



Reducing harm in drinking environments

A systematic review of effective approaches

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Evidence and Practice in Europe

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Glossary

Blood alcohol concentration/level	A measure of the percentage of alcohol in a persons' blood stream. Measured either by a breath test or blood test.
Cohort analytic study	An observational study design where groups are assembled according to whether or not exposure to the intervention has occurred. Exposure to the intervention is not under the control of the investigators. Study groups might be non-equivalent or not comparable on some feature that affects outcome.
Controlled Clinical Trial	An experimental study design where the method of allocating study subjects to intervention or control groups is open to individuals responsible for recruiting subjects or providing the intervention. The method of allocation is transparent before assignment, e.g. an open list of random numbers or allocation by date of birth, etc.
Drinking environments	An area where alcohol is sold and consumed. Throughout this report drinking environment refers to pubs, bars, nightclubs and their surrounding areas.
Interrupted time series	A time series consists of multiple observations over time. Observations can be on the same units (e.g. individuals over time) or on different but similar units (e.g. student achievement scores for particular grade and school). Interrupted time series analysis requires knowing the specific point in the series when an intervention occurred.
Odds ratio	The odds of the outcome of interest in those exposed to the intervention divided by the odds of the outcome of interest in the unexposed.
Off-licensed premises	Premises that sell alcohol for consumption elsewhere
Off-sales	See off-licensed premises
On-licensed premises	Premises that sell alcohol for consumption on the premises
On-sales	See on-licensed premises
Quality adjusted life year	A year of life adjusted for its quality or its value. A year in perfect health is considered equal to 1.0 QALY.
Randomised Controlled Trial	An experimental design where investigators randomly allocate eligible people to an intervention or control group.
Relative risk	The ratio of risk for the outcome of interest in the intervention group to the risk in the control group.
Uncontrolled before and after study	The same group is pretested, given an intervention, and tested immediately after the intervention. The intervention group, by means of the pretest, act as their own control group.

List of abbreviations

AMOD	A Matter of a Degree
ARM	Alcohol Risk Management
AUDIT	Alcohol Use Disorders Identification Test
BAC	Blood alcohol concentration
BAL	Blood alcohol level
CAS	Cohort analytic study
CCT	Controlled clinical trial
CI	Confidence interval
CMCA	Communities Mobilising for Change on Alcohol
CMDA	Complying with the Minimum Drinking Age
EAV	Electronic age verification
ED	Emergency department
EMS	Emergency medical service
EPHPP	Effective Public Health Practice Project
ID	Age identification
ITS	Interrupted time series
OR	Odds ratio
QALY	Quality adjusted life year
RBS	Responsible beverage service
RCT	Randomised controlled trial
RR	Relative risk
SNAPP	Sacramento Neighbourhood Alcohol Prevention Project
STAD	Stockholm Prevents Alcohol and Drug Problems
SVN	Single vehicle night time
TASC	Tackling Alcohol-related Street Crime
UBA	Uncontrolled before and after study

Executive Summary

Introduction

Techniques used to reduce harm in drinking environments range from rigorous police enforcement of licensing and other legislation to co-operative approaches that seek to train staff in licensed premises and engage nightlife industries in socially responsible operating. With authorities often stretched to manage intoxication and related problems in busy drinking environments, understanding which interventions can have most effects on reducing alcohol-related harm is critical. This report provides the findings from a systematic literature review that aimed to explore the effects of interventions implemented in drinking environments on a range of harms, including alcohol consumption, under-age alcohol sales, violence and road traffic crashes.

Methods

The review was based on a literature search of 10 databases including Medline, PsycINFO, ASSIA and other sources. Two reviewers independently assessed studies for inclusion against the following criteria: published since 1990, and examined an intervention with the aim of reducing harm associated with alcohol consumption, which was delivered in a drinking environment and targeted individuals, licensed alcohol serving outlets, or the sale and supply of alcohol via the off trade. Intervention studies of any design were eligible for inclusion.

Results

The literature search identified 47 studies that examined interventions designed to reduce harm in drinking environments. Seven studies examined the effectiveness of training programmes for servers and managers, five examined specific interventions delivered in pubs and bars, eight examined the enforcement of laws related to alcohol consumption, seven examined interventions aimed at reducing underage sales and 20 examined multi-component community-based programmes. Nine of the included studies were conducted in European countries including five in Sweden and four in the UK. The remaining studies were conducted in the USA, Canada, Australia and New Zealand. The methodological quality of the included studies was variable according to the study design used, and in general the methodological quality of the included studies was weak.

The clearest indication of effectiveness resulted from multi-component programmes. In particular, across three well-designed and implemented programmes, which combined community mobilisation, RBS training, house policies and stricter enforcement of licensing laws, there was evidence that these programmes were effective in reducing assaults, traffic crashes, and underage sales. In particular, the Swedish *STAD project*, a multi-agency partnership between the police, licensing authorities, health services, the council and

representatives of licensed premises, demonstrated success was based on a rigorous evaluation of effectiveness and cost-effectiveness.

The effectiveness of other intervention approaches was limited. Studies of server and bar management training programmes highlighted an overall low frequency of intervention and their effects on patrons' alcohol consumption appeared to be minimal, except where training was mandated. A training and risk management programme had a modest effect on aggression. Patron targeted interventions, which included brief intervention and promotion of responsible drinking, had a limited impact on patron behaviours. Police campaigns and other approaches to the enforcement of alcohol sales laws were shown to be largely ineffective or short lived. The effectiveness of police intervention or increased enforcement of licensing laws in reducing alcohol-related incidents was not clear, but overall, targeted police intervention in high-risk premises appeared to be a more effective strategy than 'low level' policing.

Conclusions

There is growing evidence that effective delivery of multi-component programmes in drinking environments can reduce alcohol-related harm, however, further research is required to assess the transferability of evidence about multi-component programmes in drinking environments to other settings.

1 Introduction

1.1 Drinking environments and alcohol-related harm

Drinking environments, including bars, nightclubs and their surrounds, are associated with high levels of acute alcohol-related harms, particularly in young people. High densities of drinking premises have been associated with increased binge drinking, violence, road traffic injuries and sexually transmitted infections (Livingston et al., 2007). A study of 16-35 year olds from nine European cities who use bars and nightclubs found that, in the past four weeks, seven in ten had been drunk at least once (Bellis et al., 2008), a fifth had driven whilst drunk, and a third had taken a lift from a driver who was under the influence of alcohol or drugs (Calafat et al., 2009). In the past year, 18% had been involved in a fight whilst in a drinking environment (Schnitzer et al., in press). Further, over a quarter had specifically used alcohol to facilitate sexual encounters, while levels of risky sexual behaviour (e.g. multiple partners, non condom use) were higher in those who had been drunk in the last four weeks (Bellis et al., 2008). Studies in individual countries also highlight relationships between alcohol-related harm and drinking environments. In England and Wales, for example, a fifth of all violence occurs in or around bars or nightclubs (Nicholas et al., 2007). In Switzerland, peaks seen in alcohol-related road traffic casualties occurring at weekend nights have been correlated with risky single occasion drinking occurring outside of the home (Gmel et al., 2005).

In addition to damage caused to individual health and communities, alcohol-related harm places large burdens on public services, including through health treatment, implementation of criminal justice sanctions and street cleaning after a night's entertainment. Consequently, managing drinking environments and implementing interventions to reduce harm among those visiting and working in drinking environments are major priorities in many town and city centres. Techniques used to reduce harm in drinking environments range from rigorous police enforcement of licensing and other legislation to co-operative approaches that seek to train staff in licensed premises and engage nightlife industries in socially responsible operating (Graham & Homel, 2008). However, intervening in environments that are specifically aimed at fun and the sale and consumption of alcohol can be complicated by factors including high turnover of staff in bars and nightclubs, and competing interests between those working to reduce alcohol use and harms and the alcohol industry (Ker & Chinnock, 2008).

1.2 Prevalence of harm in drinking environments in Europe

Reducing alcohol use and related harm in young people is a major European public health priority (Commission of the European Communities, 2006). Young Europeans typically consume greater quantities per drinking occasion than older drinkers (Mäkelä et al., 2006), with many binge drinking or drinking to the point of drunkenness (Hibell et al., 2009). These

drinking patterns are reflected in the disproportionate burden of alcohol-related harm seen in young Europeans. Over 25% of deaths in 15-29 year old males, and over 10% in females, are associated with alcohol use, largely through violence, road traffic crashes and unintentional injuries (Anderson & Baumberg, 2006). Drinking environments are critical locations for addressing harmful and hazardous alcohol consumption, but very little information is available across Europe on the extent of alcohol use and related harm. As shown in Table 1, research that has been conducted in Europe highlights the links between drinking environments, alcohol use and a range of health and social harms.

Table 1. European studies of harm in drinking environments

<p>Alcohol use</p> <ul style="list-style-type: none"> • A study of young nightlife users in nine European countries by the IREFREA research group found seven in ten had been drunk in the last four weeks (Bellis et al., 2008). • Among young Danish tourists in a Bulgarian resort, 98% of those approached had consumed alcohol the previous night, 85% had consumed over 8 units, and 46% had some form of memory loss the next day (Hesse et al., 2009). • Research in England found that young people’s typical alcohol consumption on a night out in a city drinking environment exceeded the UK recommended limits for an entire week (Hughes et al., 2008). 	<p>Road traffic injuries</p> <ul style="list-style-type: none"> • 18% of European nightlife users had driven when drunk in the last four weeks, and 37% had taken a lift from a driver who was drunk or drugged (Calafat et al., 2009). • In Switzerland, increases in alcohol-related road traffic casualties at weekend nights correlate with risky single occasion drinking outside of the home (Gmel et al., 2005). • Italian emergency department studies show alcohol-related traffic injuries peak in young people at weekend nights (Fabbri et al., 2002; Ricci et al., 2008). • In England, 63% of drivers and 80% of pedestrians killed on the road at weekend nights have been drinking (TRL Limited, 2008).
<p>Violence</p> <ul style="list-style-type: none"> • One in five European nightlife users surveyed by IREFREA had been involved in violence in the last 12 months (Schnitzer et al., in press). • In England and Wales, one in five of all incidents of violence occurs in or around pubs, bars and nightclubs (Kershaw et al., 2008). • An emergency department study in Norway found most assault victims were young men, typically assaulted at weekend nights by strangers in public locations, and whilst under the influence of alcohol (Steen et al., 2004). 	<p>Sexual health</p> <ul style="list-style-type: none"> • Meeting sexual partners is a major reason for young Europeans using pubs, bars and nightclubs (Calafat et al., 2003). • 29% of drinkers in the European nightlife study used alcohol specifically to facilitate sexual encounters (Bellis et al., 2008). • Alcohol intoxication is associated with regretted sex, unprotected sex and sexual assault. For example 60% of victims reporting drug facilitated sexual assault in the UK had alcohol concentrations above 150mg% (Scot-Ham & Burton, 2006).

1.3 Rationale for systematic review

With authorities often stretched to manage intoxication and related problems in busy drinking environments, understanding which interventions are most effective in reducing alcohol-related harm is critical. This report provides the findings from a systematic literature review conducted as part of the FASE (Focus on Alcohol Safe Environments) project, co-funded by the European Commission. The review aimed to examine the effectiveness of interventions implemented in drinking environments on a range of harms, including alcohol consumption, under-age alcohol sales, violence and road traffic crashes.

2 Methods

2.1 Search strategy

A database of published and unpublished literature was compiled in the Endnote software package from systematic searches of electronic sources and websites (see Table 2), and searching reference lists of retrieved articles.

Table 2. Electronic sources and websites searched

Health, social care and education databases	Websites
<ul style="list-style-type: none">• MEDLINE• PsycINFO• Cochrane Library• ASSIA• ERIC• Web of Science• OpenSIGLE• Project Cork• ETOH (Alcohol and Alcohol Problems Science Database)• Alcohol Studies Database	<ul style="list-style-type: none">• Alcohol and Education Research Council Alcohol Library• Institute of Alcohol Studies, London• Key Centre for Ethics, Law, Justice and Governance, Griffith University• National Drug Research Institute, Curtin University• Karolinska Institute• Centre for Addiction and Mental Health, Ontario• IREFREA• Drug and Alcohol Abuse• Nordic Council for Alcohol and Drug Research• Centralförbundet för alkohol

2.2 Inclusion criteria

Two reviewers screened titles and abstracts retrieved from the database searches according to the criteria described below. Full text articles of relevant studies were retrieved and screened by two reviewers independently to determine whether the study met the inclusion criteria.

a. *Interventions*

Interventions delivered in drinking environments that aimed to reduce harm associated with alcohol consumption. Interventions targeting the sale and supply of alcohol to underage drinkers via the off trade (e.g. off licences, supermarkets) were also eligible for inclusion.

Studies that examined interventions to regulate the physical availability of alcohol, for example by limiting the hours and days of sale, were not considered eligible for inclusion.

b. *Participants*

Individuals in drinking environments, including patrons, workers, owners and managers; licensed alcohol serving outlets; and areas of multiple licensed alcohol serving outlets.

c. *Study design*

With the exception of editorials, non-systematic overviews, comments, letters and conference abstracts, studies of any design were considered eligible for inclusion.

d. *Outcomes*

A wide range of outcomes were considered relevant for the review including (but not limited to) violence, injuries, assaults (including sexual assaults), aggression, anti-social behaviour, crime, road traffic crashes and pedestrian injuries, health service utilisation (e.g. emergency department visits), excessive alcohol consumption, and binge drinking.

2.3 Data extraction and quality assessment

Data relating to both study design and quality were extracted by one reviewer into an Access database and independently checked for accuracy by a second reviewer. Disagreements were resolved through consensus and if necessary a third reviewer was consulted. The quality of the studies was assessed according to the Effective Public Health Practice Project (EPHPP) Quality Assessment Tool for Quantitative Studies developed at McMaster University, Canada. This tool has been judged to be suitable for use in systematic reviews of effectiveness, and can be used to assess the quality of all quantitative study designs. To assess the methodological quality of studies based on an interrupted time series (ITS) design we used the criteria developed by the Cochrane Effective Practice and Organisation of Care group.

2.4 Methods of synthesis/analysis

The results of the data extraction and quality assessment for each study of effectiveness were presented in structured tables and as a narrative summary. Studies were grouped according to broad intervention areas, and the possible effects of study quality on the effectiveness data and review findings discussed. Findings from studies that scored highly on the quality assessment tool were prioritised.

3 Results

3.1 Summary of study identification

A total of 5,114 references were identified from the literature searches. Following title and abstract screening and removal of duplicates, 408 were judged to be eligible for screening as full text articles. In addition, 9 articles were identified through reference screening of retrieved articles. It was not possible to retrieve 15 articles and seven references were for conference abstracts. Therefore, a total of 386 articles were screened for inclusion in the review. Figure 1 summarises the process of study selection.

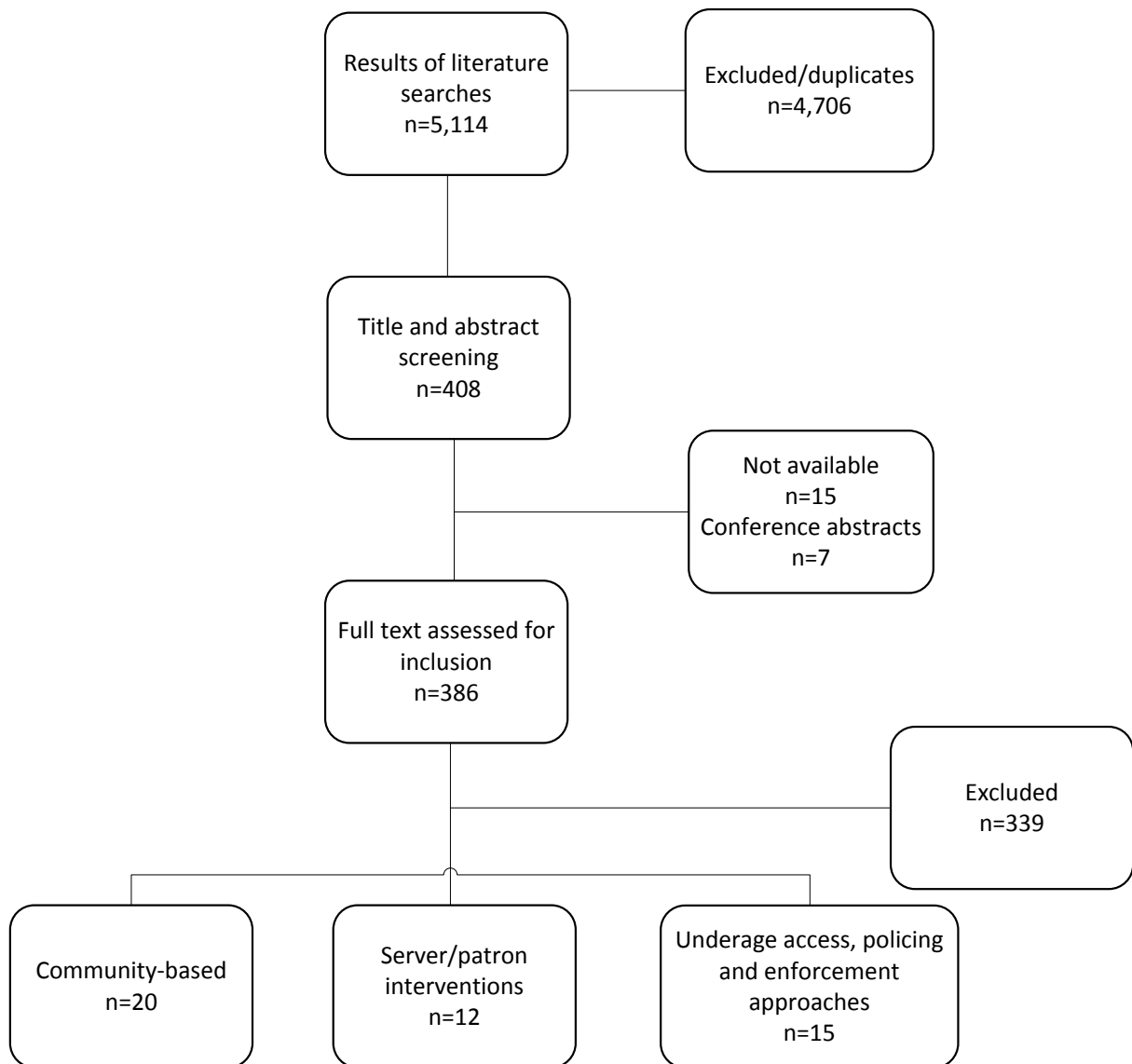


Figure 1. Flowchart of study identification

3.2 Included studies

A total of 47 studies met the criteria for inclusion in the review. Studies were grouped according to the broad intervention type that they examined. A total of 20 studies examined multi-component community-based programmes, 12 studies examined a broad range of interventions delivered within licensed alcohol outlets targeting server and/or patron behaviours, and 15 studies examined interventions targeting underage sales or the enforcement of laws related to alcohol consumption. Studies were also grouped according to the specific programme or intervention examined. The 20 studies that examined community-based programmes, covered seven programmes, and the 12 studies that examined interventions aimed at changing patron and/or server behaviour, covered nine RBS programmes and three specific interventions delivered in pubs or bars. Three interventions targeting underage sales were examined and ten enforcement programmes were examined across 12 studies. Tables 3 to 5 summarise the studies identified for inclusion.

Of the 32 programmes and interventions examined, seven programmes and interventions were evaluated based on a randomised controlled trial (RCT) design, and evaluation of eight programmes/interventions was based on a controlled clinical trial (CCT) design. Evaluations of the remaining programmes and interventions were based on observational designs and included five interrupted time series (ITS), six cohort analytic studies (CAS) and nine before and after studies that did not include a control group for comparison (uncontrolled before and after; UBA). Two programmes were evaluated based on both a CCT and ITS design, and one programme was analysed based on a CAS and UBA study. In addition two economic evaluation studies were identified; one study was based on a cost-benefit analysis and the other was based on a cost-effectiveness analysis. Tables 4 and 5 in Appendix 2 summarise the results of the quality assessment.

3.3 Excluded studies

A total of 339 articles did not meet the criteria for inclusion in the review and were excluded. Articles were excluded from the review for the following reasons: (1) examined the association between alcohol-related harm and environmental and other factors (e.g. outlet density) rather than intervention effectiveness (n=175); (2) non-systematic reviews, news articles or editorials/commentaries (n=77); (3) examined changes in the physical availability of alcohol (n=41); (4) intervention studies but did not examine an intervention delivered in drinking environments or the impact of interventions on alcohol-related harm (n=25). An additional 21 articles were excluded as full publication of the studies were reported in other articles, were pilot or poorly quality evaluations, or were duplicates. Reference details for these studies are presented in Appendix 3.

Table 3. Summary of studies identified for inclusion: responsible server/staff training programmes and interventions delivered in drinking environments

Programme name (Reference)	Country	Study design (Quality)	Target group	Intervention	Outcomes
Safer Bars programme (Graham et al., 2004)	Canada	RCT <i>Moderate</i>	Managers/owners and other staff at 38 bars; 18 received the intervention and 12 served as controls	3 hour risk management training programme	Reductions in severe and moderate aggression.
(Johnsson & Berglund, 2003)	Sweden	RCT <i>Moderate</i>	Servers at six intervention and six control 'student pubs'	Five lectures on responsible alcohol service	No differences in alcohol consumption.
(Warburton & Shepherd, 2000)	UK	RCT <i>Weak</i>	57 licensed premises; 30 intervention premises and 23 control premises (n=1,229 bar workers)	Replacement of pint glasses with toughened glassware	Risk of injury was greater in bar staff using the toughened glassware (found to have lower impact resistance).
0.05 Know Your Limits (McClellan et al., 1994)	Australia	RCT <i>Weak</i>	17 licensed premises; eight intervention premises and nine control premises (n=575 patrons)	Promotion of responsible drinking and placement of breath analysis machines	Limited impact of the programme on blood alcohol levels or drink driving.
(McKnight et al., 1991)	USA	CCT <i>Moderate</i>	Servers and managers at 100 establishments; 138 comparison establishments	6 hour training programme	Increases in server intervention, but overall low frequency of intervention.
(Gliksman et al., 1993)	Canada	CCT <i>Moderate</i>	Servers and managers/owners at four establishments; four comparison establishments	4.5 hour training session; development of house policies.	Trained servers exhibited more appropriate responses than untrained servers.
FREO Respects You (Lang et al., 1998)	Australia	CCT <i>Moderate</i>	Seven high-risk premises; 7 matched control premises	1-2 hour training programme	No change in serving practices or ID checking. Reduction in number of patrons with blood alcohol levels ≥ 0.08 .
Project ARM (Toomey et al., 2001)	USA	CCT <i>Weak</i>	Owners/managers at five intervention bars and nine matched control sites	Five one-on-one consultation sessions for owners and managers of bars (1-2 hours)	Non-significant reduction in underage sales (11%) and sales to pseudo-intoxicated patrons (46%).
(Holder & Wagenaar, 1994)	USA	ITS <i>Strong</i>	All licensed premises in the State of Oregon	Mandated training for alcohol servers	Reduction in SVN crashes (23% by end of third year).
Road Crew (Rothschild et al., 2006)	USA	CAS <i>Weak</i>	Three intervention communities and three control communities	Ride programme; transport between bars and clubs	No change in alcohol consumption but frequency of driving whilst impaired decreased.
Operation Drinksafe (Van Beurden et al., 2000)	Australia	UBA <i>Weak</i>	118 hotels and clubs (n=1,211 patrons)	Alcohol brief intervention, personalised risk assessment and BAC testing	Greatest reductions in alcohol consumption by those who initially had harmful levels of alcohol consumption.
Pick-a-Skipper (Boots & Midford, 1999)	Australia	UBA <i>Weak</i>	One community (city population 25,000)	Designated driver programme; media campaign and promotions	No change in frequency of reporting "being in a car with a driver > 0.05% BAC".
RCT – randomised controlled trial; CCT – non-randomised controlled clinical trial; CAS – cohort analytic study; ITS – interrupted time series; UBA – uncontrolled before and after study; SVN – single vehicle night time; BAC – blood alcohol concentration					

Table 4. Summary of studies identified for inclusion: Underage access and policing/enforcement approaches

Programme name (Reference)	Country	Study design (Quality)	Target group	Intervention	Outcomes
(Burns et al., 1995)	Australia	RCT <i>Moderate</i>	10 police service patrol areas; 5 received intervention and 5 acted as control sites	Heightened police supervision of the NSW Liquor and Registered Clubs Acts, particularly with regard to serving underage and intoxicated people.	Increase in all offences and assaults during intervention period.
Alcohol Linking Programme (Wiggers et al., 2004)	Australia	RCT <i>Weak</i>	400 hotels, registered clubs and nightclubs in two communities	Police feedback to high-risk premises	Reduction in alcohol-related incidents ^a (15%)
(Chandler 2002)	USA	CAS <i>Weak</i>	400 intervention outlets and 100 control outlets	Undercover compliance checks (underage sales)	No significant change in underage sales.
Operation Safe Crossing (Voas et al., 2002)	USA	ITS <i>Moderate</i>	Young people crossing the USA/Mexican border	Special patrols and sobriety checkpoints; increase in border foot patrols and enforcement of laws; media advocacy	Reduction in alcohol-related crashes among 16-20 year olds (45%)
Complying with the Minimum Drinking Age (Wagenaar et al., 2005)	USA	ITS <i>Strong</i>	Alcohol outlets in 20 cities; intervention sites consisted of one large urban city and 10 surrounding suburban incorporated cities.	Server/management training (ARM Express) and police enforcement checks	Short term impact of enforcement checks and non-significant impact of training on underage sales.
TASC project (Maguire & Nettleton, 2003)	UK	UBA <i>Weak</i>	All licensed premises in two areas of a city.	Police-led multi-agency scheme to reduce the level of alcohol-related violence and disorder	Increase in alcohol-related disorder (49%). Decrease in alcohol-related assaults based on all known incidents (4%) Reduction in incidents at targeted 'hot spots'
TASC project (Warburton & Shepherd, 2006)	UK	CAS <i>Weak</i>	All licensed premises in two areas of a city; suburban area used as comparison site	Targeted police operation and ED intervention	Increase in street assaults based on ED data (34%). Relative to total capacity there was no change in assaults in licensed premises. Greater reduction in assaults at targeted 'hot spot' venues.
Serving-Intoxicated Patrons Programme (McKnight & Streff, 1994; Levy & Miller, 1995)	USA	CAS <i>Weak</i>	40 randomly selected establishment in one intervention county and 20 control establishments	Plainclothes officers from enforcement agencies entered bars and restaurants periodically to watch for and cite servers found dispensing alcohol to intoxicated patrons.	Reduction in drink driving arrestees who reported having consumed their last drink in a bar or restaurant (from 32% to 23%). Increase in refusal of service to intoxicated patrons.
(Willner et al., 2000)	UK	CAS <i>Weak</i>	Random sample of alcohol outlets in one intervention community and one control community	Police campaign to enforce underage sales laws	Increase in underage alcohol sales.

Programme name (Reference)	Country	Study design (Quality)	Target group	Intervention	Outcomes
MinorChecker® (Bierness et al., 2001)	USA	CAS <i>Weak</i>	60 alcohol outlets in one community; one control community	Card reader system	Decrease in age verification practices and ID checking. Increase in drink driving arrests and no impact on SVN crashes.
Geelong Accord (Felson et al., 1997)	Australia	UBA <i>Weak</i>	Bars and clubs in the central business district of one community	Introduction of cover charges, prohibition of unlimited entry and increased enforcement of underage and street drinking laws	Declines in crime and damage based on observation. Decline in serious assault rate.
(Krevor et al., 2003)	USA	UBA <i>Weak</i>	Tobacco and alcohol retail stores in two communities.	Electronic age verification device	No change in age verification practices.
Project Freedom (Lewis et al., 1996)	USA	UBA <i>Weak</i>	100 stores in one community	Increased surveillance of underage sales	No significant change in sales made without age identification checks.
Auckland Regional Community Action Project (Huckle et al., 2005)	New Zealand	UBA <i>Weak</i>	Random sample of 250 outlets in one community	Enforcement of underage sales laws	Reduction in sales made without age identification checks (from 60% to 46%).
^a Not defined RCT – randomised controlled trial; CCT – non-randomised controlled clinical trial; CAS – cohort analytic study; ITS – interrupted time series; UBA – uncontrolled before and after study; ED – emergency department					

Table 5. Summary of studies identified for inclusion: Community-based programmes

Programme name (Reference)	Country	Study design (Quality)	Target group	Intervention	Outcomes
Communities Mobilising for Change on Alcohol (Wagenaar et al., 1999; 2000a; 2000b)	USA	RCT with nested time series design <i>Moderate</i>	Seven intervention communities and eight control communities	Community mobilisation to reduce youth access to alcohol	Non-significant reduction in alcohol consumption among 17-18 and 18-20 year olds. Reduction in underage sales in on-sale outlets (24%) and non-significant reduction in off-sale outlets (8%). Significant reduction in drink driving arrests among 18-20 year olds (by 30 arrests/100,000 population per year) but not 15-17 year olds (by 7 arrests/100,000 per year). Non-significant reduction in arrests for disorderly conduct for 15-17 and 18-20 year olds.
Sacramento Neighborhood Alcohol Prevention Project (Treno et al., 2007)	USA	CCT <i>Weak</i>	Two intervention neighbourhoods; wider community used as comparison site	Community mobilisation, RBS training, law enforcement	Reduction in assaults as reported by police, aggregate EMS outcomes, EMS assaults and EMS motor vehicle accidents. Reduction in underage sales in one intervention site, however increases in sales in second intervention site.
A Matter of a Degree (Weitzman et al., 2004; Nelson et al., 2005)	USA	CCT <i>Weak</i>	10 college sites and 32 comparison sites	Various environmental policies (e.g. RBS training, ban on advertising)	Reductions in alcohol consumption, alcohol-related harms, second hand effects and drink driving in sites with highest level of implementation (all self-report).
Community Trials project (Holder et al., 2000 ^b)	USA	ITS <i>Moderate</i>	Three intervention communities and three matched control communities	Community mobilisation and media advocacy, RBS training, limiting underage access to alcohol, enhanced enforcement efforts against drink driving, local restrictions on access to alcohol	Reduction in alcohol consumption (6%). Reduction in SVN crashes (10% per month) and alcohol-related crashes (6% per month). Reduction in hospital assault cases (43%) and hospitalised assault injuries (2%).
STAD project (Wallin et al., 2002; 2003; 2005; Månsdotter et al., 2007)	Sweden	ITS <i>Strong</i>	One intervention community and one control community	Community mobilisation, RBS training, enforcement of alcohol laws	Significant increase in total rate of refusal for alcohol service for all licensed premises (from 47% to 70%). Reduction in violent crimes ^a (29%). Cost-saving ratio 1:39.
Surfers Paradise Safety Action Project (Homel et al., 1997)	Australia	UBA <i>Weak</i>	18 nightclubs in a major tourist area	Community mobilisation; code of practice for nightclub managers, venue management	Reduction in physical assaults (from 9.8 to 4.7 assaults per 100 hours of observation), verbal abuse (from 12.5 to 2.3 per 100 hours) and arguments (from 7.1 to 2.3 per 100 hours).
Local Government Safety Action Projects (Hauritz et al., 1998a)	Australia	UBA <i>Weak</i>	Entertainment area in three cities	Community mobilisation; code of practice for nightclub managers, venue management	Reduction in all forms of aggression and violence (physical violence greatest).

RCT – randomised controlled trial; CCT – non-randomised controlled clinical trial; CAS – cohort analytic study; ITS – interrupted time series; UBA – uncontrolled before and after study; RBS – responsible beverage service; EMS – emergency medical service; SVN – single vehicle nighttime

^a Assaults, illegal threats and harassment, violence and threats targeted at officials (including the police and door staff).

^b also Grube 1997; Holder & Reynolds 1997; Holder et al., 1997a; 1997b; Moore & Holder 2003; Roeper et al., 2000; Saltz & Stanghetta 1997; Treno & Holder 1997

3.4 Responsible server/staff training programmes

3.4.1 Overview of evidence identified

Seven articles were identified that assessed the effectiveness of training programmes for servers and managers. Five studies (McKnight et al., 1991; Gliksman et al., 1993; Holder and Wagenaar, 1994; Johnsson and Berglund, 2003; Lang et al., 1998) evaluated server training interventions aimed at increasing responsible serving practices. Graham and colleagues (2004) examined a training programme designed to reduce aggression in bars and Toomey and colleagues (2001) assessed the effectiveness of the *Alcohol Risk Management (ARM)* training programme. Three studies were conducted in the USA, two in Canada, one in Sweden and one in Australia.

McKnight and colleagues (1991) evaluated an education intervention for servers and managers in establishments licensed to sell alcohol. The programme consisted of a 6-hour session covering the need for responsible service, ways of preventing customers from becoming intoxicated and methods of intervening with patrons who have already become intoxicated. Specifically for managers, the programme covered role plays of intervention with intoxicated patrons, the formulation of policies conducive to responsible alcohol service and guidelines for assisting managers in administering the programme to servers. Gliksman and colleagues (1993) evaluated the impact of a server training programme informing managers about their obligations and responsible serving practices, as well as encouraging them to establish policies for the sale of alcohol. Servers in the establishments were then familiarised with the policies and instructed in responsible serving practices over four one hour sessions. The programme aimed to prevent intoxication rather than intervening once a patron had reached intoxication. Holder and Wagenaar (1994) evaluated statewide mandated alcohol server training in Oregon, USA, which covered a number of areas such as the effects of alcohol, alcohol service, drinking and driving laws, legal liability issues and effective server intervention techniques. Johnsson and Berglund (2003) assessed the impact of a server training programme on alcohol consumption levels among patrons in student pubs. The training programme focused on bar tenders' own relationship with alcohol, myths and facts about alcohol, and techniques on how to refuse service to intoxicated patrons. Lang and colleagues (1998) evaluated the impact of a training programme on responsible serving practices, alcohol consumption levels and related harm. The programme lasted between 1-2 hours and covered areas such as: laws regarding service to underage individuals, recognising signs of intoxication, strategies in dealing with drunken customers, the effects of alcohol and advice on developing related policies. Graham and colleagues (2003) evaluated the impact of The *Safer Bars* programme in reducing aggression in bars. The programme consisted of a number of components including a risk assessment work book alerting bar owners to environmental factors that may lead to aggression and owner/manager rating of bars. An additional element of the programme was a training programme for bar staff and managers covering areas such as recognising early signs of aggression, early intervention and responses and legal issues relating to managing

aggression and problem behaviour. The *ARM* training programme examined by Toomey and colleagues (2001) involved one-on-one consultation sessions for owners and managers of licensed premises. Participants were provided with information on implementing written establishment policies that encouraged responsible alcohol sales to underage and intoxicated patrons and advice on how to discuss new policies with staff. The programme was implemented in five bars, all of which adopted establishment policies following the consultations

3.4.2 Quality assessment

Two studies were RCTs. In the study by Johnsson and Berglund (2003) six of 12 student organisations were selected at random to participate in the programme. Randomisation was stratified for the number of members in each organisation and the method of allocation involved the chairman of each organisation drawing lots. Overall, the quality of the study was assessed as moderate because it was not possible to tell if participants were likely to be representative of the target population, the authors did not report clearly how confounding was addressed and blinding was not described. The RCT by Graham and colleagues (1993) was well reported but the quality of this study was assessed as moderate because a number of bars were dropped from the study. From a sample of 126 eligible premises, a total of 30 bars participated in the study. Eighteen bars received the intervention programme and 12 bars acted as controls.

Five studies were based on quasi-experimental designs, including three CCTs, one cohort analytic study and one ITS. Gliksman and colleagues (1993) undertook a CCT. Of eight drinking establishments, chosen to be representative of a variety of drinking establishments, four were randomly chosen to receive the intervention and the other four acted as controls. The quality of the study was rated as moderate. The study scored well on the items assessing selection bias and blinding, but data collection methods were not shown to be valid or reliable, and how confounding was dealt with was not described. Premises with estimated annual purchases for over the bar sales in excess of AUS\$ 150,000 or with at least five customers failing a roadside breath test in the previous year were selected for the CCT by Lang and colleagues (1998). Of the 50 premises invited to participate, 10 agreed and of these seven were eligible for inclusion. Seven control premises were selected to match the intervention sites as closely as possible. The study was assessed as moderate as few of the selected bars agreed to participate and there was no description of withdrawals and dropouts from the study. However, the study was rated strong for blinding and the data collection methods used were valid and reliable. Evaluation of Project *ARM* (Toomey et al., 2001) was also based on a CCT design. Five bars located in a major metropolitan area received the intervention and were compared to nine matched control bars. Overall the quality of the study was assessed as weak because few of the bars approached agreed to participate and data collection methods were not reported to valid or reliable. The study by McKnight and colleagues (1991) was based on a cohort analytic design. The intervention was implemented at eight drinking establishments, and compared with comparison

establishments which were selected to match the intervention sites as closely as possible. Overall the quality of the study was rated as weak because it was unclear whether the sample of establishments selected were representative and the authors did not describe how confounders were accounted for. Holder and Wagenaar (1994) examined the effects of statewide mandated server training using an ITS design. Overall the study was rated as good quality, the statistical methods used were appropriate and the internal validity of the study design was strong.

3.4.3 Outcomes

Responsible serving practices

Three studies evaluated the impact of server training interventions on responsible beverage serving practices. McKnight and colleagues (1991) found that overall there were significant increases in server intervention in the intervention group ($p < 0.01$). The number of occasions in which staff served and made no attempt to intervene in the drinking of the observer decreased by 12.5% (compared to a difference of 0.8% in the comparison group). Instances where servers provided drink but made some move towards intervention increased by 10.5% (compared to 1.7% in the comparison group), and instances where servers terminated service increased by 1.9% (compared to a decrease of 0.7% in the comparison group). However, there were significant differences in the effects of the intervention between sites and an overall low frequency of intervention even where the programme appeared to have been effective. In a similar study (Gliksman et al., 1993), based on observation of server reactions to actors portraying behaviours often faced by servers, the server training programme appeared to have been effective in changing behaviour. Servers exhibited less inappropriate and more appropriate responses at follow-up than did untrained servers, who maintained the same types and levels of responses. However, further analysis suggested that this change in server behaviour was due to servers in the intervention group making less serious inappropriate responses rather than responding with appropriate responses. The use of pseudo drunk patrons to assess changes in serving practices revealed rare refusal of service in the study by Lang and colleagues (1998). Identification was rarely checked and non-photographic identification was accepted on most occasions. The authors suggest that this less than satisfactory outcome can be attributed to poor implementation of the training and a lack of support among bar managers.

Drink driving and alcohol -related crashes

One study evaluated the impact of mandated server training programmes on alcohol-related crashes and drink driving (Holder and Wagenaar, 1994). The authors found that the policy of requiring alcohol servers to be trained had a statistically significant effect on single vehicle night time (SVN) traffic crashes. There was an estimated reduction in SVN crashes of 4% in the first 6 months under the new rules, 11% at the end of the first year, 18% by the end of the second year and 23% by the end of the third year. As such, the effect of the law

increased over the first three years of experience, as the proportion of servers that were trained in the state increased.

Alcohol use

Two articles examined the impact of server training/education on alcohol consumption levels. Johnsson and Berglund (2003) assessed the impact of a server education programme on patron alcohol consumption levels. At one-month follow-up, blood alcohol concentrations (BACs) of patrons in the intervention pubs were found to have reduced by more than half those of the patrons in the control pubs (mean difference in BAC between intervention and control groups was -0.011%, 95% CI: 0.022 to 0.000). However, the differences between the changes in the intervention and control group were not significant ($p=0.12$). A BAC level greater than 0.1% was reported among 40% ($n=147$) of participants in the intervention group at baseline and 39% ($n=140$) at follow-up. In the control group 34% ($n=102$) of participants had a BAC level greater than 0.1% at baseline and 41% ($n=121$) at follow-up. The study by Lang and colleagues (1998), showed an immediate pre- to post-test reduction in patrons rated by researchers as extremely drunk in the intervention sites ($p<0.017$). An eventual reduction from pre-test to follow-up in patrons with blood alcohol levels (BALs) ≥ 0.08 in both the intervention and control group was also reported. While the rate of decline from pre-test to follow-up was significantly greater (0.029) for the intervention group, this trend was not significant (0.225) for the immediate pre- to post-test analysis. Both intervention and control groups showed falls in the percentage of patrons attaining BALs of 0.15 and over across all three test periods. Although the rate of decline in BALs over 0.15 were greater for the intervention group, this trend was not significant ($p=0.389$).

Aggression

Graham and colleagues (2004) examined the effect of The *Safer Bars* programme on aggression in bars. Results demonstrated that bars participating in the programme showed a decrease in physical aggression by patrons while control bars showed an increase. Although overall there were low rates of staff aggression, this outcome increased in both the intervention and control bars during the post intervention observations. Incidences of severe aggression (e.g. punching, kicking) and moderate physical aggression (e.g. shoving, grappling) involving verbal aggression and with definite intent were significantly greater in the control bars. Overall, the *Safer Bars* programme had a significant effect on reducing severe aggression and moderate aggression. However, this effect was moderated by turnover of managers and door/security staff with higher post intervention aggression associated with higher turnover in the intervention bars. The authors noted however that given the low rate of aggression within the bars, it was only possible to demonstrate a modest impact of the programme on aggression.

Purchase attempts

Toomey and colleagues (2001) examined the impact of the ARM intervention on rates of successful purchase attempts by pseudo-intoxicated patrons and underage patrons. Underage purchase attempts were similar at baseline between the intervention and control sites (46% vs. 48%) and at 4-6 weeks follow-up the underage purchase rate had increased slightly in the control group (49%) and decreased in the intervention group (42%). However, the relative decline of 12% between the intervention and control groups was not significant. Similar results were found for pseudo-intoxicated purchase rates. After intervention, compared to baseline (intervention 68.4% vs. control 70.1%) purchase rates were higher in the control group and lower in the intervention group (72.9% and 40%, respectively). However, the 46% relative decline was not statistically significant. Baseline refusal rates among pseudo-intoxicated buyers on either the first or second purchase attempt were higher in the intervention than control bars (intervention 83.1% vs. control 63.0%). At follow up refusal rates decreased in both the intervention and control bars (intervention 80.3% vs. control 54.8%); however, these differences were not significant.

3.5 Interventions delivered in drinking environments

3.5.1 Overview of evidence identified

Five articles were identified that examined the effectiveness of interventions aimed at reducing alcohol-related harm (consumption levels, injuries and drink driving) in drinking environments (Van Beurden et al., 2000; Warburton and Shepherd, 2000; Boots and Midford, 1999; Rothschild et al., 2006; McLean et al., 1994). Three studies were conducted in Australia, one in the UK and one in the USA.

Van Beurden and colleagues (2000) examined the effects of an alcohol brief intervention programme, *Operation Drinksafe*, on drinking behaviours among patrons in bars and taverns. The programme provided personalized risk assessments to patrons based on the Alcohol Use Disorders Identification Test (AUDIT), in combination with a breathalyser to determine BACs. Warburton and Shepherd (2000) evaluated the effectiveness of toughened glassware in reducing injuries.

Three studies were identified that evaluated the effectiveness of interventions specifically aimed at reducing drink driving among patrons (Boots and Midford, 1999; Rothschild et al., 2006; McLean et al., 1994). Boots and Midford (1999) assessed the impact of a designated driver programme, *Pick a Skipper*, on alcohol-related injury. The intervention consisted of a TV advertising campaign encouraging young people (aged 18-35) to select a designated driver when going out drinking and a promotion offering drivers with two or more passengers free soft drinks throughout the evening. Rothschild and colleagues (2006) evaluated the effectiveness of a ride programme, *Road Crew*, in reducing alcohol-impaired driving crashes. The programme aimed to prevent patrons over the legal driving limit from driving home by distributing discounted coupons to encourage use of the ride programme, which provided rides to, between and home from bars. The impact of the programme was

assessed using ridership counts and self-report behaviour relating to drinking and driving. McLean and colleagues (1994) assessed the effectiveness of an intervention programme, *0.05 Know Your Limits*, which offered promotional material on drink driving to bar staff and BAC testing to patrons in promoting responsible drinking and the avoidance of drink driving among patrons. Eighteen hotels were randomly allocated to the intervention or control group and BAC levels, patron surveys and hotel inspections were conducted between sites.

3.5.2 Quality assessment

Two studies used RCT designs (McLean et al., 1994; Warburton and Shepherd, 2000), both of which were rated weak on the quality assessment tool. The RCT by McClean and colleagues (1994) involved 18 hotels which were randomly allocated to either the intervention or control group. Although there were differences between the intervention and control premises at baseline, the authors did not report how confounders were accounted for in the analyses. In addition, data collection methods were not reported to be valid or reliable. In the RCT by Warburton and Shepherd (2000), managers of 53 bars agreed to participate and were randomised to receive either annealed glasses or toughened glasses (the intervention). Only 30 bars completed the trial, 16 in the intervention group and 14 in the control group, and therefore although the study was well reported it was rated poorly in terms of withdrawals and dropouts. In addition, data collection methods were not reported as valid or reliable.

The study by Rothschild and colleagues (2006) was based on a CAS design. Three communities which participated in the social marketing campaign were compared to five control communities. Overall the quality of the study was assessed to be weak. It was unclear whether the communities chosen to participate were representative, or if the authors had controlled for confounding. The study by Van Beurden and colleagues (2000) was based on a before and after study design. The study involved follow-up of 2,302 patrons who had participated in the intervention, but did not include a control group for comparison, and was therefore rated as weak on the quality assessment tool. The media campaign examined in the study by Boots and Midford (1999) was evaluated by cross-sectional surveys before and after the intervention campaign. The study did not include a control group for comparison and was scored poorly on the quality assessment tool.

3.5.3 Outcomes

Alcohol consumption levels

Van Beurden and colleagues (2000) evaluated the effectiveness of *Operation Drinksafe*. At the 12-month follow-up, 46% of participants reported reduced alcohol consumption and almost two thirds (60%) had reduced AUDIT scores. The mean AUDIT score reduced by 15%, weekly alcohol consumption reduced by 13% and frequency of binge drinking reduced by 19%. The greatest reductions were among those who initially had harmful levels of alcohol consumption. Females had almost twice the odds of reducing consumption compared to males (odds ratio [OR] 1.75, 95% CI: 1.33 to 2.33), as did participants with initial

consumption levels above gender specific means (OR 2.03, CI: 1.58-2.60) and those who frequently (weekly or more) felt guilty after drinking (OR 2.32, 95% CI: 1.05 to 5.22).

Injury

The results of the RCT that evaluated toughened pint glassware in pubs (Warburton and Shepherd, 2000) found that at 6 month follow-up, the risk of injury was greater in bar staff in the intervention group than in the control group (Relative risk [RR] 1.48; 95% CI 1.02 to 2.15). After adjusting for hours worked (RR 1.57; 95% CI 1.08 to 2.29) the injury rate was found to be 60% higher in the intervention group ($p < 0.05$), with no significant difference in severity. Injuries in the intervention group tended to occur simultaneously in more than one body part, reportedly caused by spontaneous disintegration of the toughened glassware. Laboratory testing showed that intervention glasses were actually less tough than the annealed glasses in the control group. Thus, the toughened glass had lower impact resistance and caused more injuries. The authors noted that these findings emphasise the need to develop quality control and standards for toughening glassware in bar environments.

Drink driving

Three studies evaluated the effectiveness of interventions aimed at reducing intentions to drink and drive. McLean and colleagues (1994) evaluated the impact of an intervention programme, *0.05 Know Your Limits*. Comparing BAC levels and intentions to drink and drive between intervention and control patrons, revealed no significant differences between the median BAC, or the proportion of patrons who intended to drive with BAC over the legal limit. Although the BAC distributions were very similar between intervention and control groups, the reported amount of alcohol consumed was significantly less in the intervention hotels. However, patrons who reported having seen the intervention information had significantly higher BACs ($p = 0.024$) and self reported alcohol consumption ($p = 0.034$) than those who had not seen the information. Moreover, only 36% of patrons had seen drink driving information in the intervention hotel and only forty percent of subjects who remembered seeing the material were able to recall a message correctly. The breath analysis component of the programme had limited impact in that only 1.4% of subjects used the breathalyser on the survey night.

Boots and Midford (1999) evaluated the effectiveness of a designated driver intervention in preventing alcohol-related injury. Although the media element of the programme appeared to have had some impact in persuading a number of drinkers to select a designated driver, the night club intervention had a limited effect, with only 35 people identifying themselves as designated drivers to door staff. Increases in consumption were reported among those reporting having been in a car with a driver over the 0.05% BAC level and those aged 18-23, if they had a designated driver. Overall, there were no significant differences in the frequency of reporting being in a car with a driver over 0.05% BAC between the pre- and post-samples.

Rothschild and colleagues (2006) assessed the effectiveness of a ride programme, *Road Crew*, in reducing alcohol-impaired driving crashes. Result showed that alcohol consumption did not significantly change as a result of the ride programme, yet there was a shift in driving habits with a total of 19,575 rides taken within the three communities over a one year period. However, there was little change in the percentage of patrons who were driving impaired on the specific night of receiving the bar coupon. Over a two week period, the frequency of driving whilst impaired had decreased significantly at the individual level.

3.6 Policing and enforcement approaches

3.6.1 Overview of evidence identified

Eight studies (Burns et al., 1995; McKnight & Streff, 1994; Maguire & Nettleton, 2003; Willner et al., 2000; Warburton & Shepherd, 2006; Wiggers et al., 2004; Voas et al., 2002; Felson et al., 1997) and one cost-benefit analysis (Levy & Miller, 1995) were identified that examined the effects of policing approaches and increases in enforcement efforts on sales to intoxicated and underage drinkers. Three studies were conducted in the USA, three in Australia and two in the UK.

Seven studies examined the effects of increased enforcement efforts targeting on-licensed premises. Burns and colleagues (1995) examined the effects of heightened police supervision of the New South Wales Liquor and Registered Clubs Acts on the number of overall criminal offences, and more specifically on the number of assault-related hospital admissions. Visits were conducted by two uniformed beat police who would conspicuously enter the premises, engage in brief conversations with the bar staff and regular patrons, and check for patrons who were intoxicated and/or under-aged. McKnight and Streff (1994) assessed the effects of enforcing laws prohibiting the service of alcohol to intoxicated patrons of bars and restaurants in Washtenaw County, Michigan, USA. The intervention was carried out over one year and involved plainclothes officers from enforcement agencies entering bars and restaurants periodically to watch for and cite servers found serving alcohol to intoxicated patrons. The intervention was county-wide and a half of enforcement visits were concentrated on ten premises responsible for the greatest number of drinking drivers, and the other half were randomly distributed over the remaining premises in the county. Levy and Miller (1995) conducted a cost-benefit analysis of this programme. Wiggers and colleagues (2004) examined the *Alcohol Linking Programme*, a police enforcement programme based on tailored feedback to licensees on incidents reported to have occurred following alcohol consumption on their premises, and covert audit of high-risk premises¹. The *Tackling Alcohol-related Street Crime (TASC)* project aimed to reduce the level of alcohol-related violence and disorder in Cardiff, Wales (Maguire and Nettleton, 2003; Warburton and Shepherd, 2006). As part of the project, all licensed premises in entertainment areas of the city were subject to targeted police intervention, which included regular monitoring of, and ongoing visits to premises, and training and registration of door

¹ Premises associated with one or more police attended incidents

staff. There were also increased efforts to target crime and disorder 'hot spots'. For example, during the project there were two eight week high profile, high visibility policing programmes. Additional aspects of the programme included measures aimed at publicising the problem of alcohol-related violent crime, a training programme for bar staff, a programme of alcohol education in schools, and support for victims of alcohol-related assaults at an emergency department (ED). The study by Warburton and Shepherd (2006) focused on the effects of an additional emergency department component, in which two consultants visited premises and presented in graphic detail the injuries sustained, treatment, and numbers of assaults occurring there to premises managers. They also informed the managers that the ED was auditing violence in their premises and that a report would be published six months later and disclosed to the local media. Felson and colleagues (1997) examined the impact of the introduction of a police led effort, the *Geelong Accord*, which was designed to stop 'pub hopping' by introducing cover charges for bars and clubs, and prohibiting unlimited entry to premises in the entertainment centre of a city in Southeast Australia.

Voas and colleagues (2002) evaluated a drink driving enforcement programme and media intervention, *Operation Safe Crossing*, conducted at the US/Mexican border (San Ysidro). The police conducted special patrols and sobriety checkpoints every 60 days. During the programme foot patrols monitoring the pedestrian crossing area were increased and the police enforced laws requiring that those aged 17 and younger attempting to cross the border be accompanied by an adult. The law enforcement programme was publicised through a media advocacy effort organised around the programme.

3.6.2 Quality assessment

Two studies were based on RCT designs. In the study by Burns and colleagues (1995) a subset of 10 police patrols, who met the trial criteria, were selected to participate in the study. Five patrols were randomly assigned to the intervention group and the remaining served as controls. Selected licensed premises² in the five intervention patrol areas were subject to supervision visits carried out by the local beat police. A total of 49 premises (or 64% of all licensed clubs and hotels in the five areas) were visited in the experimental patrols, with an average of about two visits per week to each premises. The design of the study included random allocation to the intervention group and included a control group for comparison. Overall the study was assessed as weak because bias was introduced as the outcome assessors were aware of the intervention status of the premises visited within the patrol areas and because the data collection methods were not shown to be valid and reliable. The length of follow-up was also particularly short at 2 months. The methodology used to examine the effects of the *Alcohol Linking Programme* (Wiggers et al., 2004) on

² Selection was guided by the Patrol Commander and based on prior experience with 'troublespots' in each of the patrols.

alcohol-related incidents was only reported on briefly, and overall because of the scant details reported the quality of the study was assessed to be weak.

Two studies were based on quasi-experimental designs (Voas et al., 2002; Warburton & Shepherd, 2006). The evaluation of the *TASC project* conducted by Warburton and Shepherd (2006) was based on a cohort analytic study design (Warburton & Shepherd, 2006), with assaults occurring in licensed premises being compared over three periods in the pre-intervention period, intervention period I and intervention period II. The evaluation methods of the study were not clearly reported and the study quality overall was assessed as weak. Evaluation of the effect of the *Operation Safe Crossing* programme on the number of traffic crashes in San Diego County (Voas et al., 2002) was based on an ITS design, which was judged to be good quality.

The remaining studies were based on UBA designs. Maguire and Nettleton (2003) examined trends in assaults and alcohol-related disorder in the year before and after the TASC project was launched. Few details were reported regarding the study methodology and although data were compared with trends elsewhere in South Wales, as the authors note, they were not able to make a direct comparison because of differences in data collection. In the study by McKnight and Streff (1994), pseudo-patron observations in the intervention community were compared with observations in a comparison community, but few details were reported about the comparability of the two groups, and overall the study methodology was assessed as weak. Felson and colleagues (1997) reported that more was known about the process outcomes of the *Geelong Accord* and consequently the impact of the programme was based on observations and crime data generalised to the local area. The study was therefore rated weak on the quality assessment tool.

3.6.3 Outcomes

Assaults

Burns and colleagues (1995) reported that in the intervention patrol areas the number of all offences and assaults increased significantly during the intervention phase, and decreased after intervention was withdrawn. In the control areas a reverse trend was reported on these measures. There was a non-significant decrease in the number of assault-related hospital admissions during the intervention phase in both the intervention and control patrol areas. The authors reported that the increase in incidents could be attributed to increased detection and recording by police in the experimental patrols during the intervention phase of the study, and that in support of this theory, hospital admissions for assault injuries decreased during the intervention phase of the study.

Maguire and Nettleton (2003) examined the effects of the *TASC project* in the first 12 months of its launch. During the first 12 months, based on all known incidents involving violence and disorder, there was a 49% increase in disorder while incidents involving violence fell by 4%. However, across other areas of South Wales during the same period,

incidents of violence against the person increased. The authors noted that there was a difference in trends between incidents occurring inside licensed premises and those occurring on the streets, with the number of incidents occurring on the streets rising more than those occurring inside premises. Violence and disorder were also largely concentrated on one particular street, which the authors reported had a high concentration of licensed premises. Targeted police intervention at particular 'hot spots' appeared to have a more sustained effect on violence and disorder than operations targeted at whole streets. For example, a police operation which targeted two clubs in the city resulted in reductions of 41% and 36 % of incidents in and around these clubs, respectively. In comparison, an operation which targeted two particular streets did not appear to have had an impact, with a sharp increase in the number of incidents six months after the operation. The study of the *TASC project* by Warburton & Shepherd (2006) was based on assault data collected in the ED, which was compared over three nine-month periods: pre-intervention (April to December 1999), intervention period I (April to December 2000) and intervention period II (April to December 2001). Analysis of all licensed premises and street assaults in the city centre showed an overall increase (24%) in the number of assault incidents during the pre-intervention and intervention period II. There was an overall 12% increase in the number of assaults occurring in licensed premises in the intervention area, however, relative to total capacity there was no overall change in the number of assaults/100 capacity in the intervention area. In the control area, the number of assaults in licensed premises decreased by 7% over the same period, and relative to total capacity there was a slight decrease in the number of assaults/100 capacity. Assaults in intervention area streets increased by 34% compared to an increase of 8% overall in control area streets. One city centre street accounted for between 18-30% of all street assaults over two consecutive 12 month periods; a disproportionate increase compared with other streets. Based on data from two high risk premises, which were subject to a targeted police operation and ED intervention, there was a 54% reduction in the number of assaults occurring in 'club 1'. At club 2 the number of assaults also decreased, but not significantly. In nine 'hotspot' venues, which were not targeted in the police operation, increases and decreases were observed in the number of assaults; ranging from a 69% decrease to a 73% increase. Expressing the change at 'club 1' relative to the nine control venues, indicated a significantly greater improvement in 'club 1' than in the other clubs combined (OR 0.60; 95% CI 0.37 to 0.97). Combining the two odds ratio estimates from interventions at clubs 1 and 2 gave a pooled odds ratio of 0.61 (95% CI 0.40 to 0.91). Warburton and Shepherd (2006) reported that this indicated that the targeted police operation and ED intervention was associated with a significantly greater reduction in the number of assaults compared with that achieved through the ongoing police intervention.

Following tailored feedback and covert auditing, Wiggers and colleagues (2004) reported that over the 3-month follow-up period there was a 15% ($p < 0.08$) greater reduction in

alcohol-related incidents associated with high-risk premises that received the feedback/audit approach compared to those that received normal policing.

Felson and colleagues (1997) reported that the serious assault rate for Greater Geelong decreased during the season the Accord was implemented, and continued to decline over the next few years. The authors presented a ratio of Greater Geelong's serious assault rate to the baseline rates drawn from the six other cities. Prior to the introduction of the *Geelong Accord* the ratio was 1.52, indicating that Greater Geelong's serious assault rate was 52% higher than the comparison rate. In subsequent years after the Accord was implemented, the ratio declined to 1.0, and in 1992-93, the Geelong assault rate was 63% lower than the comparison rate. Observations within the entertainment district were consistent with the declines in assaults, with police reporting that fewer problems occurred following introduction of the Accord.

Drink driving

Voas and colleagues (2002) examined the effects of *Operation Safe Crossing* on alcohol-related crashes in San Diego County. There was a 45.3% reduction in the number of 16-20 year old drivers who had been drinking and were involved in crashes. However, there were no significant effects associated with the programme in the 21-25 year old age group. McKnight and Streff (1994) observed a decrease in the percentage of drink driving arrestees who reported having consumed their last drink in a bar or restaurant following initiation of the enforcement effort, from 31.7% to 23.3% ($p < 0.01$). Changes on this outcome were not significant in other communities used to draw comparison.

Responsible alcohol service

McKnight and Streff (1994) reported that the percentage of observations by pseudo-patrons resulting in refusals of service increased from 17.5% prior to initiation of the enforcement effort to 54.3% after the first three months of enforcement. Over the next three months the percentage of observations decreased to 47.4%, and after one year to 41.0%. However, all three post-intervention refusal rates were significantly higher than the baseline rate ($p < 0.001$). The rates of refusal observed in the comparison county followed the same pattern as was observed in the intervention community, although refusal rates were consistently lower at each follow-up. The authors noted that the increase in service refusals within both the intervention and control communities was accompanied by a decline in 'partial intervention'. The authors report that the effects of enforcement proved unrelated to characteristics of the establishments or their clientele. Service refusals were not directly related to characteristics of establishments, although the incidence of service refusals was greatest when the volume of business fell in the moderate range.

Other (e.g. costs)

Levy and Miller (1995) undertook a cost-benefit analysis of the programme evaluated by McKnight and Streff (1994). To estimate the social benefits of the programme, Levy and Miller translated the decline in drink driving incidents coming from bars and restaurants into

the expected social savings from reducing alcohol-related crashes. The authors reported that the benefits ranged from \$10.1 million to \$2.3 million. Total intervention costs included those associated with enforcement of laws prohibiting the service of alcohol to intoxicated patrons, which were additional police and supervisory staff, publicity and training. The total programme costs were estimated at \$51,400 (in 1990 dollars). The authors reported that the benefits greatly exceeded the costs of the programme, but no clear cost-benefit ratio was derived.

3.7 Interventions aimed at reducing underage access to alcohol

3.7.1 Overview of evidence identified

Seven studies evaluated interventions aimed at reducing alcohol service to underage patrons. Two studies assessed the effectiveness of age verification devices in reducing the sale of alcohol to underage customers (Bierness et al., 2001; Krevor et al., 2003) and five studies examined enforcement activities designed to reduce underage alcohol sales from on- and off-licensed premises (Wagenaar et al., 2005; Willner et al., 2000; Huckle et al., 2005; Lewis et al., 1996; Chandler, 2002). Five studies were conducted in the USA, one in the UK and one in New Zealand.

Two studies assessed the effectiveness of age verification devices. Krevor and colleagues (2003) assessed the impact of an electronic age verification (EAV) device in reducing the underage sale of alcohol and increasing the accuracy of age verification in retail outlets. Bierness and colleagues (2001) examined the effectiveness of smart card technology (a magnetic strip on driving licences and a card reader system), combined with a youth underage drinking awareness programme, on age verification checks and alcohol-related crashes over a 24 month period in three communities.

Five studies examined enforcement activities. Wagenaar and colleagues (2005) assessed the effect of server management training (ARM Express) and police enforcement of age verification checks in reducing underage alcohol sales. Willner and colleagues (2000) evaluated a police intervention, which consisted of a warning letter from the area police commander to all licensed premises within the intervention area, the contents of which were reiterated in personal visits or through telephone calls. The effects of the intervention were examined through unobtrusive test purchase attempts. Huckle and colleagues (2005) examined the Auckland Regional Community Action Project, which included monitoring alcohol sales made without age identification from off-licenses, and using this data for media advocacy and direct contact with alcohol retailers, in addition to working with key enforcement staff to encourage increased monitoring and enforcement of minimum purchase age legislation for off-licenses. Lewis and colleagues (1996) evaluated the effects of a community-based substance abuse coalition. The programme focused on the enforcement of underage sales based on purchase attempts and citation. In addition, a press conference was held to alert store clerks and citizens to the surveillance activities. Chandler (2002) assessed the effect of an undercover compliance check strategy.

3.7.2 Quality assessment

The study by Wagenaar and colleagues (2005) was based on an ITS design, and also included a nested cohort design. Alcohol establishments in 20 cities were split into 10 cohorts that consisted of a random subsample of all on- and off-licensed premises. Random samples of establishments were visited every two weeks over 4.5 years. Overall the internal validity of the study was assessed to be strong. Evaluation of three programmes was based on a CAS design (Bierness et al., 2001; Willner et al., 2000; Chandler, 2002). Bierness and colleagues (2001) examined the impact of smart card technology. The evaluation design involved a comparison among three communities; one community received both the smart card and awareness programme (primary), one community received the awareness programme only (secondary), and one community received neither intervention (control). The quality of the study was assessed as weak, mainly because few details of the study methodology were reported. Following the baseline phase of data collection in the study by Willner and colleagues (2000), police in the one of the two test purchase sites introduced the intervention to reduce underage alcohol sales and the other area served as a no-intervention control site. Participants (i.e. the servers) were covertly observed and the choice of which premises to visit was made semi-randomly, based on location, ease of access and parking. Follow-up data were collected 1-2 months from when the intervention took place. Overall, the quality of the study methodology was assessed as weak. Although a moderately strong design was used bias was introduced as it was unclear whether the authors had appropriately controlled for confounding, outcome assessment was not blind to the intervention status of the participants and data collection methods were not reported as valid and/or reliable. Chandler (2002) examined the effects of an undercover compliance check strategy. The intervention group included 500 outlets that had received a pretest compliance check and the control group consisted of 100 new outlets that were not included in the pretest. The quality of the study was judged as weak overall as the author did not report a method for accounting for confounding and data collection methods were not reported as valid or reliable.

The study by Krevor and colleagues (2003) was based on a before and after design. The study did not include a control group for comparison and was scored poorly on the quality assessment tool. Two other studies were based on UBA designs (Lewis et al., 1996; Huckle et al., 2005). The evaluation of *Project Freedom* was based on visits to 100 stores in the community by adolescents (aged 14-20 years) who attempted to purchase cigarettes or alcohol (Lewis et al., 1996). Visits were made before the intervention and one month later, after intervention. Few details were reported regarding the methods of the study and it was assessed as weak. Evaluation of the *Auckland Regional Community Action Project* was based on purchase surveys conducted before and after the intervention was implemented, although the time to follow-up was not clearly reported (Huckle et al., 2005). A random sample of approximately 250 of the total population of outlets holding off-licences to sell

alcohol were selected to participate in the purchase surveys. No comparison group was included and overall the quality of the study was assessed to be weak.

3.7.3 Outcomes

Underage sales

Krevor and colleagues (2003) compared age verification behaviour among retailers in intervention and control sites across two US states. Comparing baseline and post intervention inspection data, results showed that treatment group stores and comparison stores did not differ significantly in age verification behaviour for alcohol sales at either baseline or 6 month follow-up. Overall, stores with EAV devices did not display significant increases in the rate of age verification compared to comparison stores and at 6 month follow up treatment stores did not significantly increase their age verification rates over baseline. Bierness and colleagues (2001) found that the rate of age identification (ID) checking actually decreased within the three communities following the introduction of smart card technology and a youth awareness programme. Young people were able to purchase alcohol without being asked for ID on 48% of all attempts compared to 16% at baseline. This was found to be significantly higher than during the pre-test compliance checks ($p < 0.01$). There was no difference in the rate of ID checking among the three communities ($p > 0.05$).

Wagenaar and colleagues (2005) measured the effects of the *Complying with the Minimum Drinking Age* (CMDA) programme on propensity to sell alcohol to young buyers using purchase attempts by youth under the age of 21 in off and on premises. Results showed that after controlling for confounding factors there was a 17% decrease in an off-premise outlet's likelihood of selling alcohol to youth immediately following a law enforcement check, which reduced to an 11% decrease at 2 weeks following an enforcement check and to a 3% decrease at 2 months. Analyses indicated that enforcement effects eventually reduced to zero, with no remaining long-term permanent effect. An increase in the number of TV broadcasts regarding enforcement checks initially decreased the likelihood of underage sales approximately 5%, with this effect decreasing to zero within two weeks after a broadcast. For on-premises there was a 17% decrease in the likelihood of selling immediately following an enforcement check, which once again reduced over time to a 14% decrease at 2 weeks and 10% decrease at 2 months. The long term likelihood of a decrease in selling was 8.2%. Participating in training was associated with an initial, non-significant long-term increase in sales of approximately 7% and there was a 0.4% decrease in sales following a TV broadcast.

Willner and colleagues (2000) reported that overall, the enforcement intervention did not decrease underage sales, and that sales to 16 year old boys and 13 year old girls both increased (both $p < 0.001$). Follow-up data were collected in two sampling periods, separated by 3 weeks. In the early period ($n = 20$ purchase attempts) there were indications that sales had fallen relative to baseline (25% vs. 44%; non-significant). However in the later sampling

period, there was an increase in sales relative to baseline (96% vs. 44%; $p < 0.001$). Based on the results of purchase surveys, Huckle et al and colleagues (2005) reported that the proportion of sales made without age identification in the region had significantly decreased following the community action project, from 60% to 46% between the pre- and post-intervention phases of the study. In addition, the proportion of age identification signage that was present and visible significantly increased from 53% to 64%. Following implementation of *Project Freedom*, Lewis and colleagues (1996) found that the overall percentage of store clerks willing to sell alcohol products to minors decreased between pre- and post-test (from 55% to 41%), but the difference was not statistically significant. The percentage of sales to minors decreased in liquor stores that had received a citation or commendation, from 83% to 33%; but again this difference was not statistically significant. In stores that did not receive a citation or commendation sales to minors decreased from 45% to 33%. Chandler (2002) reported that at post-test 469 outlets were subject to the intervention and that the total underage sales rate was 25.6%. The control group sales rate was 23.6%. The analysis of pre-test sale or no-sale versus post-test sale or no-sale ($n=257$) showed that the association was not statistically significant ($p = 0.084$).

Alcohol-related criminal and traffic offences

Comparing alcohol-related criminal³ and traffic offences among 15-20 year olds in three communities, Bierness and colleagues (2001) reported a dramatic increase in the number and rate of charges in the primary, and smaller increases within the secondary intervention site and control community. In terms of drink driving offences, numbers and rates were comparable among all three communities at baseline. At follow up, the number and rate of drink driving offences increased dramatically in both the control site (pre-test $n=18$ vs. post-test $n=46$) and the primary intervention community (pre-test $n=25$ vs. post-test $n=68$). Smaller increases were reported in the secondary intervention community receiving the youth awareness campaign only (pre-test $n=12$ vs. post-test $n=23$).

Traffic crashes

Comparing SVN crash rates among the 16-20 year old age group, Bierness and colleagues (2001) found that SVN crashes decreased by 13.1% (OR 0.84; 95% CI 0.55, 1.27) in the primary intervention site, by 30% (OR 0.66; 95% CI 0.38, 1.13) in the secondary intervention site and increased by 4.6% (OR 1.05; 95% CI 0.76, 1.47) in the control site. SVN crash rates among those aged 21-30 years were used as a comparison. Rates of SVN crashes among those aged 21-30 decreased by 4% in the primary intervention community, by 13.3% in secondary intervention site and by 20.3% in the control community.

³ Underage purchase, consumption or possession of alcohol

3.8 Community-based multi-component programmes

3.8.1 Overview of evidence identified

A total of seven community-based multi-component programmes were identified for inclusion, details of which were published across 20 publications. Four programmes were conducted in the USA, two in Australia and one in Sweden.

All seven programmes evaluated community-based environmental interventions designed to reduce alcohol-related incidents. The *Community Trials* project was developed by Holder and colleagues to address alcohol-involved accidental injury and death (Holder et al., 1997a; 1997b; Holder & Reynolds 1997; Grube 1997; Saltz & Stanghetta 1997; Treno & Holder 1997; Holder et al., 2000; Roeper et al., 2000; Moore & Holder 2003). The programme was conducted over five years and had five key intervention components: (1) a community mobilising component to develop community organisation and support; (2) a responsible beverage service (RBS) component to establish standards for servers and owners/managers of on-sales alcohol outlets; (3) a drinking and driving component; (4) an underage drinking component to reduce retail availability to young people; and (5) an alcohol access component designed to control outlet density and reduce the availability of alcohol. Interventions were implemented in six successive stages between 1992 and 1996 across three intervention sites in California and South Carolina, USA. The *Stockholm Prevents Alcohol and Drug Problems (STAD) project* (Wallin et al., 2002; 2003; 2005; Månsdotter et al., 2007) was based on a multicomponent programme combining community mobilisation, RBS training of servers and stricter enforcement of existing alcohol laws delivered in central Stockholm, Sweden. The *Sacramento Neighbourhood Alcohol Prevention Project (SNAPP)* was implemented in two low-income, ethnic minority neighbourhoods in North and South Sacramento, USA (Treno et al., 2007). The one-year project had four main components focused on community mobilisation, community awareness, RBS and law enforcement in relation to underage access to alcohol and intoxicated patrons. Two Australian programmes, the *Surfers Paradise Safety Action Project* (Homel et al., 1997) and the *Local Government Safety Action Projects* (Hauritz et al., 1998), specifically focused on improving the safety of licensed environments. Key features of the safety action projects included creating a community steering committee and community forum, formation of task groups to address the safety of public spaces, venue management and, security and policing. Nightclub managers were encouraged to introduce a Code of Practice and were regulated through informal community processes and formal enforcement. Two American programmes, the *Communities Mobilising for Change on Alcohol (CMCA) community trial* (Wagenaar et al., 1999; 2000a; 2000b) and the *A Matter of a Degree (AMOD) programme* (Weitzman et al., 2004; Nelson et al., 2005) specifically targeted alcohol use among young people. In the *CMCA* community trial, organisers worked with local public health officials, enforcement agencies, alcohol merchants and merchant associations, the media, schools and other community institutions to change alcohol policies to reduce youth access to alcohol. The

AMOD programme (Weitzman et al., 2004; Nelson et al., 2005), was a campus community coalition initiative to reduce college binge drinking.

3.8.2 Quality assessment

The evaluation of the *CMCA* community trial was based on an RCT design (Wagenaar et al., 1999; 2000a; 2000b). Fifteen communities participated in the trial, seven communities were randomised to receive the programme and the remaining eight communities served as controls. The 15 communities had an average population of 20,836 and were matched on state, presence of a residential college or university, population size, and on the results of a baseline alcohol purchase attempt survey. Overall the quality of the study design was rated as moderate. Follow-up data were collected after 2.5 years of intervention.

The evaluation of four programmes was based on quasi-experimental designs (*AMOD*, *SNAPP*, the *Community Trials project* and the *STAD project*). The evaluation of *SNAPP* was based on a 'phased' approach to intervention implementation (Treno et al., 1997). Baseline data were collected in the two intervention sites and the wider Sacramento community. The programme was implemented in the South neighbourhood during the first programme wave (the North neighbourhood served as a no-treatment comparison site) and in the North neighbourhood during the second programme wave. Data collected from the wider Sacramento community served to control for historical conditions. Overall, although the evaluation was based on a strong design, the quality of the study was assessed as weak. In the *AMOD programme*, 10 sites implemented the intervention programme and 32 sites that did not participate served as controls (Weitzman et al., 2004; Nelson et al., 2005). Programme sites were divided into two groups based on whether their level of programme implementation was high or low. Sites in the high implementation group had substantially more interventions focusing on the alcohol environment. The quality of the study was rated as weak because details regarding confounding were not adequately reported and the data collection methods were not reported as valid or reliable. Evaluation of the *Community Trials project* and the *STAD project* were based on an ITS design. The *Community Trials project* was based on a multiple time series design (Holder et al., 2000) and a CCT (Holder et al., 1997a; 1997b; Holder & Reynolds 1997; Grube 1997; Saltz & Stanghetta 1997; Treno & Holder 1997). Both analyses were based on three intervention communities, which had existing coalitions and populations of approximately 100,000, and were purposively chosen to participate in the project. Comparison sites were matched to the intervention sites on the basis of similar local characteristics (e.g. they were within the same state or region), industrial/agricultural bases and size of minority populations. Overall the quality of the time series design was assessed as moderate and the quality of the CCT was assessed as weak. The evaluation of the effects of the *STAD project* on violence was based on a well-designed time series which included 33 months of follow-up (Wallin et al., 2003a), and a CCT examined the effects of the programme on alcohol service to intoxicated patrons (Wallin et al., 2002; 2005).

Evaluations of the *Surfers Paradise* and *Local Government Safety Action Projects* were based on UBA studies (Homel et al., 1997; Haritz et al., 1998). Baseline measures of violence and other problems were compared with the same measures taken after the project had been implemented. A structured, systematic observation technique was employed for venue observations. The design did not include a control group for comparison and overall study quality was assessed as weak for both studies.

3.8.3 Outcomes

Alcohol consumption

Holder and colleagues (2000) found that relative to three comparison communities, in communities that participated in the *Community Trials project* there was a reduction in self-reported quantities of alcohol consumed per occasion⁴, from 1.37 to 1.29 drinks per occasion (difference = 6%; 95% CI -12% to -1%).

The primary outcome of interest in the *CMCA* community trial was the effect of the intervention on drinking behaviour among young people (Wagenaar et al., 2000a), and although the finding was not significant, the proportion of 18-20 year olds who drank alcohol in the past 30 days decreased by 7% in the intervention compared to the control communities ($p=0.07$). The number of drinking occasions in the past month and the number of drinks on the last drinking occasion also decreased relative to the control communities (again not significantly); by 4% ($p=0.19$) and 2% ($p=0.16$), respectively. There was no difference in the prevalence of heavy episodic drinking between the intervention and control communities. Among high school students (17-18 year olds), all four drinking measures showed non-significant decreases following intervention, with the largest estimated decrease in the number of drinking occasions in the past month (7%, $p=0.14$).

The main outcome measures of interest in the evaluation of the *AMOD* programme were alcohol consumption, alcohol-related harms, and alcohol-related second-hand effects (Weitzman et al., 2004). Overall there were no statistically significant changes between baseline and follow-up of the measures of alcohol consumption and alcohol-related second-hand effects when all ten *AMOD* programme sites were compared to the 32 control sites. However, when five sites with the highest implementation of environmental programming were examined, significant declines were observed over follow-up on all of the alcohol consumption measures, except any alcohol use. In addition, a significant decline was observed on nine of 11 alcohol-related harm outcomes; significantly fewer students reported that had a hangover, missed a class, fell behind in their school work, forgot where they were or what they did, got into an argument, vandalised someone else's property, or were hurt or injured because of their drinking. Among students at the five high intervention sites, significant declines were observed in five out of nine alcohol-related second-hand effects (assault, baby-sitting a drunken student, finding vomit, study or sleep interrupted,

⁴ per drinking day

and experiencing an unwanted sexual advance). No significant decrease was observed in the five low environment intervention sites for any alcohol consumption measure or alcohol-related second-hand effects compared with the control sites. However, alcohol-related harms declined significantly on the following measures: had a hangover, missed a class, and fell behind on schoolwork.

Traffic crashes

Holder and colleagues (2000) reported that monthly rates of night time motor vehicle crashes and alcohol-related crashes decreased significantly in the intervention communities that received the *Community Trials* intervention programme compared to the comparison communities. The authors reported a 10% reduction in the monthly rates of night time motor vehicle crashes (95% CI -14% to -4%) and a 6% reduction in the monthly rates of alcohol-related crashes (95% CI -8% to -3%), respectively.

The effects of the *CMCA* community trial on arrests and traffic crashes for two target age groups (15-17 and 18-20) revealed reductions in traffic crash indicators (Wagenaar et al., 2000b). Among 18-20 year olds, baseline rates of arrests for drink-driving declined in both the treatment and control communities, but the net reduction (-30.296 arrests/100,000 population per year; $p=0.05$) was significantly in favour of the intervention. In addition, the net difference in drink-driving arrests among 15-17 year olds in the intervention and control communities (-7.051 arrests/100,000 population per year; $p=0.08$) approached significance. The authors noted that there was a general decline over the period of analysis in SVN injury-producing traffic crashes, but that there were no significant differences between the intervention and control communities in either age group.

Nelson and colleagues (2005) examined the effect of the *AMOD* programme on driving after drinking. Across all 10 intervention sites the results revealed a decline over time relative to the change in the comparison sites. In a model analysing change from baseline to follow-up only, the authors found a significant change for the overall programme relative to no change in the comparison sites. Programme participants from interventions sites that had a greater number of environmental interventions showed significant changes over time relative to the comparison colleges, but not relative to the comparison sites in the low intervention programme sites.

Violence and aggression

Holder and colleagues (2000) found that the *Community Trials* programme reduced the number of assault injuries. Relative to the comparison communities, in the intervention communities assault injuries observed in the emergency department declined by 43% (95% CI -71% to 11%) and all hospitalised assault injuries declined by 2% (95% CI -3% to -1%). Wallin and colleagues (2003a) examined the effects of the *STAD project* on violent crimes. Assaults, illegal threats and harassment, violence and threats targeted at officials (including the police and door staff) were included in the violence indicator. The authors reported that during the intervention period there was a significant reduction in crimes in the intervention

area when controlling for the development in the control area; this change was estimated at -29%. Wagenaar and colleagues (2000b) examined the effects of the *CMCA* community trial on arrests for two target age groups (15-17 and 18-20). The net difference between intervention and control communities in arrests for disorderly conduct was not significant in the 18-20 year old group (-16.122 arrests/100,000 population per year; $p=0.14$), but approached significance in the 15-17 year old group (-82.268 arrests/100,000 population per year; $p=0.06$). Treno and colleagues (2007) reported that *SNAPP* resulted in significant reductions in assaults based on police reports, aggregate emergency medical service (EMS) outcomes, EMS assaults and EMS motor vehicle accidents ($p<0.05$). The authors found an estimated reduction of 3.9% in police calls involving assaults and reductions of 33.4% in EMS calls involving motor vehicle accidents in the South intervention site.

Evaluation of the *Surfers Paradise Safety Action Project* was based on observations in 18 nightclubs in the central area of Surfers Paradise, Australia (Homel et al., 1997). Levels of observed aggression and violence were reported to have declined following the project, but aggressive and violent incidents were found to have occurred disproportionately in a small number of venues. The total number of incidents (physical and non-physical) fell from a mean of 0.63 per visit in 1993 to 0.16 per visit in 1994; non-physical incidents fell from 0.43 to 0.09 per visit, and physical incidents fell from 0.20 to 0.09 per visit (not significant). Expressed as a rate per 100 hours of observation, physical assaults declined by 52%, from 9.8 to 4.7 assaults per 100 hours of observation. Verbal abuse declined by 81.6%, from 12.5 to 2.3 per 100 hours, and arguments 67.6%, from 7.1 to 2.3 per 100 hours. There was a decline in the number of recorded incidents by security personnel in each of the time periods between 1992 and 1993. The data suggest that the project may have influenced street incidents. Data from police recorded incidents indicated that in relation to assaults, in the pre-intervention phase there was a significant increase in incidents, and no significant difference across the two post-intervention phases. However, the authors noted that the actual decline for the second post-intervention phase was 34%, and that the decline in serious assaults over this period was significant. In addition, there was an overall drop in incidents, including stealing, indecent acts and, drunk and disorderly behaviour. There was also a decline in all forms of aggression and violence following the implementation of the *Local Government Safety Action Projects* (Hauritz et al., 1998), with physical violence recording the greatest reduction, regardless of whether all incidents are included (75.1%; $p=0.018$) or only those for which full details could be recorded (81.2%; $p=0.000$). Of the non-physical indicators, verbal abuse showed the greatest decline (60.4%; $p=0.034$). Although there were reductions in the number of arguments (28.2%; $p=0.440$), challenges/threats (40.5%; $p=0.520$), and total verbal aggression (48.8%; $p=0.069$), the reductions did not reach significance. There were declines in each city on overall physical and non-physical aggression (with the exception of verbal aggression in Cairns), and on all observed incidents of aggression and violence. However, the only change that was statistically significant was the reduction in physical violence in Cairns (88.3%; $p=0.017$), despite consistent declines on

all indicators in all cities. The authors note that the p-values reflect small sample sizes in each city, as well as the fact that aggressive incidents were relatively rare events. Declines in male and female drinking rates were not observed over the course of the project. Female drunkenness was observed to decline, but this finding was not significant ($p=0.13$). However, overall male drunkenness decreased significantly ($p=0.0004$). The authors report that there was a trend away from drinking full strength beer to low alcohol beer, soft drinks and water (and also wine for women), but that normal beer and mixed spirits remained by far the preferred drinks for both sexes.

Drink driving

Holder and colleagues (2000) reported that the *Community Trials* projects resulted in a reduction in self-reported frequencies of driving when having had too much to drink, and driving when over the legal limit, in the intervention communities relative to the comparison communities.

Responsible alcohol service

Wallin and colleagues (2005) examined the effects of the *STAD project* on alcohol service to intoxicated patrons at licensed premises. A total of 100 licensed premises were visited, 56 in the intervention area and 44 in the control area. Of the 100 premises visited, 45 had servers that had been trained in RBS. Follow-up was conducted 3 and 5 years from baseline. The total rate of refusal for alcohol service for all licensed premises increased significantly between the 3- and 5-year follow-up; from 47% to 70%, respectively. Across intervention and control areas, the refusal rate was higher in premises that had undertaken RBS training compared with licensed premises with no training (76% vs. 65%), although this finding was not significant. The refusal rate was statistically significantly higher for RBS-trained licensed premises in the intervention area compared with licensed premises in the intervention area with no RBS-training (72% vs. 40%; net difference = 26%; 95% CI 6% to 58%). Logistic regression analyses revealed that at the 5-year follow-up, day of the week, estimated age of guests, hygiene at the restrooms and the overall order had a significant impact on the probability of being refused service. The probability of being served was lower during weekends, when the majority of the patrons had an estimated average age <30 years, when there was average hygiene in the restrooms and when the overall order was under control at the premises.

Sales to underage drinkers

Treno and colleagues (2007) reported a reduction in sales to apparent minors in the South *SNAPP* site relative to baseline (from 49% to 32%) compared with the North *SNAPP* site (from 20% to 61%) and in the wider community (from 38% to 47%). There were increases in service to pseudo-intoxicated patrons in the South, North, and wider community of 26.5%, 8.8%, and 46.0%, respectively, between Waves 1 and 2. Between Waves 2 and 3 the authors found decreases of 28.1%, 59.0%, and 76.6%, respectively for sales to apparent minors and of 3.5%, 5.7% and 17.4% for sales to pseudo-intoxicated patrons.

The results of the evaluation of the *CMCA* programme indicated that the intervention had significantly affected access to alcohol via on- and off-sale alcohol outlets (Wagenaar et al., 2000). In the intervention communities there was a 17% increase in the proportion of servers who reported checking age identification among on-sale alcohol outlets ($p=0.06$) and a 15% increase among off-sale outlets ($p=0.17$). These effects were seen uniformly across all 15 intervention sites. There was a decrease of 24% ($p=0.06$) in the proportion of outlets selling to buyers who appeared underage among on-sale outlets and an 8% decrease ($p=0.29$) among off-sale outlets. Based on merchant self-reported behaviours there was no evidence of an intervention effect on whether merchants checked ID for all customers who appeared under age 30 in either on-sale or off-sale outlets. There was an increase in the perceived likelihood being cited among managers of on-sale and off-sale outlets in the intervention communities, with outlets showing a 5% ($p=0.28$) and a 12% ($p=0.13$) increase, respectively. The proportion of outlets reporting that they would refuse sales to a 21-year-old accompanied by an underage person also increased, by 17% ($p=0.25$) in on-sale outlets and by 25% ($p=0.20$) in off-sale outlets. Surveys of 18- to 20-year-olds revealed a decrease of 25% ($p=0.06$) in the proportion of older teenagers who tried to buy alcoholic beverages. This age group also reported increased difficulty in getting alcohol from outlets ($p=0.07$).

Other (e.g. costs)

Based on a cost-effectiveness analysis (Månsdotter et al., 2007), net savings of the *STAD project* (discounted estimates; 3%), were estimated at €30.518 million in the base case scenario⁵ and at €13.641 million based on the assumption that the only violence-related consequence among non-respondents was the cost of police handling. When the responses from a survey of the victims of violence were ignored, the cost-savings decreased to €4.554 million. Corresponding health gains were 236, 83 and zero quality adjusted life years (QALYs), respectively.

⁵ Calculations of savings were based on a survey of victim of violence; the average cost of an assault was estimated to be €9,935.

4 Discussion

4.1 Summary of findings

Forty-seven studies were identified which examined interventions designed to reduce harm in drinking environments. Seven studies examined the effectiveness of training programmes for servers, managers and other staff, five examined specific interventions delivered in pubs and bars, seven examined interventions aimed at reducing underage sales, eight examined the policing and enforcement of laws related to alcohol consumption and 20 examined multi-component community-based programmes. Nine of the included studies were conducted in European countries including five in Sweden and four in the UK. Twenty-eight studies were conducted in North America including 26 conducted in the USA and two in Canada, and 10 studies were conducted in Australia and New Zealand.

4.1.1 Responsible server/staff training programmes

There was no clear evidence to suggest that server training on its own had an impact on responsible serving practices. Two of the three studies that examined this outcome found some increases in server intervention, but highlighted that overall there was a low frequency of intervention (McKnight et al., 1991; Gliksman et al., 1993). The effects of server training programmes on patrons' alcohol consumption were also unclear; one study (Lang et al., 1998) found a reduction in the number of patrons with high blood alcohol levels and another study (Johnsson & Bergland, 2003), conducted in student pubs, found no change. However, a study of a state-wide mandated server training programme indicated that the programme was effective in reducing traffic crashes (Holder & Wagenaar, 1994). One study that examined an intervention to reduce aggression in bars through training and risk management (the *Safer Bars programme*) was effective in reducing severe and moderate aggression (Graham et al., 2004). The authors noted that the overall reduction in aggression was modest and that high staff turnover may have reduced the impact of the intervention.

4.1.2 Specific interventions delivered in drinking environments

One study (Van Beurden et al., 2000) that examined a brief intervention utilising personalised risk assessment for patrons suggested that the intervention was of most benefit to heavy drinkers. Three programmes, two of which targeted drink driving through a designated driver and a ride programme respectively, and a third which promoted responsible drinking, had limited impact on patron behaviours (Boots & Midford, 1999; Rothschild et al., 2006; McLean et al., 1994). A study that examined the replacement of pint glasses with toughened glassware found that the glassware had lower impact resistance and resulted in more injuries to bar staff (Warburton and Shepherd, 2000).

4.1.3 Policing and enforcement approaches

The effectiveness of police intervention or increased enforcement of licensing laws in reducing alcohol-related incidents was not clear. Two studies (Burns et al., 1995; Warburton & Shepherd, 2006) reported that following police intervention there was an increase in assaults. However, this may have been due to better detection and recording of incidents by police during the intervention phase of these studies or the data source analysed. For example, a study of the *TASC project* based on ED admissions alone indicated a sizeable increase in alcohol-related violence compared to a small decrease when all known assault incidents were examined (Maguire and Nettleton, 2003). Targeted police intervention in high-risk premises appeared to be a more effective strategy than 'low level' policing, with a reduction in alcohol-related incidents reported for high-risk premises targeted as part of the *Alcohol Linking Programme* (Wiggers et al., 2004) and the *TASC project* (Maguire & Nettleton, 2003; Warburton & Shepherd, 2006).

4.2 Interventions aimed at reducing underage access to alcohol

There was no evidence that programmes specifically targeting underage sales of alcohol through the placement of age identification devices were effective (Krevor et al., 2003; Bierness et al., 2001), and the effects of police campaigns and other approaches to the enforcement of underage sale laws appeared to be short lived. Four studies that examined enforcement activities designed to reduce underage alcohol sales from off-licences, found that sales either increased following intervention (Willner et al., 2000) or the intervention had little impact (Huckle et al., 2005; Lewis et al., 1996; Chandler, 2002). However, a study (Wagenaar et al., 2005) that examined a programme of combined training and police enforcement checks found that the intervention had a short term impact on underage sales. The authors reported that this suggested the need to sustain the effects of enforcement through more frequent checks.

4.2.1 Multi-component community-based programmes

Overall, the clearest indication of effectiveness resulted from multi-component programmes combining community mobilisation, RBS training, house policies and stricter enforcement of licensing laws. In particular, across three well-designed and implemented programmes (*Communities Mobilising for Change on Alcohol*, the *Community Trials project* and the *STAD project*) there was evidence that these types of programmes were effective in reducing assaults, traffic crashes, and underage sales. All three programmes were based on a strategic, planned approach to reducing alcohol-related harm in communities.

The *Community Trials project* (Holder et al., 1997a; 1997b; Holder & Reynolds 1997; Grube 1997; Saltz & Stanghetta 1997; Treno & Holder 1997; Holder 2000; Holder et al., 2000; Roeper et al., 2000; Moore & Holder 2003) was conducted over five years and intervention components included community mobilisation, RBS training, controls on outlet density and components designed to address drinking and driving, and underage drinking. In communities that received the intervention programme there were reductions in the

quantities of alcohol consumed, alcohol-related traffic crashes and assault injuries. The *STAD project* was a 10 year community action project conducted in Stockholm, Sweden, in which the authorities and hospitality industry worked together to reduce problems related to alcohol in drinking environments (Wallin et al., 2002; 2003a; 2005). The programme combined community mobilisation, RBS training and stricter enforcement of existing alcohol laws. During the period of intervention there were significant reductions in violent crimes (assaults, illegal threats and harassment, violence and threats targeted at door staff/police) in the intervention area, and within premises that had RBS training there was a higher rate of service refusal to pseudo-intoxicated customers. A cost-effectiveness analysis of the programme estimated a cost-saving ratio of 1:39, indicating that the savings accrued were 39 times higher than the costs of implementation (Månsdotter et al., 2007). The *CMCA programme* was a community organising intervention designed to reduce youth access to alcohol (Wagenaar et al., 1999; 2000a; 2000b). The intervention significantly affected underage access to alcohol, with a reduction in sales from on- and off-license premises and an increase in age identification checking. There were also reductions in arrests and traffic crashes and non-significant decreases in alcohol consumption among 18-20 year olds.

4.3 Methodological quality

Inclusion in the review was not limited according to study design and overall the quality of the included studies was variable according to the study design used. Of the programmes/interventions that were based on RCT designs just over half were rated as moderate quality (Burns et al., 1995; Johnsson & Berglund, 2003; Graham et al., 2004; Wagenaar et al., 2000) and the quality of the remaining studies was rated as weak (Warburton & Shepherd 2008; McClean et al., 1994; Wiggers et al., 2004). The studies that were rated as weak failed to adequately account for confounding, did not describe tools for outcome assessment in a valid and reliable manner, and poorly reported withdrawals and dropouts. The studies rated moderate were generally well reported but selection bias was not fully accounted for and details regarding blinding were lacking. The quality of studies based on CCT designs was also variable. Of the studies rated moderate, selection bias and withdrawals and dropouts were inadequately addressed in one study (Lang et al., 1998), and data collection methods were not described as valid or reliable in another two (Gliksman et al., 1993; McKnight et al., 1991). Of the studies rated weak, confounders and selection bias were generally poorly or not addressed (Treno et al., 2007; Weitzman et al., 2004; Toomey et al., 2001; Wallin et al., 2002, 2005; Holder et al., 1997a) and only one study reported that data collection methods were valid and reliable (Wallin et al., 2002, 2005). Withdrawals and dropouts were poorly reported on or not addressed in three studies (Treno et al., 2007; Weitzman et al., 2004; Holder et al., 1997a).

The effects of five programmes/interventions were analysed using an ITS design. A different scale was used to rate these designs and all five ITS studies were well reported with two studies, which met all of the criteria, rated strong for quality (Holder & Wagenaar, 1994; Wallin et al., 2003a). The remaining ITS studies were rated moderate (Voas et al., 2002;

Holder et al., 2000; Wagenaar et al., 2005). All 13 studies that were based on CAS or UBA designs were rated weak for quality. Studies based on a cohort analytic design (Bierness et al., 2001; Chandler, 2002; McKnight & Streff, 1994; Rothschild et al., 2006; Warburton & Shepherd, 2006; Willner et al., 2000) failed to adequately address confounding and did not describe outcome measures as valid or reliable. Selection bias and blinding were also poorly addressed in some studies (McKnight & Streff, 1994; Rothschild et al., 2006; Warburton & Shepherd, 2006). The inherent weakness of uncontrolled study designs, and the limitations of attributing intervention effects in the absence of a control group, meant that the eight studies (Boots & Midford, 1999; Lewis et al., 1996; Van Beurden et al., 2000; Krevor et al., 2003; Huckle et al., 2005; Homel et al., 1997; Hauritz et al., 1998; Maguire & Nettleton, 2003) based on UBA designs met few of the criteria on the quality assessment tool.

4.4 Other approaches to reducing harm in drinking environments

Although a large volume of literature was examined for inclusion in the review we have focused on those interventions that are intended to minimise the harm from alcohol in drinking environments. However, other intervention strategies may also have an impact on alcohol-related disorder and crime, such as environmental interventions designed to impact on crime and violence in public spaces (for example, improvements in street lighting and installation of closed circuit television) and regulatory measures that aim to manage where, when and how alcohol can be sold. Although no direct studies of the effectiveness of improved street lighting or installation of CCTV on alcohol-related crime are known to the authors, improved street lighting has been shown to effectively prevent crime in public spaces (Welsh & Farrington, 2008a). The effects of CCTV, however, have been found to be modest (Welsh & Farrington, 2008b) and a study that examined the effects of CCTV on assault injury and violence detection (Sivarajasingam et al., 2003) found no evidence that it had a deterrent effect. Regulatory approaches that restrict access to alcohol, including through reduced hours and days of sale, have been used successfully to reduce the availability of alcohol and its associated harms (Babor et al., 2003). However in recent years, several countries have extended alcohol service times, often in attempts to stagger the departure of drinkers from areas with high densities of pubs, bars and nightclubs. In Australia, extended alcohol service times have been linked to increased violence in venues staying open later (Chikritzhs & Stockwell, 2002). In England and Wales, extended alcohol sales times have not been linked to increased violence, but rather to a shift in the timing of violence to later in the night (Department for Culture, Media & Sport, 2008; Hough et al., 2008).

4.5 Implications

This review identified that a range of intervention approaches have been utilised in an attempt to reduce harm in drinking environments. However, there is a great deal of variability in the study designs used to evaluate these interventions and also in the outcomes measured, which makes it challenging to develop a strong evidence base to make recommendations about what works in preventing harm in drinking environments in

Europe. Other challenges relate to gaps in knowledge and understanding of drinking behaviours and related harms in young Europeans in pubs, bars and nightclubs.

4.5.1 Implications for policy and practice

The findings of this review indicated that multi-component programmes, which combined community mobilisation, RBS training, house policies and stricter enforcement of licensing laws, were the most effective approaches for reducing harm in drinking environments. However, although these strategies have proven to be successful in settings in the USA and Sweden their effectiveness in other settings is unknown. Currently, there are several interventions ongoing across Europe to create safer drinking environments, but few of these have or are being rigorously evaluated, and support is required to enable national and local agencies to build evaluation planning and follow-up into programme design and implementation. A major limitation of many interventions in drinking environments is their short-term approach, and action is needed at a local and national level to ensure the long-term sustainability and ‘institutionalisation’ of effective strategies.

4.5.2 Implications for future research

The methodological quality of the included studies was variable according to the study design used. Studies based on an RCT design may not always be practical for evaluating public health interventions (Victora et al., 2004) and inclusion in the review was not limited according to study design. Advances in study methodology have strengthened the inferences that can be made about the causal effect of interventions based on observational study designs (West et al., 2008) and the most methodologically sound studies identified for inclusion in this review were based on interrupted time series analyses. Future studies of interventions in drinking environments should be based on the strongest possible design, and pay careful attention to the viability of the assumptions of the design used (West et al., 2008).

A wide range of outcomes were measured across the included studies. For example, some studies focused on the impact of interventions on traffic accidents (e.g. Holder & Wagenaar, 1994), whilst others focused on impacts on violence (e.g. assault injuries; Wallin et al., 2003a). Currently there is no common understanding of what a ‘safe’ drinking environment is and there is a need for researchers in the field to reach a consensus on what are the primary outcomes of interest. In any drinking environment, interventions should not focus solely on preventing harm, but also on reducing drinking behaviours, and addressing other behavioural, environmental and cultural factors that contribute to harm. In addition, establishing whether interventions in drinking environments have an economic benefit to the health and criminal justice services, as well as the night time economy itself, is an important factor in sustaining effective practice. This should be seen as a research priority. There is currently a lack of economic analyses of interventions designed to reduce harm in drinking environments, and only two economic evaluation studies were identified in the process of conducting this review (Levy & Miller, 1995; Månsdotter et al., 2007).

Although the clearest indication of effectiveness resulted from multi-component programmes, these programmes will require adaptation before implementation in other countries or localities due to differences in behavioural, environmental and cultural factors across drinking environments in Europe. Programme context may also play a role in intervention effectiveness, in that successful interventions may be effective due to pre-existing factors of the context into which the intervention was introduced (Jackson et al., 2004). For example, Graham and Homel (2008) propose that cultural and historical factors in Sweden facilitated the community action-based approach of the STAD project, resulting in “a powerful partnership between formal regulation... and informal regulatory processes” (Graham & Homel, 2008; pg 233). It is therefore critical that intervention approaches shown to be effective, such as the *STAD project*, are adapted, implemented and subject to rigorous evaluation in other settings. Determining the applicability of the results of this review is limited by the difficulties in determining which specific intervention components of these multi-component programmes were effective or the synergy between components. Further research is therefore required to assess the transferability of evidence about multi-component programmes in drinking environments in Europe.

A major challenge for the development and implementation of interventions in drinking environments is that there are gaps in the understanding of drinking behaviours of young Europeans, with no consistent data available on this group and very few studies conducted even at a country level. As highlighted in Table 1, research that has been conducted indicates high levels of alcohol consumption, experience of violence and engagement in risky behaviours within this group. There is therefore a need to develop further knowledge and understanding of drinking behaviours and alcohol-related harm in Europe in order to facilitate the creation of healthier drinking environments and to target and adapt interventions effectively.

5 Conclusions

This systematic review examined the effectiveness of a range of intervention approaches designed to reduce harm in drinking environments. The study designs used to evaluate these interventions varied greatly and in general the methodological quality of the included studies was inadequate. The clearest indication of effectiveness resulted from multi-component programmes, which combined community mobilisation, RBS training, house policies and stricter enforcement of licensing laws. In particular, the Swedish *STAD project*, a multi-agency partnership between the police, licensing authorities, health services, the council and representatives of licensed premises, demonstrated success and was based on rigorous evaluation of effectiveness (Wallin et al., 2003a) and cost-effectiveness (Månsdotter et al., 2007). The long-term success of the *STAD project* has been attributed to factors including its long-term sustainable approach, effective partnership working, continued media work and ongoing evaluation (Graham & Homel, 2008).

The effectiveness of other intervention approaches was limited. Studies of server training highlighted an overall low frequency of intervention (McKnight et al., 1991; Gliksman et al., 1993) and its effects on patrons' alcohol consumption appeared to be minimal (Lang et al., 1998; Johnsson & Bergland, 2003), except where training was mandated (Holder & Wagenaar, 1994). Four studies of patron targeted interventions (Van Beurden et al., 2000; Boots & Midford, 1999; Rothschild et al., 2006; McLean et al., 1994), which included brief intervention and promotion of responsible drinking, revealed a limited impact of these approaches on patron behaviours. The effectiveness of police intervention or increased enforcement of licensing laws in reducing alcohol-related incidents was not clear, but overall, targeted police intervention in high-risk premises appeared to be a more effective strategy than 'low level' policing (Wiggers et al., 2004; Maguire & Nettleton, 2003; Warburton & Shepherd, 2006). There was no evidence that interventions specifically targeting underage sales of alcohol through the placement of age identification devices were effective (Krevor et al., 2003; Bierness et al., 2001), and the effects of police campaigns and other approaches to the enforcement of underage sale laws appeared to be short lived (Wagenaar et al., 2005), suggesting the need to sustain the effects of enforcement through more frequent checks.

The findings of the review indicate that there is growing evidence that effective delivery of multi-component programmes in drinking environments can reduce alcohol-related harm and consequently costs to health services, criminal justice agencies and a range of other public services. However, further research is required to assess the transferability of evidence about multi-component programmes in drinking environments to other settings. Ensuring that effective interventions are implemented and sustained in European drinking environments requires a commitment to public health from a range of agencies and ongoing

evaluation. Support is needed to enable national and local agencies to build effective measures into routine practice.

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Appendix 1. Search strategy

#	Search History
1	Exp Alcohol Drinking/
2	Exp Alcohol-Related Disorders/
3	Exp Alcohol-Induced Disorders/
4	Exp Alcoholic Intoxication/
5	Exp Alcoholic Beverages/
6	(alcohol\$ or beer or wine\$ or cider or alcopop\$ or spirit or spirits).ti,ab.
7	(drink\$ or alcohol\$ adj2 (problem\$ or bing\$ or excessive or risk\$ or harm\$ or heavy or misus\$ or abus\$ or consum\$ or behavio\$ or underage\$)).ti,ab.
8	(intoxicat\$ or inebriat\$ or drunk\$).ti,ab.
9	1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10	exp Accidents/
11	exp "Wounds and Injuries"/
12	exp Violence/
13	exp Aggression/
14	exp Suicide/
15	exp Self-Injurious Behavior/
16	exp Poisoning/
17	exp Death, Sudden/
18	(injur\$ OR death\$ OR mortalit\$ OR fatalit\$ OR trauma\$ OR fall OR falls OR falling OR burn\$ OR fire\$ OR flame\$ OR drown\$ OR abus\$ OR violen\$ OR suffocat\$ OR fractur\$ OR laceration\$ OR ruptur\$ OR wound\$ OR scald\$ OR crash\$ OR accident\$ OR suicid\$ OR crim\$ OR offen\$ OR assault\$ OR murder\$ OR homicid\$ OR attack\$ OR stab OR stabbed OR stabbing\$ OR danger\$ OR drunk\$ OR driv\$ OR impair\$ OR convict\$ OR arrest\$ OR anti-social behavio?r OR antisocial behavio?r).ti,ab.
19	(poison\$ adj2 alcohol\$).ti,ab.
20	10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19
21	(serve\$ OR serving OR pub OR pubs OR bar OR bars OR nightclub\$ OR club\$ OR restaurant\$ OR hotel\$ OR staff\$ OR shop\$ OR outlet\$ sell OR selling OR sale OR supply\$ OR supplier\$ OR supplied OR purchas\$ OR licens\$ OR licenc\$ OR nightlife OR night-life).ti,ab.
22	(industr\$ adj2 (alcohol OR beer OR brewery OR liquor OR wine)).ti,ab.
23	((alcohol OR drinking OR nightlife) adj2 (environment\$ OR setting\$)).ti,ab.
24	21 OR 22 or 23
25	exp intervention studies/
26	exp program evaluation/
27	exp harm reduction/
28	(educat\$ or train\$ or promot\$ or interven\$ or program\$ or administer\$ or campaign\$ or evaluat\$ or assess\$ or control\$ or compar\$ or prevent\$ or safe\$ or strateg\$ or

	scheme\$ or incentive\$ or trial\$ or policy or policies or reduc\$ or approach\$ or enforce\$).ti,ab.
29	25 or 26 or 27 or 28
30	9 and 20 and 24 and 29
31	(comment OR letter OR editorial).pt
32	30 NOT 31
33	32 not (rat or rats).mp.
34	33 not (pregnan\$ or anorexi\$).mp.
35	34 not (drink\$ adj2 water).mp.
36	limit 35 to (humans/ and yr="1990 - 2008")

Appendix 2. Quality assessment tables

Table 6. Results of quality assessment (RCTs, CCTs, CAS and UBA studies)

Reference	Study design	Global rating for paper	Ratings					
			Selection bias	Study design	Confounders	Blinding	Data collection methods	Withdrawal and dropouts
Bierness et al., 2001	CAS	Weak	Moderate	Moderate	Weak	Moderate	Weak	Weak
Boots & Midford, 1999	UBA	Weak	Weak	Weak	Weak	Weak	Weak	Weak
Burns et al., 1995	RCT	Moderate	Moderate	Strong	Strong	Moderate	Weak	Strong
Chandler et al., 2002	CAS	Weak	Moderate	Moderate	Weak	Moderate	Weak	Not applicable
Gliksman et al., 1993	CCT	Moderate	Strong	Strong	Moderate	Strong	Weak	Strong
Graham et al., 2004	RCT	Moderate	Moderate	Strong	Strong	Moderate	Strong	Moderate
Hauritz et al., 1998	UBA	Weak	Strong	Weak	Weak	Weak	Weak	Weak
Holder et al., 1997a	CCT	Weak	Weak	Strong	Weak	Moderate	Weak	Weak
Homel et al., 1997	UBA	Weak	Weak	Weak	Weak	Weak	Weak	Strong
Huckle et al., 2005	UBA	Weak	Strong	Weak	Weak	Weak	Weak	Strong
Johnsson & Berglund, 2003	RCT	Moderate	Moderate	Strong	Weak	Moderate	Strong	Strong
Krevor et al., 2003	UBA	Weak	Weak	Weak	Weak	Weak	Weak	Weak
Lang et al., 1998	CCT	Moderate	Weak	Strong	Moderate	Strong	Strong	Weak
Lewis et al., 1996	UBA	Weak	Weak	Weak	Weak	Weak	Weak	Weak
Maguire & Nettleton, 2003	UBA	Weak	Weak	Weak	Weak	Weak	Moderate	Not applicable
McKnight & Streff, 1994	CAS	Weak	Weak	Moderate	Weak	Weak	Weak	Weak
McKnight et al., 1991	CCT	Moderate	Moderate	Strong	Moderate	Strong	Weak	Moderate
McLean et al., 1994	RCT	Weak	Moderate	Strong	Weak	Moderate	Weak	Moderate
Rothschild et al., 2006	CAS	Weak	Weak	Moderate	Weak	Moderate	Weak	Moderate
Toomey et al., 2001	CCT	Weak	Weak	Strong	Moderate	Moderate	Weak	Strong
Treno et al., 2007	CCT	Weak	Weak	Strong	Weak	Weak	Weak	Weak
Van Beurden et al., 2000	UBA	Weak	Moderate	Weak	Weak	Weak	Strong	Weak
Wagenaar et al., 2000	RCT	Moderate	Moderate	Strong	Strong	Moderate	Weak	Moderate

Wallin et al., 2002; 2005	CCT	Weak	Moderate	Strong	Weak	Weak	Moderate	Moderate
Warburton & Shepherd, 2006	CAS	Weak	Weak	Moderate	Weak	Weak	Moderate	Not applicable
Warburton & Shepherd, 2008	RCT	Weak	Strong	Strong	Weak	Moderate	Weak	Weak
Weitzman et al., 2004	CCT	Weak	Moderate	Strong	Weak	Moderate	Weak	Weak
Wiggers et al., 2004	RCT	Weak	Weak	Strong	Weak	Weak	Weak	Weak
Willner et al., 2000	CAS	Weak	Moderate	Moderate	Weak	Moderate	Weak	Not applicable

Table 7. Results of quality assessment (ITS)

Author(s)	Global rating for paper	Intervention at clearly defined point in time	≥3 data points	Independent of other changes	Sufficient data points	Formal test for trend	Intervention unlikely to affect data collection	Blinded assessment	Completeness of data set	Reliable primary outcome measure	Analyses
Holder & Wagenaar, 1994	Strong	Done	Done	Done	Done	NA	Done	Done	Done	Done	ARIMA
Holder et al., 2000	Moderate	Done	Done	Not clear	Done	NA	Done	Not clear	Not done	Not clear	Seemingly unrelated regression equation models
Voas et al., 2002	Moderate	Done	Done	Done	Done	NA	Done	Not done	Done	Done	OLS linear regression
Wagenaar et al., 2005	Moderate	Done	Done	Done	Done	NA	Done	Done	Done	Done	ARIMA models with transfer functions
Wallin et al., 2003	Strong	Done	Done	Done	Done	NA	Done	Done	Done	Done	ARIMA

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