

Alcohol consumption as a risk factor suicidal behaviour: a systematic review of associations at the individual and at the population level

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Abstract

Objectives: To provide an updated review of the magnitude of the relationship between alcohol use and suicidal behaviour at the individual and the population level. Methods: Systematic literature searches retrieved 14 reviews of individual level studies and 16 primary population level studies. Results: Alcohol abuse and alcohol intoxication are often present in suicidal behaviour; risk of suicide is elevated in alcohol abusers ; and increasing population drinking tends to be associated with increase in suicide rates. Estimated magnitude of the relationship differs for men and women and it varies at the population level across cultures with different drinking pattern. These variations probably reflect gender differences and cultural variation in drinking behaviour generally. Conclusion: Empirical evidence for a causal relationship is still urgently needed.

Key words: Alcohol, suicidal behaviour, review, individual level, population level, drinking pattern

INTRODUCTION

Alcohol use is a well-established risk factor for suicide and deliberate self-harm (Stack 2000; Conwell, Duberstein et al. 2002; Evans, Hawton et al. 2004; Yoshimasu, Kiyohara et al. 2008; Darvishi, Farhadi et al. 2015), two phenomena that account for a substantial proportion of premature deaths and loss of healthy life years (Bertolote and Fleischmann 2009; Rehm, Mathers et al. 2009; Kerkhof 2012). There are two aspects of alcohol use that seem to be of particular importance in this respect; chronic heavy drinking (e.g. alcohol abuse), and acute alcohol intoxication (Hufford 2001; Conner and Chiapella 2004; Borges and Loera 2010). Both these aspects of alcohol use vary substantially with gender and across countries and drinking cultures (Wilsnack, Vogeltanz et al. 2000; Babor, Caetano et al. 2010). The present paper provides a review of the literature addressing the association between alcohol and suicidal behaviour. Our focus is on assessment of causality; the estimated magnitude of this association, and to what degree it is affected by gender and drinking culture. We make a distinction between individual-level studies and population-level studies (in the form of time-series analyses). By way of introduction, we will briefly discuss possible causal mechanisms underlying the relation in question and assumptions about how differences in drinking behaviour with respect to gender and drinking culture may affect the association between alcohol and suicidal behaviour.

Theories of possible causal mechanisms

As should be expected, the suggested mechanisms underlying the relation between alcohol and suicidal behaviour differ across scientific disciplines. Within psychiatry and psychology, a diathesis-stress model (Mann 1998; Sher 2006; Barzilay and Apter 2014), or similar approaches (Hufford 2001; Brady 2006; Bagge and Sher 2008; Conner, McCloskey et al. 2008; Lamis and Malone 2012) are often used to explain suicidal behaviour. Within this framework, alcohol abuse represents a vulnerability or predisposition (diathesis) of suicidal behaviour as it often leads to – and co-occurs with – conditions that predispose for suicidal behaviour, such as depression and other psychiatric disorders, severe physical illness, loneliness, low self-esteem, hopelessness, impulsivity and aggressiveness. Furthermore, alcohol abuse is also associated with triggering events (stress) for suicidal behaviour, such as depressive episodes, conflicts in intimate relationships, divorce, unemployment and financial problems. The elevated risk of suicidal behaviour among individuals with alcohol abuse can thus in part be explained causally as the outcome of the interaction between vulnerability factors and precipitating life events.

The role of alcohol intoxication in suicidal behaviour may also be understood within this framework. Alcohol's acute effect on neurotransmitters and cognitive functions implies that alcohol intoxication increases the feeling of despair or sadness, increases aggressiveness, reinforces impulsivity and suicidal thoughts, weakens or removes barriers to self-harm, and narrows the ability to find alternative solution strategies (Hufford 2001; Cherpitel, Borges et al. 2004; Brady 2006; Bagge and Sher 2008). Notably, the suggested causal mechanisms within this framework mainly pertain to the individual level association.

Within sociology Durkheim's theory (Durkheim 1952 [1897]) provides the most influential perspective on suicide. A key concept in this theory is that the suicide risk is inversely related to the degree of social integration. Alcohol abuse can certainly be socially disintegrating, as it often leads to loss of social relations in most important arenas, such as the workplace and in the family sphere (Skog 1991). Also the importance of alcohol intoxication in suicidal behaviour can be understood in the light of Durkheim's theory and concepts. Alcohol intoxication may be considered as a form of anomie, that is, a condition in which normal control mechanisms are weakened or eliminated (Skog 1991; Cherpitel, Borges et al. 2004). Both the reinforcing effect of intoxication on suicidal impulses, and its destructive consequences for social relations ('anomic intoxication') may explain why alcohol intoxication increases the risk of suicidal behaviour (Skog, 1991).

Empirical assessment of causal association

While there is ample theoretical basis for assuming causal effects of alcohol use on suicidal behaviour, empirical studies assessing a causal association need to take spurious effects and indirect effects into account. Regarding spurious effects, it seems quite plausible that the elevated risk of suicidal behaviour among individuals with alcohol abuse or alcohol intoxication is not solely caused by the drinking itself. We may assume that common risk factors for both detrimental drinking behaviour and suicidal behaviour, such as genetics, personality traits and mental disorders, are likely to account for some – or much – of the association at the individual level (Brady 2006). We should therefore avoid interpreting all cases of suicidal behaviour where alcohol abuse or alcohol intoxication was present as alcohol induced; - some of these cases had probably occurred also in the absence of alcohol. Correspondingly, it is also conceivable that alcohol abuse or alcohol intoxication may have contributed causally to cases of suicidal behaviour even in the absence of such drinking at the time of the event. For instance, alcohol abuse may have led to depression and social isolation but have ceased prior to the suicidal behaviour (Berglund and Öjehagen 1998). Regarding possible indirect effects, there are some indications that alcohol abuse or alcohol intoxication may impact on suicidal behaviour in other family members, as children or spouses (Grøholt, Ekeberg et al. 2000;

Kizza, Hjelmeland et al. 2012; Rossow and Moan 2012). Likely mechanisms include the adverse effects of alcohol abuse on other family members such as physical or emotional abuse and financial problems (Room, Ferris et al. 2010), which in turn may increase the risk for suicidal behaviour in affected family members.

Thus, there are several issues that complicate the assessment of the magnitude of a causal association between drinking and suicidal behaviour. One approach to overcome the problem of self-selection (spurious association due to common risk factors) and also account for the possible indirect effect of heavy drinking on others, is to estimate the association at the population level where the issue is how changes in total alcohol consumption affect the suicide rate in the society. A key finding in alcohol epidemiology is that an increase in a country's total consumption is linked to an increase in the proportion of alcohol abusers and the number of occasions of alcohol intoxication (Skog 1985). In view of the mechanisms between alcohol use and suicidal behaviour discussed above, we should thus expect a relationship between the two also at the population level.

Gender and drinking culture differences

In adult general populations, alcohol abuse and alcohol intoxication occur more frequently among men than among women (Wilsnack, Vogeltanz et al. 2000). This implies that we may expect similar differences among suicides and attempted suicides at the individual level; that is higher proportions of alcohol abusers or intoxicated persons in cases of male – as compared to – female suicidal behaviour. However, as women seem more vulnerable to adverse health consequences from chronic heavy drinking compared to men (Wilsnack, Vogeltanz et al. 2000; Nolen-Hoeksema and Hilt 2006), the *relative* risk of suicidal behaviour is likely to be higher in female alcohol abusers compared to their male counterparts. At the population level, an increase in total alcohol consumption means a larger increase in the number of alcohol abusers and episodes of alcohol intoxication among men than among women, which may suggest a stronger impact – in absolute terms – on male suicide rates than on female suicide rates.

Correspondingly, we may expect that, in comparison to other drinking cultures or countries, suicidal behaviour under the influence of alcohol occurs more frequently where alcohol intoxication is more widespread and occurs more frequently. Moreover, estimates of the association at the population level can easily be compared across drinking cultures with different drinking patterns and thereby indicate the importance of acute heavy drinking.

Reviewing the alcohol and suicidal behaviour literature

The studies of the alcohol – suicidal behaviour association at the individual and at the population level mainly reflect different disciplines and theoretical approaches and they constitute two parts of the literature that rarely are brought together. Most of the scientific literature that has addressed the relationship between alcohol use and suicidal behaviour, both in empirical and theoretical sense, is based in the medical disciplines, particularly psychiatry, psychology, and epidemiology. A search in MedLine showed that 48 652 articles published between 1990 and 2014 mentioned ‘suicide’ in the title and/or in the abstract and among these 2 735 articles also mentioned ‘alcohol’, whereas a corresponding search in Social Sciences Citation Index showed that 32 of 401 suicide articles mentioned alcohol. There are, indeed, many reviews of individual level studies of alcohol and suicidal behaviour and some of these have also included some aggregate level studies (Berglund and Öjehagen 1998; Rossow 2000; Pirkola, Suominen et al. 2004; Pompili, Serafini et al. 2010). However, to our knowledge there are none so far that have systematically addressed population level studies and none that have reviewed both individual level and population level studies based on systematic literature searches.

Against this backdrop, this study applies systematic literature searches and reviews the magnitude and variation in estimates of the association between alcohol consumption and suicidal behaviour, both at the individual and the population level and integrates findings from these two levels. Gender and drinking culture differences in estimates of association and capacity for causal inference are also addressed.

METHODS

The literature on the association between alcohol use and suicidal behaviour at the individual level is very extensive, these associations are of various kinds and they are estimated from various types of study designs. As several reviews have already been written on individual level studies, we have chosen to summarize the results of existing reviews carried out so far. By conducting a review of reviews the ability to cover a broad literature is optimised. The literature on the association at the population level is, on the other hand, less extensive, it has not been systematically reviewed previously and therefore we aimed at covering primary studies from this part of the literature. Consequently, two separate systematic literature searches were conducted. Both searches were limited to the period 1980 through March 2014 and limited to publications in English or Scandinavian

languages. The following data bases were searched: MedLine, Embase, Psycinfo, Web of Knowledge, Pubpsych, SveMed+, and Cochrane. The search strategy that was used for PsycINFO included the following search strings in the two searches: “alcohol*”, “drink*”, “drunk*” and “suicid*”, “parasuicid*”, “selfdestructive”, “selfharm”, “selfinjurious”, “selfkill” (* indicates truncation) and this was adapted in minor ways for other databases. The search strategy included different terms to specify study designs: searches for reviews of individual level studies included the term “review*” and searches for primary studies at the population level included “time serie*”. Inclusion criteria for the review of reviews of individual level studies comprised: (i) a review (not necessarily based on systematic searches) of primary studies and/or reviews of primary studies conducted on individual level data, (ii) a clear focus on the association between alcohol use and suicidal behaviour (completed or attempted suicide), (iii) presentation of estimates of association between alcohol use and suicidal behaviour (e.g. prevalence rate, odds ratio, life time risk) and comparable estimates of an association from several (at least two) primary studies. We used the following inclusion criteria for the review of population level studies: (i) that the study was based on time-series data, (ii) that an adequate analytical technique had been applied that considered the common methodological complications in the modelling of time-series data, such as non-stationarity, and (iii) presentation of estimates of association between per capita alcohol consumption and suicide rates.

The search for reviews of individual level studies resulted in 1253 unique records after removal of duplicates. The abstracts were screened and a total of 63 journal articles were retrieved in full text. Of these, 49 studies reviewed the literature with a primary focus on the alcohol – suicidal behaviour association and a total of 14 studies met all the inclusion criteria and were included in this review.

The search for studies at the population level resulted in 305 hits after removal of duplicates. A total of 16 studies met all the inclusion criteria and were included in this review. In addition, some studies that use various mortality rates as proxy indicators of per capita alcohol consumption are reviewed in the discussion section.

RESULTS

Alcohol and suicidal behaviour at the individual level

Ten of the 14 included studies reviewing associations at the individual level, were based on systematic literature searches. The primary studies covered by these reviews stemmed from 32 countries, a majority of these being in Europe, whereas few studies stemmed from Asian, African,

Middle East or South American countries. The terminology varied between (and within) studies and we will in the following summary of the reported findings in the text use the term alcohol abuse (or alcohol abusers) when referring to alcohol use disorder, alcoholism, chronic heavy drinking, etc. and the term alcohol intoxication when referring to acute alcohol use, positive alcohol cases, being under the influence of alcohol, etc. In the tables and presentations of studies we apply the terminology as used in the included reviews. The reported associations between alcohol use and suicidal behaviour could mainly be grouped into two categories: (i) descriptions of co-occurrence of alcohol use and suicidal behaviour; that is prevalence of alcohol use (alcohol abuse or alcohol intoxication) among cases of suicidal behaviour (suicide or attempted suicide/DSH), or life-time risk of suicide in alcohol abusers, and (ii) estimates of relative risk of suicidal behaviour (suicide or attempted suicide) in alcohol abusers or in cases of alcohol intoxication. These associations have been reported for overall, as well as age or gender specific, samples. In addition, one study (Moller, Tait et al. 2013) reviewed associations between substance use and attempted suicide/DSH in the general population, mainly based on surveys among school or university students. This review included some primary studies reporting fairly comparable associations between alcohol use and suicidal behaviour.

Prevalence estimates of alcohol abuse among completed suicides were mainly obtained in psychological autopsy studies and were reported in 8 reviews. The estimates varied between 15 and 61 % (Table 1). Prevalence of alcohol abuse in attempted suicide/DSH was described in one review based on two primary studies among young people and varied from 12 to 35 % (Esposito-Smythers and Spirito 2004). Many of the reviews noted that the observed prevalence of alcohol abuse in cases of suicide/attempted suicide is generally higher than what is observed in the general population, often without specifying the relative magnitude. Furthermore, presence of alcohol use other than alcohol use disorder is addressed in several reviews. Prevalence of alcohol intoxication in completed suicide was covered by 3 reviews including altogether 35 adult population studies (Cherpitel, Borges et al. 2004; Pompili, Serafini et al. 2010; Vijayakumar, Kumar et al. 2011) and prevalence rates ranged between 6 and 69 %. Prevalence of alcohol intoxication in attempted suicide /DSH was described in one review of 15 primary studies (Cherpitel, Borges et al. 2004) and prevalence rates ranged between 10 and 73 %.

Life time risk of suicide in alcohol abusers (i.e. alcoholics) was reviewed in one study (Murphy and Wetzel 1990) and although the estimated risk was of substantial magnitude, it was lower than previously assumed, and ranging between 1.8 % and 6.2 % . The lowest estimate of life time risk was derived from studies of alcohol abusers who were not in treatment and the highest estimate was derived from studies of in-patient treated alcohol abusers.

Heterogeneity in prevalence figures was generally apparent in all nine reviews presented in Table 1. The prevalence of alcohol abuse in suicides and attempted suicides/DSH was generally higher among males than females (Berglund and Öjehagen 1998; Pirkola, Suominen et al. 2004; Schneider 2009). Correspondingly, the prevalence of alcohol intoxication in suicides and attempted suicides was higher in males compared to females (Cherpitel, Borges et al. 2004). In three reviews (Murphy and Wetzel 1990; Cherpitel, Borges et al. 2004; Wilcox, Conner et al. 2004) the authors discussed differences in study characteristics (e.g. demographic sample composition, sample size, diagnostic criteria and inclusion criteria) as possible reasons for the observed variation in prevalence rates. Moreover, Murphy and Wetzel (1990) assessed whether life time suicide risk in alcohol abusers varied with overall suicide rate level.

None of the reviews assessed, however, the variation in magnitude of association at the individual level with respect to drinking culture. We therefore conducted a meta-analysis regression of reported results from the primary studies included in the review by Cherpitel and co-workers (2004). Their review of prevalence of acute alcohol use in completed suicide provided the most adequate data for this purpose, by covering 32 studies from 11 countries. As an aggregate indicator of variation in drinking culture, we applied a detrimental drinking pattern score ranging from 1 (the least detrimental drinking pattern with little extent of alcohol intoxication) to 4 (the most detrimental drinking pattern with extensive alcohol intoxication) for various countries (Rehm, Room et al. 2004). After adjusting for proportion of males in the sample and weighting for sample size, we found, however, no statistically significant association between the prevalence of alcohol intoxication in completed suicide and detrimental drinking pattern score ($B=1.4$, $SE=3.3$, $P=.671$).

The other main category of associations at the individual level included relative risks of suicidal behaviour in alcohol abusers, obtained in terms of odds ratios (OR) or standardized mortality ratios (SMRs), showing that alcohol abusers consistently had an elevated risk of suicide or attempted suicide. Two reviews (Harris and Barraclough 1997; Wilcox, Conner et al. 2004) reported SMRs for alcohol abuse and completed suicide from the same primary studies (also referenced in Schneider, 2009) and these varied largely. Averaged SMR across samples of both sexes was 979 (i.e. suicide risk was 9.8 times higher in alcohol abusers compared to the general population). Corresponding averaged estimate for males was 483 (i.e. 4.8 times higher suicide risk) and the estimate was clearly higher for females (1690) (i.e. 16.9 times higher suicide risk) (Table 2). Two other reviews (Schneider 2009; Borges and Loera 2010) also reported large variations in the relative risk (OR) of suicidal behaviour (suicide attempt or suicide) among alcohol abusers (Table 2). Moreover, in their review of

the alcohol – suicidal behaviour association in youth populations Esposito-Smythers and Spirito (2004) reported that the suicide risk in young alcohol abusers was consistently elevated, on average by a factor of eight. However, the picture was mixed regarding alcohol use other than alcohol abuse and suicidal behaviour. While alcohol intoxication is found to elevate risk of suicide attempt/deliberate self harm in emergency room studies (OR range 6.2 – 9.6) (Borges and Loera 2010) and in youth population surveys (1.3 – 19.0) (Moller, Tait et al. 2013) other measures of alcohol intake were not necessarily associated with suicidal behaviour. In 10 out of 35 survey studies, no statistically significant association was found (Moller et al., 2011).

Several reviews have reported that among individuals with alcohol abuse, the risk of suicide or suicide attempt is elevated with co-occurrence of other mental disorders, particularly depression (Berglund and Öjehagen, 1998). Other factors that increase the risk of suicide or suicide attempt in this group include impulsivity and aggression, social isolation, unemployment, divorce or other loss or conflict with other economic difficulties, physical illness, and having been subjected to physical or sexual abuse (Pirkola et al., 2004). In other words, the association between alcohol abuse and suicidal behaviour is compounded by other risk factors for suicide and attempted suicide (Beautrais 2000; Conwell, Duberstein et al. 2002).

The estimated relative risks of suicidal behaviour in alcohol abusers varied markedly across primary studies, and one of the four reviews in Table 2 (Wilcox et al. 2004) analysed this heterogeneity by conducting a meta-analysis of the relative risk estimates (SMR). The outcome suggested that publication year influenced variation in SMR, whereas study region did not. Apart from this, neither of these four reviews nor the two other reviews presenting relative risk estimates (Esposito-Smythers and Spirito 2004; Moller, Tait et al. 2013) provided findings of relevance for assessing the potential influence of drinking culture on the association between alcohol and suicidal behaviour. Variations were substantial also when comparing studies within the same country or drinking culture and they rather appeared to reflect differences in measures of chronic or acute heavy drinking and random variation due to small study samples.

While the reviews generally reported study findings implying a strong association between alcohol abuse or alcohol intoxication and suicidal behaviour, only a few discussed to what extent the observed associations reflect causal effects. Cherpitel et al. (2004) discussed the limitations of descriptive prevalence figures of alcohol intoxication in cases of suicidal behaviour as indicative of a causal effect, and they suggested case-cross-over design in future studies to better test for causality. Pompili and co-workers (2010) questioned a causal relationship between 'binge' drinking and suicide

attempts and Borges and Loera (2010) discussed whether the primary study estimates could be interpreted as net effects.

Notably, among the reviews covering individual level studies, a few (Berglund and Öjehagen, 1998; Pompili et al., 2010) addressed also several aggregate level studies of the alcohol – suicide association and the authors noted that these analyses appeared to obtain a stronger association in ‘dry’ as compared to ‘wet’ drinking cultures.

Alcohol and suicide at the population level

All studies but two present gender-specific estimates of the relationship between per capita alcohol consumption and suicide (the two exceptions are Gruenewald et al. (1995) and Norström et al. (2012) who present beverage-specific estimates only). An overview of the estimates from these studies is shown in Table 3. Four studies reported estimates for males only, while the estimate in one study (Skog and Elekes 1993) pertained to the whole population. However, in the text the authors claim that this estimate was obtained also in gender-specific analyses. We thus used the overall estimate as estimates for females and males. As semi-log models were applied in the gender-specific analyses, we converted the estimates to per cent per litre estimates, that is, expressing how many per cent the suicide rate is expected to change if per capita consumption increases by one litre. As can be seen, there was one negative estimate that was statistically significant. More than half (59%) of the relationships for men were positive and statistically significant; for women, this proportion was markedly lower, or 40%. Below we give an overview of some general key features of the findings reported in Table 3.

A couple of studies aim at examining whether the relationship between alcohol and suicide vary between drinking cultures. Although there are several reasons to expect such a variation (Norström 1995; Ramstedt 2001), it is mainly differences in drinking patterns that should be relevant. A comparative survey of alcohol consumption in six European countries (Leifman 2002) lent support to the stereotypical notion that drinking to intoxication is more common in dry cultures (represented by Finland and Sweden) than in the wet (France and Italy), where the drinking to a higher degree is drinking with meals and distributed on most days of the week. This means that a given increase in total consumption should yield a stronger impact on intoxication drinking (and thus the suicide rate) in a dry compared to a wet drinking culture. Two studies find support for this hypothesis; thus Norström (1995) observed a stronger correlation between total consumption and suicide in Sweden

than in France. In a study based on 14 European countries Ramstedt (2001) reports strong and statistically significant relationships for the Nordic countries, but weak and mostly non-significant relationships for mid- and southern Europe. To obtain an additional and more global test of the hypothesis at issue, the studies in Table 3 are grouped on the basis of the drinking pattern as evaluated by Rehm et al. (2004). Thus, we applied the same detrimental drinking pattern score for aggregate level comparisons as we did for individual level comparisons (the score varies between 1 and 4, with 1 indicating the least, and 4 the most harmful drinking pattern). The table shows a pattern that is consistent with the hypothesis; for females as well as males there is thus a marked gradient in the pooled estimates, being weakest in the country group with pattern score 1 and strongest in the country group with pattern score 4.

The estimates are generally stronger for males than females, that is an increase in alcohol consumption is generally accompanied with a larger relative increase in male suicide rates than female suicide rates. An exception to this pattern is observed for the country group with pattern score 2.

Some studies suggest that certain alcoholic beverages would be more strongly linked to suicide than others. This is primarily valid for spirits (Japan (Norström, Stickley et al. 2012), Norway (Norström and Rossow 1999), Russia (Razvodovsky 2009), Sweden (Norström and Rossow 1999), and the USA (Gruenewald, Ponicki et al. 1995)); but also beer (Norway, (Norström and Rossow 1999)). The most obvious interpretation is that spirits (and to some extent beer) is the alcoholic beverage of choice for alcohol abusers .

Integrating findings from individual level and population level studies

As noted above, both individual level and population level studies often report findings in line with the assumption that alcohol abuse and alcohol intoxication both constitute risk factors for suicidal behaviour. Individual level studies show clearly that alcohol abuse or alcohol intoxication are often present in suicidal behaviour. Moreover, cohort studies show that alcohol abuse elevates the risk of suicidal behaviour and there are indications that alcohol intoxication may also do so. Studies at the population level show that increase in total consumption – which implies an increase in prevalence of alcohol abusers – tends to be accompanied by an increase in suicide rates.

Notably, neither individual level nor population level studies produced unambiguous results. Among individual level studies, the review by Moller and colleagues (2013) showed that a fairly large fraction (a third) of studies reported no statistically significant association between alcohol consumption and

suicidal behaviour from surveys among school/university students. Correspondingly, a large fraction of the estimated associations at the population level were of modest magnitude and not statistically significant. Thus, the observed association between alcohol use and suicidal behaviour appears robust and unambiguous only when one considers estimates of excess suicide mortality in alcohol abusers obtained from cohort studies. However, when a broader range of study designs and measurements of alcohol use are also included in the review, the picture becomes more mixed and ambiguous.

Both at the individual level and at the population level, there was considerable variation in the estimates of association. However, this variation seemed to reflect differences across drinking cultures in studies at the population level but not at the individual level. Thus, the strength of the association at the population level tended to be larger in drinking cultures where acute alcohol intake is more prominent. This, as well as the substantial fraction of alcohol intoxication in cases of suicidal behaviour, lend support to the assumption that such drinking behaviour is an additional contributing factor.

Gender differences in the alcohol – suicidal behaviour association were found both in individual level and population level studies. A higher prevalence of alcohol abuse or alcohol intoxication was found in male, as compared to female, suicidal behaviour and a stronger association between population drinking and suicide rates was found for males than for females. Thus, the gender differences in alcohol abuse and alcohol intoxication in the general population were reflected in the observations both at the individual and population level, in expected directions given a causal association.

The individual level studies were to limited extent reviewed with respect to their capacity to infer causality, and it seems probable that the observed excess risk of suicidal behaviour in alcohol abusers does not entirely reflect a causal effect but may, at least in part, be attributable to shared risk factors, such as depression. While such selection effects are mainly avoided in time series analyses of population level data, the association was in many of these studies not statistically significantly different from zero. Such null findings are not incompatible with a causal effect of alcohol use on suicide and they may be ascribed to relatively small data sets, little variation in the explanatory variable and conservative estimation methods.

DISCUSSION

This review has shown that there is a fairly extensive literature addressing the magnitude of the association between alcohol use and suicidal behaviour and it is the first to address the association systematically at both the individual and the population level. The magnitude of the estimated associations varies considerably, also in gender specific analyses and at the individual and aggregate level. Pooled analyses of the latter type of data suggest that a stronger association between alcohol consumption and suicide rates can be expected in countries with more detrimental drinking pattern.

Our systematic search for reviews at the individual level revealed that a considerable number of studies (n= 49) have previously reviewed various aspects of the association between alcohol and suicidal behaviour and most of these had primarily or solely addressed the individual level association. Many of the previous reviews cover broad areas and various types of studies and therefore go into little detail about estimates of association, while others are devoted to defined topics and study designs; for instance prevalence of acute alcohol intake in suicides (Cherpitel et al. 2004) or excess suicide mortality in heavy drinkers (Wilcox et al., 2004). While some studies have demonstrated elevated risk of suicidal behaviour among children or spouses of heavy drinkers (Grøholt, Ekeberg et al. 2000; Kizza, Hjelmeland et al. 2012; Rossow and Moan 2012), none of the previous reviews have addressed such indirect effects. Moreover, none of the previous reviews have systematically reviewed aggregate level studies nor integrated the findings from both individual level and aggregate level studies; the present review thus appears to be the first in this respect.

Among studies at the population level, there are some studies of relevance in addition to those included in this review. There are a few studies that used alcohol-related mortality as a proxy for consumption. Pridemore and Chamlin (2006) report a significant positive correlation between this proxy and suicide for both men and women for the period 1956 – 2002 in Russia. Stickley et al. (2011) found that this relationship was of about the same strength in Russia in the period 1956-2005 as during the period 1870-1894. Razvodovsky (2007) reports a significant relationship between suicide and rates of alcohol psychoses morbidity for the period 1970-2005 in Belarus. Thus, these studies suggest that an increase in alcohol abusers in a society is accompanied by an increase in suicide, which corresponds well with the findings from time series analyses of population drinking and suicide rates. There is also a study of alcohol consumption and suicide rates in young people in EU countries that found – in contrast to the pooled estimates presented in this review – a stronger association for females than for males (Innamorati, Lester et al. 2010). These contrasting findings

may, at least in part, be due to differences in population groups, statistical analyses and pooling of data.

Alcohol use in suicidal behaviour is most probably both underestimated and underreported. A study of serious suicide attempts showed that parents less frequently reported heavy drinking, suggesting that psychological autopsy studies of suicides are likely to underestimate the occurrence of heavy drinking (Velting, Shaffer et al. 1998). In toxicological studies, detection of alcohol is not considered a reliable indicator due to the high rate of false-negatives (Dhossche 2000). As regards under-reporting, many studies apply a combined measure of heavy substance use, not separating drinking from other substance use (Esposito-Smythers and Spirito 2004; Schneider 2009). Indeed, some alcohol abusers are also heavy users of other illicit substances (Teesson, Hall et al. 2000). However, a combined measure of substance abuse in relation to suicidal behaviour probably mainly reflects that alcohol abusers were included in a larger mixed groups of substance abusers, and thereby conceals the proportion of alcohol abusers in these studies of suicidal behaviour.

Consequently, comparison of estimates of association across primary studies at the individual level is hampered by substantial variability in criteria and assessment of measurement and differences in sampling may further weaken comparability. This is a lesser problem for population level studies applying similar measurements and statistical methods. Thus, such differences in comparability between individual level and population level studies may, at least in part, explain why stronger associations in drinking cultures with detrimental drinking pattern were observed at the population level, but not at the individual level.

The question of to what degree the observed relationships between alcohol and suicidal behaviour are causal, is of course paramount to the implications of these relationships. To further our understanding in this respect future research should take note of the fact that the observed individual level associations are likely to be biased by confounders to a high degree, simply because few studies attempt to control for causes that are common to excessive drinking and suicide risk. More studies are thus needed that go beyond simple case finding but employ research designs that address the problem of confounding. Further, studies of alcohol use in the general population show that there is no clear distinction between alcohol use and chronic heavy drinking (Johnstone and Rossow 2009). This suggests that exposure is of a continuous rather than dichotomous nature which calls for studies that address a possible dose - response relationship between alcohol consumption and suicidal behaviour.

As already noted, this risk of confounding is less likely at the population level, where instead the risk of type 2 error may be more acute. Thus, the high prevalence of null-associations at the aggregate level may well indicate that the statistical power typically is too low to detect the weak associations that are expected in wet drinking cultures. A possible remedy in this situation is to select a period with a marked variation in total consumption, resulting in increased power to detect a possible relationship. One example is Denmark, where Ramstedt (2001) found no significant correlation based on data for the period 1951-1993. Skog (1993) instead used the period 1911-1924. The small number of observations is offset by the fact that consumption decreased by about 75% between 1916 and 1918, giving sufficient power to obtain a significant estimate of the expected weak effect (2.5% per litre). A similar example is France, where Ramstedt's analysis (2001) for the period from 1950 to 1994 did not yield any significant estimate, which, however, Norström's analysis (1995) did, probably because it was based on a period (1930-1987) with stronger fluctuations in total consumption.

Limitations

This review covers a broad area and a rich literature and primary studies at the individual level were not covered if they had not been included in a previous review. Thus, an important limitation of this review is that in particular primary individual level studies of more recent date or with a different scope or study design than those included in the reviews, are not covered by this review. Moreover, population level studies applying other data and methods than those specified in our literature search were not covered. Consequently, this review does not provide a complete picture of studies estimating associations between alcohol use and suicidal behaviour.

Another limitation, pertaining to all reviews, is publication bias, that is, the likelihood that studies demonstrating an association are more likely to be published. In our context, such selective reporting implies that the picture of heavy drinking as a strong risk factor for suicidal behaviour, which emerges from the literature as overall fairly consistent, may – in reality – be somewhat less consistent and more diverse.

Finally, the studies covered by this review most often stem from high income countries. Globally, both drinking behaviour (Babor, Caetano et al. 2010) and suicidal behaviour (Nock, Borges et al. 2008) vary tremendously between regions and countries. Moreover, several societal factors are likely to interact with the alcohol – suicidal behaviour association, such as social welfare systems, employment, and poverty, and these factors also vary globally. Thus, the findings reported here may not necessarily apply beyond the types of societies from which they were derived.

Conclusions

An extensive literature demonstrates an association between alcohol use and suicidal behaviour, both at the individual level and population level. Variations in the estimated associations with respect to gender and drinking culture are compatible with theories of alcohol as a causal factor in suicidal behaviour. However, empirical assessment of a causal association between alcohol use and suicidal behaviour is still needed.

Moreover, this review shows that most studies of the association between alcohol and suicidal behaviour are based on data from relatively few countries, and mainly high income countries in Europe, North America and Australasia. Future studies applying data from LAMI countries are therefore highly needed.

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Table 1. Estimates of prevalence of alcohol use (alcohol abuse or alcohol intoxication) in suicidal behaviour (completed or attempted suicide).

First author, year	Alcohol abuse (terms used by the authors)	Suicidal behaviour	Population	Number of studies included	Prevalence of alcohol abuse in suicidal behaviour (per cent), range
Murphy, 1990	Alcoholism	Completed suicide	General population	7	15 - 54
Berglund, 1998	Alcohol abuse or dependence, alcoholism	Completed suicide	General population	8	15 - 56
Pirkola, 2004	Alcohol abuse or dependence	Completed suicide	General population	22	15-56
Schneider, 2009	Alcohol abuse or dependence	Completed suicide	General population	25	15 - 56
Vijayakumar, (2011)	Alcohol use disorder	Completed suicide	General population	2	15-17
Giner, (2007)	Alcohol abuse	Completed suicide	Youth < 20 years	6	21 – 43
Esposito-Smythers, 2004	Alcohol abuse or dependence	Completed suicide	Youth population	4	22 - 27
Pompili, 2012	Alcohol abuse or dependence	Completed suicide	Youth population	3	26- 42
Esposito-Smythers, 2004; Pompili, (2012)	Alcohol abuse or dependence Alcohol use disorder	Suicide attempt/DSH	Youth population	2	12 - 35

Note: The reviews by Esposito-Smythers & Spirito (2004) and Pompili et al. (2012) refer to the same two primary studies regarding prevalence of alcohol abuse in suicide attempts.

Table 2. Estimates of relative risk of suicidal behaviour (suicide or attempted suicide) by alcohol abuse.

First author, year	Alcohol abuse (terms used by the authors)	Suicidal behaviour	Population	Number of studies reviewed	Association measure and magnitude (range)
Borges, 2010	Alcohol disorder, alcohol abuse or dependence	Suicide attempt	General population	14	OR, range 1.6 – 18.0
Schneider, 2009	Alcohol abuse or dependence	Completed suicide	General population	7	OR, range 1.6 – 11.6
Harris, 1997;	Alcohol dependence and abuse	Completed suicide	General population	18	Average SMR 916 * (95% CI 833-1003)
Wilcox, 2004	Alcohol use disorder	Completed suicide	General population	11	Average SMR 979 (95% CI 898-1065)
Harris, 1997;	Alcohol dependence and abuse	Completed suicide	Male population	11	Average SMR 390 * (95% CI 345-438)
Wilcox, 2004	Alcohol use disorder	Completed suicide	Male population	15	Average SMR 483 (95% CI 444-524)
Harris, 1997;	Alcohol dependence and abuse	Completed suicide	Female population	5	Average SMR 1846 * (95% CI 1293-2556)
Wilcox, 2004	Alcohol use disorder	Completed suicide	Female population	7	Average SMR 1690 (95% CI 1246-2241)

*Calculated by Wilcox et al. (2004)

Table 3. Estimates of percentage change in suicide rate following a 1-litre increase in per capita alcohol consumption, per study and pooled for country groups by drinking pattern. DDP= detrimental drinking pattern score.

Study	Country	Study period	DDP	Males (%)	SE	Females (%)	SE
(Ramstedt 2001)	Austria	1955-1995	1	-1.49	1.31	0.9	1.61
(Ramstedt 2001)	Belgium	1954-1992	1	4.6	2.33	9.86**	3.25
(Norström 1995)	France	1930-1987	1	2.74***	0.4	NA	
(Ramstedt 2001)	France	1950-1994	1	0.2	1.01	0.1	1.31
(Ramstedt 2001)	Italy	1951-1993	1	-1.29	1.41	0.3	1.21
(Ramstedt 2001)	Netherlands	1950-1995	1	-1.59	1.92	6.72**	2.43
Skog, Teixeira et al. (1995)	Portugal	1931-1989	1	1.92**	0.6	0.4	0.9
(Ramstedt 2001)	Portugal	1955-1995	1	1.61**	0.5	1.41	0.9
(Ramstedt 2001)	Spain	1951-1994	1	-2.76**	1.21	0.1	1.41
(Ramstedt 2001)	West-Germany	1952-1995	1	0.6	1.41	2.94	1.51
(Gmel, Rehm et al. 1998)	Zwitzerland	1950-1990	1	-0.2	0.5	-0.5	0.2
	Pooled		1	1.21***	0.20	0.10	0.20
(Landberg 2008)	Bulgaria	1964-2003	2	4.39***	0.8	6.08*	2.63
(Ramstedt 2005)	Canada	1950-1998	2	3.87**	1.11	10.08***	1.82
(Landberg 2008)	Czech Republic	1953-1991	2	4.19**	1.51	1.21	2.22
(Skog 1993)	Denmark	1911-1924	2	2.53*	1.01	NA	
(Ramstedt 2001)	Denmark	1951-1993	2	-1.78	2.94	-0.2	3.46
(Ramstedt 2001)	UK	1950-1995	2	-1.09	2.33	2.74	3.25
(Caces and Harford 1998)	USA	1934-1987	2	3.98	2.02	4.08*	2.02
(Landberg 2009)	USA	1950-2002	2	0	1.71	6.08	3.46
(Kerr, Subbaraman et al. 2011)	USA	1950-2002	2	1.92*	0.72	5.97***	1.31
	Pooled		2	2.84***	0.40	3.05***	0.80
Mäkelä (1996)	Finland	1950-1991	3	4.08*	2.02	5.13	3.05
(Ramstedt 2001)	Finland	1952-1995	3	3.67	2.22	4.29	2.84
(Skog and Elekes 1993)	Hungary	1950-1990	3	10.52**	3.05	10.52**	3.05
(Landberg 2008)	Hungary	1955-2002	3	3.15*	1.41	1.71	1.82
(Ramstedt 2001)	Ireland	1950-1994	3	3.25	5.13	1.11	8.22
(Rossow 1993)	Norway	1911-1990	3	9.42**	3.05	3.05	4.08
(Norström and Rossow 1999)	Norway	1918-1994	3	16.18***	3.05	NA	
(Ramstedt 2001)	Norway	1951-1980	3	12.86*	6.18	24.61***	6.08
(Ramstedt 2001)	Sweden	1951-1995	3	10.63**	3.05	8.22*	3.56
(Norström 1995)	Sweden	1930-1989	3	11.4***	2.84	NA	
	Pooled		3	6.50***	0.80	3.56**	1.11
(Landberg 2008)	Poland	1959-1996	4	7.68***	2.12	1.51	2.22
(Nemtsov 2003)	Russia	1965-1999	4	13.2**	4.08	6.4**	2.02
(Landberg 2008)	Russia	1959-1998	4	8.33***	1.01	4.39***	0.6
(Razvodovsky 2009)	Russia	1970-2005	4	4.08*	1.51	2.84**	1.01
	Pooled		4	8.44***	0.90	4.39***	0.60

*p<0.05; **p<0.01; ***p<0.001

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