elevated rates of self-harm (e.g. Major Depression) [32,44], other pathological forms might increase the risk of violence by, or on, the person. Indeed, comorbid psychopathology has been associated with increased likelihood of committing homicide, and this risk is exacerbated by comorbid substance dependence [45]. In particular, there is a strong association between both Antisocial Personality Disorder (ASPD) and Borderline Personality Disorder (BPD) and dependent substance use [21]. ASPD and BPD are of direct relevance, as both diagnoses are defined by impulsivity, risk-taking and violent behaviours [21]. Pre-existing psychosis, exacerbated by substance use, might also increase the risk of violence [24,45]. This is particularly true of the psychostimulants, which exacerbate psychotic symptomatology [23]. At a more proximal level, we must also bear in mind the acute paranoid schizophreniform psychosis associated with psychostimulant use discussed above.

### Psychoactive substances and homicide rates

We now turn to the role psychoactive substances play in the commission of homicide, and how risk factors play a role in these crimes. Before specifically examining the prevalence of substances among homicide offenders, we will first briefly examine the global associations between substance use and homicide rates. One of the most robust features of the literature in recent years has been a strong correlation between national alcohol sales and homicide rates, a finding that has been reported across a range of nations and cultures [8,46–50]. Thus, in periods when total volume alcohol sales increase, so do homicide rates. Conversely, when there are declines in sales, homicide rates typically decline. The effect size is not negligible: Pridemore [47] estimated that a 1% increase in consumption was associated with a 0.25% increase in the homicide rate, with similar figures having been reported elsewhere [48–52]. These global trends have major implications for reducing homicide rates, which will be discussed later. It is important to note that the relationship between alcohol sales and

homicide rates is stronger among males [49,50]. This in all probability reflects the epidemiology of both alcohol consumption and of violence, both of which are dominated by males. It should also be noted that, at a local level, higher total volume alcohol sales from local outlets have also been related to increased rates of violent assault in neighbouring locales [52].

Although many of these studies have shown a positive correlation between total volume alcohol sales [8,46–50], the effect appears to relate to the drinking culture of a particular region. Thus, in eastern Europe, the effect is strongest for spirits [48,49]. This would suggest that it is the high alcohol concentration of spirits that is behind this effect, with spirits essentially a marker for heavy intoxication. In northern Europe, however, the effect is strongest for beer, and in southern Europe for wine, reflecting the drinking patterns of these cultures [48,49]. Although drinking patterns are, of course not immutable, and might change over time within a culture, it would not appear to be the alcohol concentration of the predominant drink *per se*, but the extent of its use and its role in a particular society's drinking culture that is of import.

There is also tentative data suggesting a similar relationship for illicit drugs [9,53,54]. At a national level, in the USA increases and declines in the level of violent crime were contiguous with increases and declines in the use of cocaine in that country [54]. At a local level, Ousey and Lee [9] reported within city variations in homicide were related to local variations in illicit drug markets. A correlation between homicide rates and the proportion of victims positive for illicit and alcohol was also recently reported from New York City [53].

### Psychoactive substances and homicide: offenders

Given the proximal and distal links between substance use and violence, and the global associations between substance use and homicide rates, high rates of substance use would be expected among homicide offenders. Such, indeed, appears to be the case (Table 1). Although, as would be expected, there is some variability, the picture is remarkably consistent. As can be seen, in all listed studies, substances were present in substantial proportions [10–12,45,55–74]. Although not frequently reported, males appear more likely to have substances present [55,66,73]. The limitations of such studies should, however, be noted. Studied that use blood or urine from offenders are limited to detecting recent use, and substances might have been eliminated from the body by the time of arrest and testing. The use of recall data by offenders of consumption at the time of the incident is also subject to the limitations of memory, although recall of substance use and criminal activities

**Table 1.** Toxicology of homicide at time of fatal incident: offenders

Study	Country	Major findings
Davies & Mouzos (2007) [55]	Australia	Substance 52%, alcohol 41%, illicit/prescription 13%, alcohol + illicit/prescription 7%
Dooley (1995) [56]	Ireland	Alcohol 42%
Dooley (2001) [57]	Ireland	'Intoxicated' by alcohol and/or drugs 39%
English <i>et al.</i> (1995) [58]	International	Aetiological fraction alcohol induced assault = 0.47
Eronen <i>et al.</i> (1996) [59]	Finland	Alcoholism: males 39%, females 32%
Fendrich <i>et al.</i> (1995) [60]	USA	Substance 49%, drug 33%, alcohol 33%, cannabis 20%, cocaine 18% heroin 4%. Multiple substances 23%
Goldstein <i>et al.</i> (1989) [61]	USA	Drug-related 53%, drug dealers 29%. Crack 65%, cocaine 28%, alcohol 14%, cannabis 6%, heroin 1%
Holcomb & Anderson (1983) [62]	USA	Alcohol and/or drugs 56%, alcohol only 24%, alcohol + drugs 16%, drugs only 16%
Linquist (1991) [63]	Sweden	Intoxicated 99%. 100% alcohol dependent intoxicated with alcohol; 95% illicit users intoxicated with illicit
MacDonald (1961) [64]	USA/Europe	Median alcohol 54%
McLaughlin <i>et al.</i> (2000) [65]	USA	Drug-related 28%
Phillips <i>et al.</i> (2007) [10]	USA	Alcohol 39% (16% 'very intoxicated')
Roe-Sepowitz (2008) [66]	USA	Juvenile offenders. 'Clinically significant' substance use 55%
Schanda <i>et al.</i> (2004) [45]	Austria	Odds of committing homicide increased by alcohol dependence among those with schizophrenia (20.7 vs. 7.1) or Bipolar Disorder (3.1 vs. 0.4)
Sharps <i>et al.</i> (2001) [67]	USA	Substance 71%, alcohol 60%, drugs, 38%, alcohol + drugs 27%
Shaw <i>et al.</i> (2006) [68]	UK	Alcohol contributed to offence 45%, drugs 15%. 42% alcohol dependence, 40% drug dependence
Shupe (1953) [69]	USA	Alcohol 83%. >0.1 g/100 mL 67% (urine)
Spunt <i>et al.</i> (1994) [70]	USA	Alcohol affected 33%; 19% believed homicide related to alcohol status. Mean of 7 h continuous drinking prior to homicide.
Spunt <i>et al.</i> (1995) [71]	USA	45% 'drunk' and/or 'high: drunk' 32%, cannabis 18%, cocaine 14%, heroin (2%). 19% believed homicide related to alcohol status, 8% to cocaine and 5% to cannabis.
Tardiff <i>et al.</i> (2002) [11]	USA	Substance-related 31%. Direct pharmacological relation 12%, lifestyle-related 19%
Verano & Cancino (2001) [72]	USA	'Deviant homicide': alcohol 43%, drug motivation 37%. 'Non-deviant homicide': alcohol 57%, drug motivation 63%
Verano <i>et al.</i> 2004 [12]	USA	Drug involvement of either offender or victim 49%
Virkkunen (1974) [73]	Finland	Alcohol 66%
Wieczorek <i>et al.</i> (1990) [74]	USA	Alcohol and/or drugs 57%; Alcohol only 36%, drugs only 7%, alcohol + drugs 13%. >5 drinks 37%.

by substance users has been repeatedly found to have high levels of validity and reliability [75–77].

As would be expected, given its epidemiology, alcohol is the most commonly reported substance among offenders. Studies consistently report that between a third and two-thirds of offenders were affected by alcohol at the time of their offence (Table 1). English *et al.* [58] estimated the aetiological fraction of alcohol in relation to homicide (aetiological fractions derive from epidemiology, and in terms of substance use represent the degree to which drug use is considered a contributory cause of the condition in question). **The authors estimated the aetiological fraction for offenders to be 0.47, indicating that nearly half of homicides offenders have alcohol as a factor contributing to the offence.** Although not often reported, the degree of

intoxication of offenders appears high [10,57,69–71,74]. Thus, in two typical scenarios, Spunt *et al.* [70] reported an average of 7 h drinking by the offender before the homicide, whereas Wieczorek *et al.* [74] reported that over a third of offenders had consumed more than five drinks immediately before the offence.

**Illicit drugs are also reported in high frequencies, most commonly cocaine and cannabis, although typically not at the levels seen with alcohol** (Table 1). Something like a third of offenders, however, have drugs other than alcohol present at the time of the offence, with younger offenders more likely to have illicit drugs present [60,68,74]. Reflecting the polydrug using behaviours of illicit drug users [33,35,77,78], these substances also frequently co-occur with alcohol, which might increase the risk of an offence.



In order to put the figures presented in Table 1 into perspective, we need to compare them with population consumption figures, with daily use providing the best comparison [79–82]. **For all major drug classes, population use occurs at far lower levels than that seen among offenders.** Although between a third and two-thirds of offenders have consumed alcohol at the time of their offence, population surveys show daily alcohol use in major western countries to occur at significant lower levels: 7% [79], 9% [80], 16% [81]. Similarly, less than 10% of general populations in western countries have consumed an illicit drug in the preceding month, and daily use levels occur at even lower levels [79,80,82]. **In all studies of offenders, reported levels of illicit drug use occur at levels many magnitudes that of population norms.**

Given the substantial over-representation of substances seen among offenders, it is reasonable to conclude that the presence of such substances increased the risk of a fatal incident, whether through proximal or distal effects. Whether classified *post hoc* by researchers, or on reflection by offenders, it is the direct pharmacological effects of alcohol that most strongly relate to violent offence [10,11,60,63,68,69,71,72,74]. Such classification is consistent with specific research showing that alcohol, and heavier levels of alcohol intoxication, are associated with heightened immediate risk of violent behaviours [19,66]. As noted earlier, however, distal factors play a role even in the presence of proximal effects. In particular, in large proportions of cases, both offender and victim were drunk at the time of the incident [11,57,63,70,71,73,74]. **A typical scenario is of co-intoxication, often while drinking together, followed by an argument, a physical altercation and a fatality. Indeed, the distinction between an offender and a victim in these situations might owe more to happenstance than anything else, as both might have been drunk and aggressive, and both possibly being in a high risk environment for violence.**

In contrast to alcohol, distal factors are more commonly associated with illicit drug-related homicide offenders (although, as with alcohol in large proportions of cases both offender and victim are under the influence of illicit drugs) [11,61,73]. **Thus, illicit drug-related homicides are more likely to revolve around drug dealing, dealing networks and violent arguments about drugs than to be due to direct pharmacological effects [11,12,61,63,67,73].** An exception to this statement should be noted for psychostimulants, where in addition to distal factors, paranoid ideation and psychostimulant-induced psychosis have been showed to play a direct role in many psychostimulant-related homicides [61,83]. It should also be noted that many psychostimulant users combine the use of psychostimulants with alcohol, which might increase the

proximal risk of violence from the direct effects of these drugs [22–24].

### Psychoactive substances and homicide: victims

In the previous section, we saw high levels of substance use among homicide offenders immediately before the fatal incident. Given the proximal and distal risk factors for violence associated with psychoactive substances, and the strong association between offenders and victims in terms of co-intoxication and drug markets, high levels of substances would be expected in victims. Toxicological results from victims indicate that this certainly appears to be the case [10,53,55,58,61,63,68,73,74,84–102] (Table 2). Indeed, the levels of substances seen among victims are comparable with those seen among perpetrators. Typically, a half or more of victims have a psychoactive substance present in their blood at the time of the fatal incident, with substances more likely to be found in male [12,55,74,84,86–88,101,102] and younger victims [12,63,67,86,88,96,100,102]. Again, there is some variability in these figures. For example, cocaine, reflecting the epidemiology of its use, is more commonly seen among US homicide cases. As with offenders, however, what stands out is the degree of concordance between cases in disparate nations and cultures. We must note again the limitations inherent in such studies. Toxicological studies, by definition, might only examine substances or their metabolites that are present at the time of death. Thus, although an accurate measure of consumption among victims immediately before death, they are likely to underestimate the proportion of substance users and drug involvement seen among such cases. A regular substance user, for example, might die in a drug-related homicide, but have not used substances immediately before death.

As with offenders, alcohol is by far the drug most common drug detected, typically seen in 40–50% of cases. English *et al.* [58] estimated the aetiological fraction of alcohol in relation to homicide victims to be 0.43, a figure almost identical to that calculated for offenders, indicating that in approximately 43% of cases, alcohol use by the victim was a factor contributing to their violent death. Where it has been reported, the blood alcohol concentration (BAC) does not typically indicate that the person had only consumed a small number of drinks [74,88,89,97,102]. Duflou *et al.* [89] reported that 30% overdose victims had BACs in excess of 0.20 g/100 mL, whereas 56% female victims studied by Lerer [97] had BACs in excess of 0.1 g/100 mL. In recent research conducted by the author and colleagues [86], the median BAC among alcohol positive victims was 0.15 g/100 mL, approximately equal to seven standard (Australian) drinks.

**Table 2.** Toxicology of homicide at time of fatal incident: victims

Study	Country	Major findings
Abel (1987) [84]	USA	Alcohol 45%, drugs 4%
Adeagbo <i>et al.</i> (2008) [85]	USA	Substance 74%, cocaine 20%, cannabis 14%, alcohol 11%, diazepam 5%
Albreksten <i>et al.</i> (1989) [86]	Denmark	Alcohol 41% (assault survivors)
Allgulander & Nilsson (2000) [87]	Sweden	Alcohol dependence 9%, drug dependence 1%
Darke <i>et al.</i> (2008) [88]	Australia	Substance 63%, illicit 33%, multiple substances 25%, alcohol 42%, (median BAC 0.15 g/100 mL), cannabis 21%, opioids 11%, psychostimulants 10%
Davies & Mouzos (2007) [55]	Australia	Substance 49%, alcohol 36%, illicit/prescription 24%, alcohol + illicit/prescription 9%
Dooley (1995) [56]	Ireland	Alcohol 42%
Dooley (2001) [57]	Ireland	'Intoxicated' by alcohol and/or drugs 42%
Duflou <i>et al.</i> (1988) [89]	South Africa	Alcohol 63%, 30% BAC > 0.20 g/100 mL
English <i>et al.</i> (1995) [58]	International	Aetiological fraction alcohol = 0.43
Galea <i>et al.</i> (2002) [90]	USA	Substance 55%, alcohol 27%, cocaine 24%, opioids 10%, cannabis 20%
Garriott <i>et al.</i> (1993) [91]	USA	Substance 69%, alcohol 57%, cocaine 11%, heroin 4%
Gill & Catanese (2002) [92]	USA	Substance 61%
Gill <i>et al.</i> (2003) [93]	USA	Substance 56%, alcohol 14%, illicit 48%, cannabis 40%, cocaine 4%
Goldstein <i>et al.</i> (1989) [61]	USA	Drug dealers 34%
Harruff <i>et al.</i> (1988) [94]	USA	Cocaine 17%
Hocking (1989) [95]	UK	Alcohol 50% (assault survivors)
Hood <i>et al.</i> (1990) [96]	USA	Cocaine 27%
Lerer (1992) [97]	South Africa	Alcohol 62%, 56% BAC > 0.10 g/100 mL
Linquist (1991) [63]	Sweden	Intoxicated 86%
Lunetta <i>et al.</i> (2001) [98]	Finland	Alcohol 63%
McLaughlin <i>et al.</i> (2000) [65]	USA	Substance 27%, alcohol 18%
Rivara <i>et al.</i> (1997) [99]	USA	Case control. Higher levels use of alcohol and illicit among cases
Rogers (1993) [100]	USA	Gang homicide: alcohol 52%, cocaine 20%, opioids 0%. Non-gang: alcohol 48%, cocaine 28%, opioids 4%
Sharps <i>et al.</i> (2001) [67]	USA	Substance 21%, alcohol 18%, drugs, 3%, alcohol + drugs 4%
Tardiff <i>et al.</i> (1995) [101]	USA	Alcohol 35%, cocaine 31%, heroin 12%
Tardiff <i>et al.</i> (2005) [53]	USA	Substance 59%, alcohol 30%, cocaine 28%, cannabis 18%, opioids 11%
Verano & Cancino (2001) [72]	USA	'Deviant homicide': alcohol 45%, 'Non-deviant homicide': alcohol 55%
Verano <i>et al.</i> (2004) [12]	USA	Drug involvement of either offender or victim 49%
Virkkunen (1974) [73]	Finland	Alcohol 68%. Mean BAC > 0.20 g/100 mL
Welte & Abel (1989) [102]	USA	Alcohol 42% (71% of positives BAC > 0.10 g/100 mL)

These figures are similar to those reported above for intoxicated offenders [70,74].

As was the case with offenders, drugs other than alcohol are commonly detected in victims (Table 2). The two drug classes most commonly detected are psychostimulants and cannabis. Although not as common as these drugs, opioids are also present in significant proportions. Again, comparison with population consumption patterns indicates that the levels of alcohol and other substances seen in victims far exceeds population norms [79–82]. As with offenders, it is reasonable to conclude that intoxication with these substances was a factor that directly, and indirectly, contributed to death in many of these cases.

As noted above, large proportions of both offenders and victims are intoxicated at the time of the fatal incident, and in many cases are known to each other, whether as acquaintances, family or in a relationship

[11,57,63,71–74]. In many cases, both victim and offender might have been intoxicated and aggressive, particularly when drinking together. Indeed, where it has been examined, in large proportions of cases the victim was deemed to be the main aggressor [63,74]. We thus see the proximal effects of alcohol occurring in a context of high situational risk, and in situations that might frequently recur when victims and offender are known to each other. Consistent with this scenario, alcohol has been reported as more likely to be found in victims who died in the course of a physical altercation, than in homicides where an altercation was not involved [88]. The transient situational nature of the homicide risk associated with alcohol is further showed by weekly and diurnal patterns of homicide and substances. The proportion of alcohol positive homicide victims increase on Fridays and weekends, and in the evenings and early mornings, with the lowest rates occurring on

Mondays and during the day [86,88,95]. These proportions also mirror homicide patterns, and drinking patterns, which also peak on weekends and evenings [55,88]. Given all that has been discussed to date, it is reasonable to conclude that the global homicide pattern is strongly influenced by alcohol consumption patterns.

By contrast, as with offenders, the circumstances surrounding illicit drug positive homicides relate more strongly to persistent lifestyle risks associated with drug dealing and procurement [61,88,94]. This is not surprising among illicit drug users, as both offenders and victims are exposed to high levels of continuous risk. Thus, although the proportion of alcohol positive victims increases throughout the week and in the evenings, this is not the case for illicit drugs [88], reflecting the regular and frequent use of dependent illicit substance users.

One major circumstance that is worthy of comment is the finding of a strong association between psychostimulant positive victims and firearm deaths [53,66,88,90,100]. Although much of this is attributed to gang violence and the maintenance of drug markets, it needs to be noted that no such association has emerged in relation to opioids, which is a similar market. It has also been noted in countries in which gun ownership is rare [88]. In all probability, this represents a confluence between the proximal effects of psychostimulant (e.g. paranoia, psychosis, explosive aggression) and the distal circumstance of gun possession by persons involved in drug markets. It should also be noted that this association has also recently been noted among cases of completed suicide [103].

### Homicide as a cause of death among substance users

The previous section reported substantial proportions of psychoactive substances among homicide victims. We now turn to examine the extent to which homicide impacts as a cause of death on dependent substance users. Given the prevalence of substances among victims, death because of homicide would be expected to play a significant role in deaths among such populations. This appears to be the case, although only a minority of studies of substance user deaths specifically report homicide as a cause of death [104–141] (Table 3). The studies in Table 3 consist of both cohorts and retrospective coronial studies, typically of dependent substance users. As can be seen, significant proportions of deaths are due to homicide, ranging up to over a third of fatalities. Overall, it would appear that we would typically expect approximately one in 20 deaths among such populations to be due to homicide, a rate similar to deaths because of suicide among these populations [1].

The proportion of substance users deaths because of homicide appears high. Again, to contextualise, how do the rates of death seen among substance dependent cohorts compare with those of the broader population? As would be expected, given the proximal and distal risk factors involved, the homicide specific mortality rates of substance using cohorts typically far exceed population rates [105,106,108,110,111,113–116,119, 120,127,128,130,136,138,139]. Thus, although mortality rates because of homicide in countries, such as the USA, the UK/Europe and Australia, range 0.01–0.06 per 1000 [142–144], incidence rates in cohort studies are frequently double or more these rates [1].

### Reducing homicide rates

The preceding sections have suggested that substance use plays a major role in the causation of homicide, both from the perspective of offenders and of victims, and constitutes a major cause of death among dependent substance users. In this section, we will briefly examine what, if anything, can be carried out to reduce drug-related homicide rates. Before considering this, however, is it possible that the link between substance use and homicide is not causal, but simply an artefact? This question is crucial if are to intervene successfully. Crime may lead to substance use, for instance, or there may be a common cause of both. Thus, it could be argued that homicide offenders are simply people who like to abuse alcohol and other drugs. The presence of substances among offenders would thus merely reflect the preference of offenders for intoxication. This appears unlikely, and the data presented appear to support a causative relationship. First, homicide rates decline when population alcohol use declines [8,46–50], and there is similar evidence for psychostimulants [54]. This may, of course be a statistical artefact of some kind, but these data must be taken in the context of other data. Thus, second, and as emphasised above, there are remarkable similarities in the toxicology of both of offenders and victims, particularly in relation to alcohol intoxication, although the fact that victim and offender are often known to each other should be borne in mind. We must also consider the plausibility of a causal role, given the circumstances of many alcohol-implicated deaths (e.g. victim and offender drinking heavily together over periods of hours and getting into arguments that result in death) and illicit drug deaths (e.g. drug deals resulting in violence). Then, of course, there are the elevated death rates from violence among drug- and alcohol-dependent people, indicative of the proximal and distal effects of substance use. Finally, there is good evidence from pharmacology that alcohol and psychostimulants, in particular, have cognitive and other effects that are likely to increase the lethality of

**Table 3.** Homicide as a proportion of deaths among substance users

Study	Country	Substances	Homicide %
Andreasson <i>et al.</i> (1991) [104]	Sweden	Alcohol	13
Bartu <i>et al.</i> (2004) [105]	Australia	Heroin, amphetamine	2
Benson & Holmberg (1984) [106]	Sweden	Cannabis, solvents, LSD, stimulants	0
Bentley & Busuttill (1996) [107]	UK	Opioids	2
Bewley <i>et al.</i> (1968) [108]	UK	Heroin	9
Bjornaas <i>et al.</i> (2008) [109]	Norway	Heroin	3
Bucknall & Robertson (1986) [110]	UK	Heroin	14
Concool <i>et al.</i> (1979) [111]	USA	Heroin	38
Darke <i>et al.</i> (2005) [112]	Australia	Cocaine	0
Engstrom <i>et al.</i> (1991) [113]	Sweden	Amphetamine, cocaine, heroin	4
Eskild <i>et al.</i> (1993) [114]	Norway	IDU	4
Fugelstad <i>et al.</i> (1997) [115]	Sweden	Heroin, amphetamine	3
Galli & Musicco (1994) [116]	Italy	Heroin	5
Gill <i>et al.</i> (2002) [117]	USA	MDMA	5
Goldstein & Herrera (1995) [118]	USA	Heroin	17
Gossop <i>et al.</i> (2002) [119]	UK	Heroin	14
Gronbladh <i>et al.</i> (1990) [120]	Sweden	Heroin	1
Jonsson <i>et al.</i> (2007) [121]	Sweden	Heroin	5
Karch <i>et al.</i> (1999) [122]	USA	Amphetamine	10
Logan <i>et al.</i> (1998) [123]	USA	Amphetamine	27
Maxwell <i>et al.</i> (2005) [124]	USA	Heroin	4
Marshall <i>et al.</i> (1994) [125]	UK	Alcohol	0
Nicholls <i>et al.</i> (1974) [126]	USA	Alcohol	0
Oppenheimer <i>et al.</i> (1994) [127]	UK	Heroin	1
Orti <i>et al.</i> (1996) [128]	Spain	Heroin	12
Osesjo <i>et al.</i> (1981) [129]	Sweden	Alcohol	4
Oyefeso <i>et al.</i> (1999) [130]	UK	Heroin	0
Raikos <i>et al.</i> (2002) [131]	Greece	MDMA	0
Rathod <i>et al.</i> (2005) [132]	UK	Heroin	0
Schmidt & de Lint (1972) [133]	USA	Alcohol	0.5
Smith <i>et al.</i> (1994) <sup>a</sup> [134]	USA	Alcohol	18
Shaw (1999) [135]	Taiwan	Amphetamine	14
Tunving (1988) [136]	Sweden	Heroin, amphetamine	3
Vaillant (1983) <sup>b</sup> [137]	USA	Alcohol	32 (clinic sample) 10 (college sample)
Wille (1981) [138]	UK	Heroin	0
Zaccarelli <i>et al.</i> (1994) [139]	Italy	IDU	2
Zador & Sunjic (2000) [140]	Australia	Heroin	5
Zhu <i>et al.</i> (2000) [141]	Japan	Amphetamine	27

<sup>a</sup>'Accident or violence'. <sup>b</sup>'other violence', excluding suicide.

violence [1,4,5]. Taken together, the conclusion that substance use plays a causal role in substantial proportions of homicides appears unavoidable.

What then are the major facts of homicide and substance use seen in this review that might inform interventions? First, alcohol is the substance that plays the single largest role in homicide. Second, alcohol in homicide is most commonly proximally related to homicide. Third, and by contrast, the distal factors surrounding illicit drug markets appear to play a larger role in illicit drug-related homicide than the proximal effects of substances.

A campaign focusing specifically on the reduction of homicide is difficult to conceptualise. Rather than focus

on homicide, it would appear sensible to focus on substance use *per se*, and reduce the extent of substance-related risk factors contributing to homicide. The national data on alcohol sales and homicide rates referred to previously [8,46–50] provides a hint as to the possibility of such an approach. As noted earlier, when total volume alcohol sales increase, so do homicide rates, and they decline when there are reductions in sales [8,46–50]. The reduction of national alcohol sales, whether through regulation or health campaigns, will have a great many positive health effects for a nation, including reduced rates of dependence and alcoholic liver disease. One such tangential effect would be to reduce the rate of homicide, as the proximal effect



of alcohol as a factor in homicide is reduced. It is beyond the scope of this review to determine how this would be achieved in any particular jurisdiction. For instance, global reductions in alcohol use might involve taxation, health campaigns or stricter licensing laws. Of course, reducing sales will only be effective if there are corresponding reductions in use. **It is not sales *per se* that are the factor underlying the link with violence, but consumption. The point to be emphasised is that reducing overall use rates is an aim that will have an indirect effect of reducing the number of intoxicated individuals who are at risk of either committing homicide, or becoming a victim, owing to the proximal effects of alcohol.** It should be emphasised that aiming for such reductions does not imply a commitment to the total prohibition of alcohol, which would be expected to increase the distal violence associated with illicit drug markets, as seen in the USA in the 1920s and 1930s.

At an individual level, it has been suggested that targeting prevention initiatives on binge and excessive drinking at high risk groups, such as young, might reduce their exposure to high-risk situations [6,13]. In doing so, it is being recognised that it is not only dependent alcohol users who are at risk, although it is the dependent user who presents the highest risk. Binge drinkers, who might not meet criteria for alcohol dependence, might be at recurrent transient risk, particularly males drinking heavily in public locations on weekends and late at night. In framing interventions, it must be borne in mind that there are no specific data on how risk of violence relates to the amount consumed on a drinking occasion.

To continue examining alcohol, there are, of course, environmental factors that might be controlled that might assist in reducing alcohol-related homicide. As noted above, overcrowding, unsafe glassware, poorly trained and aggressive staff might contribute to higher risks of alcohol related aggression [39,145–148]. Training of bar staff might have a positive impact, as there is evidence that interventions can influence whether staff escalate or de-escalate aggression in patrons [146,147], and toughened glassware might reduce the severity of injuries from broken glasses in violent confrontations [145,148]. At a broader level, higher densities of liquor outlets correlate with higher rates of violent crime in that area, and actively controlling the density of such outlets has a local impact on violence and homicide [36–38]. Similarly, late night public drinking represents a time of great risk [86,88,95]. Longer licensing hours would be expected to increase the risk of late-night violence and resultant homicide, and restricted licensing to reduce the opportunity for such risk [149–151]. It could, of course, be argued to the contrary that longer licensing hours might encourage more sensible drinking patterns, rather than heavy consumption in

short periods. The evidence, however, does not support such a position [149,150], and it is unlikely to be relevant given the late night/early morning time frames in which homicides peak [55,88]. The focus here is not on national, global reductions in alcohol use, but in the local circumstances in which it is sold.

Illicit drugs present a different range of problems to those posed by alcohol. Although the proximal effects of some of these substances play a role in homicide (although there are no data on the proximal effects of the amounts and risk of violence), **it is drug seeking and drug dealing that most likely to expose the individual to heightened risk of violence and homicide.** Although successful interventions have been implemented to reduce many of the harms associated with illicit drug use (e.g. blood borne viruses, overdose), it would appear that the major means to reduce homicide rates associated with illicit drug use is by reductions in drug use *per se*. Thus, as with alcohol, national reductions in the use of illicit substances, whether through policing or demand reduction, would be expected to reduce the rate of drug-related homicide.

**At an individual level, for the dependent drug user treatment would appear to be the most realistic intervention to reduce homicide risk. Stable, prolonged treatment is associated with substantial reductions in drug use, crime and mortality [152–155]. The individual is thus removed from the distal risk surrounding the drug market, as well as the proximal effects of substances. One of the social benefits of treatment is thus that we would expect a lower homicide rate.** Although global reductions in mortality are well documented, to date there are no data on the extent to which drug treatment reduces homicide rates among illicit drug users. **It should also be noted that alcohol treatments have also been documented to reduce levels of drinking among dependent users, and to lower mortality rates [2,156,157]. Indeed, higher rates of regional Alcoholics Anonymous membership have been correlated with lower regional rates of both cirrhosis and homicide [8].** As with alcohol, it must also be borne in mind that recreational users might place themselves at recurrent risk, even if they do not meet criteria for substance dependence. This review has showed that the risk of violence is an aspect of substance use. It is unlikely that recreational users are aware of the extent of this risk.

Finally, although reductions in substance use are crucial, **the link between firearms and psychostimulant use is worthy of attention** [53,66,88,90,100]. **One strategy that has been used in the USA is to target the availability of firearms to psychostimulant users involved in drug markets.** This might involve direct policing of gun-crime hotspots, restricting gun sales, placing further restrictions on firearms purchases, etc.

[54]. The results of such interventions have been encouraging [54]. Such strategies are of particular relevance to countries, such as the USA, where gun ownership is widespread. These strategies also might be of relevance to knife crime in countries, such as the UK, where the public saliency of knife crime appears to have increased.

A range of other interventions could be conceived to reduce the distal and proximal risk of substance-related homicide. Overall, however, it is by reducing rates of substance use that both substance-related homicide and global homicide rates can be most readily reduced.

Before closing this section, the question arises as to what research could tell us that might inform interventions to reduce substance-related homicide. First, a limitation of much current research is the reliance on urine and blood analyses. Although these are useful in determining recent consumption, they do not provide data on longer-term consumption patterns. Hair analyses would provide a longer window period into the illicit drug use patterns over the months leading up to a homicide, both for offenders and victims, which would better quantify the relative roles of recreational and dependent drug users in these events. Second, and related to this, more research on violence among the binge drinker and recreational drug user is necessary. Currently, much of the focus, understandably, is on the dependent user. The role of violence among weekend users is necessary if we are to accurately characterise offenders and victims, and to intervene among these groups. Third, more research on the proximal relationships between individual substances, and combinations of substances, is necessary. In particular, are there threshold blood concentrations, or particular combinations of drugs, that particularly engender violence? Finally, longitudinal studies of substance users tend to focus on drug use, overdose and disease as outcome measures, to the neglect of violence. Longitudinal studies of violent offending and victimisation, and the factors that predict these, might improve the ability of treatment to affect these events. This list is not exhaustive, but the answers to these questions would be of enormous clinical and public importance in reducing substance-related homicide rates.

## Conclusions

In summary, psychoactive substances are strongly associated with homicide, and the data make it abundantly clear that this is true of both offender and victims. Homicide is also an important cause of death among dependent substance users. The sheer extent of the association between substance use and homicide needs to be recognised. One of the major societal benefits that can be derived from active attempts to reduce alcohol

and other drug use is that we might reduce the global rates of homicide, as well the death rates of substance users from such violence.

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