Comparative cost-effectiveness of policy instruments for reducing the global burden of alcohol, tobacco and illicit drug use

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Abstract
Alcohol, tobacco and illicit drug use together pose a formidable challenge to international public health. Building on earlier estimates of the demonstrated burden of alcohol, tobacco and illicit drug use at the global level, this review aims to consider the comparative cost-effectiveness of evidence-based interventions for reducing the global burden of disease from these three risk factors. Although the number of published cost-effectiveness studies in the addictions field is now extensive (reviewed briefly here) there are a series of practical problems in using them for sector-wide decision making, including methodological heterogeneity, differences in analytical reference point and the specificity of findings to a particular context. In response to these limitations, a more generalised form of cost-effectiveness analysis (CEA) is proposed, which enables like-with-like comparisons of the relative efficiency of preventive or individual-based strategies to be made, not only within but also across diseases or their risk factors. The application of generalised CEA to a range of personal and non-personal interventions for reducing the burden of addictive substances is described. While such a development avoids many of the obstacles that have plagued earlier attempts and in so doing opens up new opportunities to address important policy questions, there remain a number of caveats to population-level analysis of this kind, particularly when conducted at the global level. These issues are the subject of the final section of this review. [Chisholm D, Doran C, Shibuya K, Rehm J. Comparative cost-effectiveness of policy instruments for reducing the global burden of alcohol, tobacco and illicit drug use. Drug Alcohol Rev 2006;25:553 – 565]

Key words: alcohol, cost effectiveness, illicit drug, policy, tobacco.

Introduction

The global disease burden of alcohol, tobacco and illicit drug use
Alcohol, tobacco and illicit drug use together pose a formidable challenge to international public health. Whether expressed in epidemiological, economic or social terms, the combined burden or impact of these three lifestyle behaviours is enormous. Rates of use or consumption of course vary across countries and indeed whole regions of the world, both in terms of absolute aggregate burden and in terms of the relative contribution of alcohol, tobacco and illicit drug use to these aggregated estimates, but nowhere could be said to be at all free of the often pernicious consequences placed on society by these lifestyle behaviours.

Studies of the economic and social impact of substance abuse are plentiful in number, but are essentially restricted to high-income countries which, together with significant differences in the methodology used to estimate costs, limit their usefulness at the global level. Nevertheless, country-specific studies have demonstrated the enormous toll on health and welfare services, as well as broader social impacts including reduced productivity resulting from morbidity or premature mortality, and the effects of alcohol or illicit drug use on rates of domestic violence or criminal behaviour [1 – 3]. For example, Single et al. [1] estimated that the misuse of alcohol, tobacco and illicit drugs cost more
than Canadian $18.4 billion in 1992, representing $649 per capita or 2.7% of gross domestic product.

At a more genuinely global and comparative level, the World Health Organisation has quantified the epidemiological burden associated with alcohol, tobacco and illicit opioid use as risk factors for disease in different regions of the world using disability-adjusted life-years (DALYs) [4]; see also the review by Rehm et al., this issue. Figure 1 shows the combined burden for three mega-regions: developed regions with very low child and adult mortality (representing 22% of the world’s population); developing regions with low child and adult mortality (39%); and developing regions with high or very high child and adult mortality (39%). Even at this highly aggregate level of estimation, it is clear that the burden—70% of which is incurred among the (adolescent and adult) male population—represents a public health challenge everywhere, even in high-mortality developing regions (4% of total burden).

It is arguably in this latter groups of countries, where fledgling markets are strongest and regulatory structures weakest, that most attention should be paid to controlling rates of hazardous drinking and preventing the transition to more elevated stages of the tobacco epidemic.

Reducing the global burden of alcohol, tobacco and illicit drug use

Once the attributable burden of alcohol, tobacco and illicit drug use has been established, two subsequent questions for decision-making and priority-setting relate to avoidable burden (the proportion of attributable burden that could be avoided via scaled-up use of effective strategies; [5]) and resource efficiency (determining the most cost-effective ways of reducing burden).

Building on earlier methods and estimates of the epidemiological burden of addictive substances at the global level [4–6]; see also Rehm et al., this issue), this review aims to consider the comparative cost-effectiveness of evidence-based interventions for reducing the global burden of disease from these three risk factors. Concerning illicit drug use, cannabis use accounts for around 80% of illicit drug use world-wide, but the focus here is on opioid dependence, because it represents the major illicit drug problem in most regions of

![Figure 1. Global disease burden attributable to addictive substances in 2000 (DALYs per thousand population, by level of development, sex and risk factor). There may be double counting due to interactions in causing some cancer and injury categories. Thus, the combined estimates of adding the burden of all three substances represent an overestimate. However, the impact of the categories affected by double counting on the overall estimate is relatively small. For Australia in 1998–99, it was estimated that double counting lead to an overestimate of 2.2% of the total mortality caused by addictive substances [3]. Based on this estimate, the overall effect of alcohol, tobacco and illicit drugs would be 20.19 DALYs lost per 1000 population rather than 20.64 as indicated in the figure (last column). Source: Annex Tables 10 and 12, World Health Report, 2002 [4].]
In order to achieve this aim, a fundamental analytical requirement is the presence of a standardised evaluative methodology which can be used to generate consistent estimates of cost, effect, or their interaction in terms of cost-effectiveness. Such a standardised method has been hard to attain, which has effectively confounded attempts to systematically compare the efficiency of different interventions across or even within the three risk factors considered here. As illustrated below, however, such a method is now available, as a result of developments in the health sector-wide analysis of cost-effectiveness, and it has been applied to a number of key alcohol and tobacco control strategies [8,9]. Preliminary use of these methods also has been partially extended to the treatment of opioid dependence, results from which are included here. Analyses such as these mean that like-with-like comparisons of the relative efficiency of preventive or individual-based strategies are now technically feasible, not only within but also across diseases or their risk factors. While such a development avoids many of the obstacles that have plagued earlier attempts and in so doing opens up new opportunities to address important policy questions, there remain a number of important caveats to population-level analysis of this kind, particularly when conducted at the global level. These issues are the subject of the final section of this review.

Current cost-effectiveness methods and results for addictions policy

Current economic evidence related to addictive substances

In the necessarily brief review of the accumulated literature to date that now follows on the cost-effectiveness of interventions for reducing the burden of tobacco, alcohol and opioid dependence, we distinguish between personal interventions—such as brief counselling, nicotine replacement therapy and opioid detoxification—and non-personal interventions such as excise taxation, advertising bans and clean indoor air laws, with a view to drawing out key empirical findings and methodological differences among studies.

Personal interventions

Alcohol. A distinction needs to be made between personal interventions targeted on the disease entity of alcohol dependence versus hazardous drinking (a risk factor for many diseases including but not restricted to alcohol dependence). Cost-effectiveness analysis of treatments for alcohol dependence have covered psychosocial treatments such as motivational enhancement therapy and medications such as acamprosate or disulfiram [10,11], but are not the focus for this review, which deals specifically with the globally more burdensome problem of hazardous or high-risk alcohol use.

The only personal intervention aimed at hazardous drinking that has been subjected to economic evaluation is brief advice or counselling by a primary care physician [12]. Using effectiveness results from the WHO’s Drink-less programme, Wutzke et al. [13] estimated the cost-effectiveness of different strategies for reducing alcohol consumption (in Australian dollars). Compared to a do-nothing scenario, the cost per life-year saved was estimated to be AUS $645 for a control group (no initial training or ongoing support), AUS $581 for a no-support group (5 minutes of initial training with no further contact or support) and AUS $653 for a maximal-support group (5 minutes training plus alternate telephone and personal visits every 2 weeks).

In a US primary care setting, Fleming et al. [14] undertook an economic evaluation of brief physician advice for problem drinkers, in which patient and health care costs were compared to the monetised benefits associated with reductions in emergency department and hospital use, crime and motor vehicle accidents (reductions in consumption, although substantial, were not monetised). Summing the total economic costs and benefits, the average benefit per subject was $1151 and the ratio of benefits to costs was more than 5 to 1.

Tobacco. Concerning tobacco control, a substantial evidence base exists for the cost-effectiveness of smoking cessation programmes (in high-income countries at least), covering brief counselling as well as pharmacological interventions such as bupropion and various nicotine replacement therapies (NRT). A recent systematic review included no less than 17 economic studies [15], and concluded that between 1 and 3 life-years are saved per quitter, each of these additional years of life achieved at quite a low cost (below £1000 for NRT versus current practice, for example).

A number of studies have adopted a decision-analytical framework in order to demonstrate the impact of improved rates of cessation on mortality and morbidity and to extend comparison beyond a placebo control group. For example, a decision model was developed for the UK’s National Health Service, which showed that by comparison to advice or counselling alone, an extra year of life saved could be obtained at an additional cost of $1441 – 3455 for NRT, $920 – 2150 for bupropion and $1282 – 2836 for their combination [16]. More recently a dynamic population model applied to a Dutch population compared the net cost (adjusted for savings from avoided smoking-related diseases) per life-year and QALY gained over 1, 10 and 75 years for telephone counselling, minimal and intensive counselling by a primary care physician, NRT and bupropion [17].
With the exception of telephone counselling (which was expected to be both less costly and more effective than current practice), incremental cost-effectiveness ratios were found to fall within a similar range ($1400 – 6200 per life-year gained, $1100 – 4900 per QALY gained).

Comparison of smoking cessation interventions to other, non-personal interventions has rarely been attempted, although one recently completed study did compare the cost per QALY of NRT ($4400) with a smoke-free policy in the workplace ($506) [18].

**Opioid dependence.** A wide range of approaches to assisting dependent heroin users are available and include detoxification and relapse prevention treatment programmes, therapeutic communities, out-patient drug-free counselling and long-term opioid substitution (or maintenance).

Using results from the National Evaluation of Pharmacotherapies for Opioid Dependence (NEPOD) Project in Australia, a cost-effectiveness analysis has compared five in-patient and out-patient detoxification methods [19]. The buprenorphine-based out-patient detoxification method was found to be the most cost-effective method overall, and rapid opioid detoxification under sedation was the most cost-effective inpatient method. Also in Australia, Doran et al. [20] compared the cost-effectiveness of detoxification from heroin using buprenorphine in a specialist clinic and in a shared-care setting, and found that buprenorphine detoxification in the shared-care setting was $17 more expensive per patient than the costs of treatment at the clinic ($236 per patient), but with no significant differences in outcomes.

The limited economic evaluations of drug-free treatment have used data from observational studies of treatment outcomes in samples of patients with mixed substance abuse problems, including opioids. For example, one US study calculated a range of estimated costs for achieving an abstinence year in 408 patients treated at two different treatment facilities in the United States [21]. For out-patients with the least severe drug problems, the cost of an abstinence year was $7000, whereas the same outcome in patients with more severe problems who received long-term residential treatment cost $20 000.

Concerning the cost-effectiveness of substitutive maintenance treatments for opioid dependence, Doran et al. [2] conducted a cost-effectiveness analysis of buprenorphine maintenance treatment (BMT) versus methadone maintenance treatment (MMT), using change in heroin-free days as the primary outcome measure, and concluded that buprenorphine provides a viable and cost-effective alternative to methadone in the treatment of opioid dependence. The National Evaluation of Pharmacotherapies for Opioid Dependence (NEPOD) also evaluated a range of maintenance treatments. The results of the cost-effectiveness analysis suggest, for the primary outcome measure of change in heroin-free days, that LAAM (levo-alpha-acetyl-methadol) and MMT are statistically equivalent in terms of cost-effectiveness while MMT (and LAAM) are dominant treatment options compared with BMT and naltrexone [23]. Finally, Barnett et al. [24] measured the cost-effectiveness of addiction treatment in terms of life-years gained or quality-adjusted life-years and demonstrated that MMT and BMT are cost-effective treatment options under certain conditions.

**Non-personal interventions**

While there is a considerable literature documenting the social and economic costs of substance abuse, economic analysis of the relative cost-effectiveness of different policy instruments has rarely been attempted, hampered by the lack of population-level data on the costs of their implementation or their expected impact on health outcomes. An exception to this general statement is a comparative analysis of the cost-effectiveness of price increases and other policies undertaken as part of a World Bank report on the economics of tobacco control [25]. The authors of this study used a static model to estimate the number of smoking-attributable deaths that could be averted by price increases (via tax), NRT and a package of other non-price interventions such as advertising bans and information dissemination [26]. Cost-effectiveness was expressed in terms of US dollars per DALY saved, calculated by weighing approximated public-sector costs against the years of health life saved. Price increases were found to be the most cost-effective intervention ($3 – 70 per DALY saved in low- and middle-income regions of the world, $83 – 2771 in high-income countries), considerably more cost-effective in fact than either NRT ($280 – 870 and $750 – 7206, respectively) or a package of other non-price interventions other than NRT ($36 – 710 and $696 – 13 924, respectively). Although this study goes beyond others in its attempt to generate economic evidence relevant to policy-makers, it is heavily undermined by its assumption that the costs of non-personal interventions can be expressed adequately as a fraction of GNP (0.005 – 0.02%).

**Methodological limitations of the current economic evidence base**

Although the number of published cost-effectiveness studies in the addictions field is now extensive, briefly and not at all comprehensively reviewed above, there are a series of practical problems in using them for sector-wide decision making [27,28]. The first is that most published studies take an incremental approach, addressing questions such as how best should small changes (almost always increases) in resources be
allocated, or whether a new technology is more cost-effective than the existing one it would replace. Traditional analysis has not been used to address whether existing health resources are allocated efficiently, despite evidence that in many settings current resources do not in fact achieve as much as they could [29,30].

The second problem is that most studies are very context-specific. The efficiency of additional investment in an intervention aimed at a given health problem depends partially on the level and quality of the existing health infrastructure (including human resources). This varies substantially across settings and is related to a third problem—individual interventions are almost always evaluated in isolation despite the fact that the effectiveness and costs of most will vary according to whether other related interventions are currently undertaken or are likely to be introduced in the future.

A fourth methodological limitation all too apparent from the cursory review above relates to the multiplicity of health outcome measures used, ranging from the very specific (change in heroin-free days, for example) to the very generic (life-years saved or quality-adjusted life-years gained). This makes it quite impossible to compare the efficiency of different interventions against a common standard. Related to this is the decision to include or exclude other, non-health outcomes, which is likely to alter radically the findings and implications of an economic evaluation. By including and measuring in monetary terms the consequences of brief physician advice on the incidence of criminal acts and road traffic collisions, for example, Fleming et al. [14] provide a very different perspective—a cost–benefit approach—and set of findings to studies that only considered direct health effects of brief interventions.

Two final concerns relate to uncertainty and scale effects. Although there is now increasing attention given to uncertainty in the theoretical literature on cost-effectiveness analysis, full and appropriate handling of uncertainty in published economic evaluations is still not reported in a majority of studies [31]. This makes it unclear how certain policy-makers can be that one intervention is more efficient than another. Uncertainty when interventions are inter-related in terms of costs and effects is an even more complex issue. Similarly, analysts rarely estimate costs and effects at different levels of coverage or scale, so do not provide policymakers with important information about how far they should expand (or contract) an intervention.

**New developments in the generation of economic evidence for addictions policy**

*Cost-effectiveness methodological framework*

Until quite recently, there had been only a limited connection made between disease burden estimates and the generation of cost-effectiveness evidence, despite this being an overall objective of the Global Burden of Disease study. In response to this need, WHO developed a form of economic evaluation called generalised cost-effectiveness analysis (GCEA), which—via its CHOICE project (CHOosing Interventions that are Cost-Effective)—was designed to allow policy-makers to evaluate the efficiency of the mix of health interventions currently available and to maximise the generalisability of results across settings [32,33]. At the same time, it sought to rectify some of the aforementioned problems of traditional CEA by incorporating interactions between interventions in terms of costs and effects as well as by evaluating interventions at different levels of coverage. GCEA allows for an assessment of the efficiency of the current mix of interventions by analysing all interventions and combinations incremental on doing nothing, sometimes referred to as a null or ‘do nothing’ scenario [32,33]. This does not mean assuming that no interventions were ever undertaken, something that is not feasible or necessary. Operationally, the counterfactual that has been adopted in applied studies is defined in terms of what would happen to population health if all interventions being provided now were stopped [8,9,34].

Consider Figure 2, in which two sets of interventions are depicted, one for reducing exposure to hazardous alcohol use, the other for reducing exposure to tobacco use, for a region consisting of Latin American and Caribbean countries with low levels of child and adult mortality—designated here as AmrB ([8,9]; underlying data are also provided in Table 1). The vertical axis is the yearly cost of the intervention in a standardised population of 1 million people, in international dollars, while the horizontal axis measures health improvements in terms of disability-adjusted life-years (DALYs) averted. If a country could select its interventions from scratch and if efficiency were the only objective, it would first choose the intervention with the lowest slope first, the lowest cost per unit of health effect (TOB4, a high rate of taxation on tobacco products). As resources increase it would move to TOB12 (a combination of excise tax plus a comprehensive advertising ban), as the slope of the line TOB4 to TOB12 is lower than that from the origin to ALC6. Should more resources become available, it would also purchase ALC6 (a high rate of tax on alcoholic beverages), the most cost-effective intervention for reducing hazardous alcohol use, and this process continues.

Let us assume, however, that a country decided not to tax alcohol products, relying instead on the enforcement of drink-driving laws via random breath-testing of drivers (ALC3). Traditional incremental analysis would suggest that if new resources became available, it would be most efficient to move from ALC3 to ALC2 (brief physician advice for heavy drinkers), and then to the...
combination of these (ALC9). Without reference to a common starting point (of doing nothing), however, such an analysis fails to identify that ALC3 is an inefficient use of resources compared to other single or combined interventions for alcohol or tobacco control, thereby providing decision makers with incomplete and potentially misleading information.

Accumulated cost-effectiveness evidence for addictive substances

Generalised CEA has been applied to a range of personal and non-personal interventions for reducing the burden of addictive substances. Details of the methods and data sources employed in the calculation of population-level costs and effects can be found elsewhere [4,8–9,35,36]. Here, we summarise these methods only very briefly, and then provide results for three illustrative WHO sub-regions, each representing one of the distinct levels of economic development used earlier in relation to disease burden: American sub-region AmrB (countries with low rates of child and adult mortality, for example Brazil or Mexico); European sub-region EurA (countries with very low child and adult mortality, for example France or Norway); and South East Asian sub-region SearD (countries with high child and adult mortality, for example India or Nepal).

Analyses of alcohol and tobacco control strategies used standard WHO—CHOICE methods and tools, whereby burden averted via the implementation of evidence-based interventions was compared to a counterfactual scenario of no intervention using a state transition population model [33]. Costs were estimated using a bottom-up, ingredients approach built up from the prices and quantities of resources needed at the programme-level, and where appropriate (e.g. nicotine replacement therapy, brief interventions for heavy drinkers) at the patient- or facility-level. Cost-effectiveness analysis of opioid dependence treatments was carried out as part of the second edition of Disease Control Priorities in Developing Countries [30], which overlaps closely with CHOICE methodology but uses US rather than international dollars to report costs and removes age-weights from the estimation of DALYs. Here, all costs are expressed in international dollars (I$)—which seek to adjust for differences in purchasing power and thereby facilitate comparisons across settings—and, along with DALYs, are discounted at a rate of 3%. Age-weights were not applied to health effects for the present analysis, but previous analyses have shown that over 20% more DALYs are averted when these are used, due to the fact that substance use is highest among people of working age [8,9].
### Table 1. Comparative costs, effects and cost-effectiveness of interventions for reducing the burden of alcohol, tobacco and illicit drug use in three WHO sub-regions (at different levels of economic development)

<table>
<thead>
<tr>
<th>WHO sub-region</th>
<th>Americas sub-region AmrB</th>
<th>Europe sub-region EurA</th>
<th>South East Asia sub-region SearD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coverage</td>
<td>Cost per 1m per year (I$)</td>
<td>DALYs per 1m per year</td>
</tr>
<tr>
<td>Hazardous Alcohol Use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALC-2: Brief physician advice</td>
<td>50%</td>
<td>626,541</td>
<td>807</td>
</tr>
<tr>
<td>ALC-3: Random Breath Testing</td>
<td>80%</td>
<td>586,843</td>
<td>306</td>
</tr>
<tr>
<td>ALC-4: Excise tax (current)</td>
<td>95%</td>
<td>237,535</td>
<td>653</td>
</tr>
<tr>
<td>ALC-5: Excise tax (current + 20%)</td>
<td>95%</td>
<td>237,535</td>
<td>728</td>
</tr>
<tr>
<td>ALC-6: Excise tax (current + 50%)</td>
<td>95%</td>
<td>237,535</td>
<td>799</td>
</tr>
<tr>
<td>ALC-7: Reduced retail access</td>
<td>95%</td>
<td>150,308</td>
<td>310</td>
</tr>
<tr>
<td>ALC-8: Comprehensive ad ban</td>
<td>95%</td>
<td>143,724</td>
<td>268</td>
</tr>
<tr>
<td>ALC-9: Combination (ALC2 + ALC3)</td>
<td>95%</td>
<td>1,152,715</td>
<td>1,091</td>
</tr>
<tr>
<td>ALC-10: Combination (ALC6 + ALC8)</td>
<td>95%</td>
<td>694,039</td>
<td>563</td>
</tr>
<tr>
<td>ALC-11: Combination (ALC3 + ALC8)</td>
<td>95%</td>
<td>967,488</td>
<td>1,818</td>
</tr>
<tr>
<td>ALC-12: Combination (ALC2 + ALC3 + ALC6 + ALC8)</td>
<td>95%</td>
<td>1,514,910</td>
<td>2,093</td>
</tr>
<tr>
<td>Tobacco Use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOB-2: Excise tax (80% supply price)</td>
<td>95%</td>
<td>74,532</td>
<td>1,442</td>
</tr>
<tr>
<td>TOB-3: Excise tax (300% supply price)</td>
<td>95%</td>
<td>74,532</td>
<td>3,225</td>
</tr>
<tr>
<td>TOB-4: Excise tax (600% supply price)</td>
<td>95%</td>
<td>74,532</td>
<td>6,051</td>
</tr>
<tr>
<td>TOB-5: Clean indoor air law</td>
<td>95%</td>
<td>279,171</td>
<td>233</td>
</tr>
<tr>
<td>TOB-6: Comprehensive ad ban</td>
<td>95%</td>
<td>111,365</td>
<td>363</td>
</tr>
<tr>
<td>TOB-7: Information dissemination</td>
<td>95%</td>
<td>233,992</td>
<td>435</td>
</tr>
<tr>
<td>TOB-8: Nicotine replacement therapy</td>
<td>50%</td>
<td>1,656,571</td>
<td>435</td>
</tr>
<tr>
<td>TOB-9: Combination (TOB4 + TOB7)</td>
<td>95%</td>
<td>308,523</td>
<td>4,717</td>
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<tr>
<td>TOB-10: Combination (TOB4 + TOB5 + TOB7)</td>
<td>95%</td>
<td>587,695</td>
<td>4,894</td>
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<tr>
<td>TOB-11: Combination (TOB4 + TOB6 + TOB7)</td>
<td>95%</td>
<td>419,888</td>
<td>4,994</td>
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<tr>
<td>TOB-12: Combination (TOB4 + TOB6 + TOB7)</td>
<td>95%</td>
<td>185,897</td>
<td>6,635</td>
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<tr>
<td>TOB-13: Combination (TOB4 + TOB5 + TOB6)</td>
<td>95%</td>
<td>465,068</td>
<td>6,329</td>
</tr>
<tr>
<td>TOB-14: Combination (TOB4 + TOB5 + TOB6 + TOB7)</td>
<td>95%</td>
<td>699,060</td>
<td>5,168</td>
</tr>
<tr>
<td>TOB-15: Combination (ALL)</td>
<td>95%</td>
<td>2,355,631</td>
<td>5,490</td>
</tr>
<tr>
<td>Illicit Drug Use (Opioids)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRG-1: Methadone maintenance</td>
<td>50%</td>
<td>111,184</td>
<td>243</td>
</tr>
<tr>
<td>DRG-2: Buprenorphine maintenance</td>
<td>50%</td>
<td>135,856</td>
<td>228</td>
</tr>
</tbody>
</table>

Sources: Alcohol: Chisholm et al., 2004 ([9]; adjusted to remove the effect of age-weighting); tobacco: Shibuya et al., 2003 ([8]; adjusted to remove the effect of age-weighting); illicit drug use: Hall et al., 2006 [36].
Alcohol use

Intervention analysis carried out to date relates to the risk factor hazardous (or heavy) alcohol use—defined as an average rate of consumption of more than 20 g pure alcohol daily for women and more than 40 g daily for men [37,38]—which represents at least 75% of the total attributable burden associated with alcohol use [35].

Recent reviews of measures to reduce alcohol misuse [12,38] assessed the quality of evidence for four types of interventions specifically aimed at reducing high-risk alcohol use: (1) policy and legislative interventions, including taxation on alcohol sales, drunk-driving laws, restricted licensing outlets and advertising control; (2) measures to enforce these laws more effectively, for example random breath-testing of drivers; (3) mass media/awareness campaigns; and (4) brief interventions with individual high-risk drinkers. Based on these reviews, the following strategies and intervention effects were included in the analysis [9]: drinking-driving legislation and random breath testing, taxation on alcoholic beverages, reduced hours of sale in retail outlets, and advertising bans (all population-based interventions) and so-called brief interventions (an intervention based on personal behaviour). Mass media or school-based awareness campaigns were omitted, on the grounds that evidence for its effectiveness was weak, both in terms of methodological quality and in terms of their actual effect on consumption (use of such interventions, however, may still be used to generate awareness or address the right to be informed) [12,38,39].

Results for three illustrative WHO sub-regions are presented in Table 1. There are very substantial differences in costs and effects (standardised to 1 million population), both between interventions and between the three sub-regions. The most costly interventions tend to be random breath testing (due to the need for regular sobriety checkpoints administered by law enforcement officers) and brief advice in primary care (provision of the intervention itself, plus programme costs associated with training). Other interventions including taxation had a cost per capita in the range US$ 0.04–0.45, depending in part on the efficiency of the taxation collection system and the degree of anti-drinking sentiment. Where the prevalence of heavy drinking is high (more than 5% of the total adult population, as in Americas sub-region AmrB and European sub-region EurA) taxation was the most effective and cost-effective strategy (each DALY averted costs less than US$ 500). By contrast, tax is actually least effective and efficient in South East Asia sub-region SearD, where low rates of heavy consumption appear to favour more targeted approaches such as breath-testing and brief physician advice.

Tobacco use

Countries that have adopted comprehensive tobacco control programmes—involving a mix of interventions including a ban on tobacco advertising, strong warnings on packages, controls on the use of tobacco in indoor locations, high taxes on tobacco products and health education and smoking cessation programmes—have had considerable success in reducing tobacco-related mortality [25,40]. The costs and effects of each of these strategies have been assessed [4,8]. Concerning taxation, three rates were evaluated: the current average level across six WHO regions (a 79% mark-up), the current maximum observed across these regions (a mark-up of 300%) and double the current maximum (a mark-up of 600% corresponding to a situation where taxes account for 89% of the final retail price).

The benefits of anti-smoking interventions for population health (in terms of DALYs) were estimated through the impact of reduced smoking on the incidence of cardiovascular disease, respiratory disease and various forms of cancer. The interventions, not surprisingly, have a larger impact on population health in regions with a high prevalence of tobacco use, especially those in the second or third stage of the tobacco epidemic (including Americas sub-region AmrB and South East Asia sub-region SearD).

As with alcohol control strategies, but to a much lesser extent, costs and cost-effectiveness vary across the three sub-regions shown in Table 1, not only because of variations in exposure to tobacco but also differences in the efficiency of the tax collection system, the degree of anti-tobacco sentiment and the amount of smuggling. If only one intervention can be chosen, taxation is the intervention of choice in all regions. Not only does it have the greatest impact on population health, but it is also the most cost-effective option (one DALY is averted at a cost of less than US$ 100). Taxation also raises revenue for governments. To achieve greater improvements in population health, the combination of taxation, comprehensive bans on advertising, and information dissemination activities would be affordable and cost-effective in all of the sub-regions illustrated here. Although nicotine replacement therapy is not a very cost-effective intervention, and would considerably add to the cost of other anti-smoking activities, the additional expense would be justified on purely cost-effectiveness grounds in higher-income sub-regions.

Opioid dependence

Concerning the potentially avoidable disease burden from opioid dependence, two pharmacological maintenance treatments have been assessed using a cost-per-DALY method (methadone and buprenorphine; MMT and BMT). Oral methadone maintenance treatment
(MMT) substitutes a long-acting, orally administered opioid for (the shorter-acting) heroin, with the aim of stabilising dependent heroin users so that they are amenable to rehabilitation. Buprenorphine is a mixed agonist–antagonist that also blocks the effects of heroin. Meta-analyses have found that buprenorphine is effective in the treatment of heroin dependence [41] and of equivalent efficacy to MMT when delivered in primary health care and specialist treatment settings in Australia [42].

For the disease modelling exercise, prevalence data and population attributable fractions related to opioid dependence were taken from the comparative risk assessment [43]. Using a baseline treatment coverage rate of 50%, maintenance treatment is estimated to reduce the average level of disability associated with opioid dependence by a quarter, and mortality by 25% (methadone) and 20% (buprenorphine), respectively [36]. Cost estimates were based on an earlier economic evaluation [22], which estimated the cost of MMT at AUS $1415 and BMT at AUS $1729 for 6 months of treatment. These estimates were subsequently converted into international dollars and annual estimates of treatment cost.

Results are presented in Table 1. There are again quite wide discrepancies in DALYs averted between regions, which primarily reflect differences in population attributable fractions. The cost-effectiveness analysis suggests that for MMT the cost per DALY averted ranges from a low of I$ 458 in America’s sub-region AmrB to more than I$ 2500 in South East Asia sub-region SearD. Because the methods and data used to estimate avoidable DALYs are subject to certain limitations (see Discussion), the results should be considered preliminary.

**Sectoral comparison of intervention cost-effectiveness for addictions control**

Use of a standardised approach to the evaluation of costs and effects provides the opportunity to make like-with-like comparisons of interventions across different health conditions. Figure 3 depicts the costs, effects and cost-effectiveness of selected interventions for reducing alcohol, tobacco and drug use for one of the regions discussed above, WHO European sub-region EurA (countries with a combined population of 410 million that have very low rates of child and adult premature mortality). Here, costs and effects are plotted on a logarithmic scale in order to provide a 'bird’s eye' view of the comparative cost-effectiveness of the various

![Figure 3. Costs, effects and cost-effectiveness of selected interventions for reducing alcohol, tobacco and drug use in WHO European sub-region EurA. Note: Perforated diagonal lines are cost-effectiveness isoquants, each of which represents one order of magnitude difference in the cost associated with one averted DALY. For example, interventions falling below the isoquant closest to the south-east corner have a cost-effectiveness ratio below I$ 100 per DALY averted. Source: see Table I.](image-url)
strategies. Each diagonal isoquant represents one order of magnitude difference in cost-effectiveness terms, ranging in this instance from I$ 100 – 10 000 per DALY averted. While lacking precision, use of such a broad-brush perspective can usefully inform policy-makers about what really makes a difference and what does not, and in fact may represent a more appropriate information set than exact ratios given the inherent uncertainty surrounding point estimates of cost-effectiveness.

In this region of Europe, for example, total costs and total effects per 1 million population vary substantially (for example, cost per capita ranges from I$ 0.2 to more than I$ 4, while effects range from a few hundred to a few thousand DALYs). Taxation has the highest impact on population health and the lowest cost of implementation (cost per DALY < I$ 500), while personal interventions such as nicotine replacement therapy, brief physician advice and opioid maintenance treatment are the least cost-effective (cost per DALY > I$ 1000). Although such findings may appear intuitively obvious in a population with relatively high rates of substance abuse, this analysis provides some underlying evidence for these pre-sentiments.

Discussion

The limits and limitations of economic modelling

At the methodological level, the application of a broad sectoral approach using whole regions of the world as the unit of analysis clearly places important limits on its use in specific country contexts, as demographic, epidemiological or treatment characteristics may not coincide with estimates for the region as a whole. In addition, extrapolation of intervention effect sizes from relatively information-rich countries to other socio-cultural settings lessens the precision of derived estimates of population-level health gain. Work is now under way in a number of developed and developing countries to ‘contextualise’ regional estimates down to the national level, whereby local investigators replace regional epidemiological rates, cost estimates and effect sizes with locally derived values [28].

A further methodological issue that invariably courts its fair share of debate is the use of the DALY, both as a summary measure of population health and as a primary measure of intervention outcome [45]. Some of the most heated debate is around issues that can be rather easily dealt with (such as use or not of age weights and the preferred discount rate), but there remain important constraints concerning the scope of DALYs as an outcome measure, such as its inability to capture potential health gains beyond the person at-risk (such as informal caregivers). As a strictly health-related measure, by definition it is also not equipped to capture non-health outcomes, which in the context of substance abuse may constitute an important component of the relative superiority of one intervention over another.

On this note, there remain considerable challenges in the appropriate measurement of certain societal costs and effects falling outside the boundaries of the health system. Thus, the present analysis has not been able to capture potential reductions in (work-force and household) productivity losses among high-risk drinkers or illicit drug users, nor does it incorporate the economic costs associated with addiction-related crime, violence and harm reduction. Assuming these consequences could be measured and valued reliably, their inclusion within the evaluative framework of a comparative economic analysis would certainly shift the goal posts, particularly as the key consequences in question (e.g. property damage, violence, injuries) apply to alcohol and opioid use but not to tobacco use. Compared to analyses that only consider health benefits, their inclusion would also have the effect of enhancing the relative efficiency and policy attractiveness of these strategies vis-à-vis other potential areas of health investment that do not exhibit these negative spill-over effects. Building in part on previous developments in the area of costing the social costs of substance abuse [1 – 3], work is under way at WHO to develop internationally applicable guidelines and methods for measuring and valuing these non-health consequences.

Turning to measurement issues, it is important to note that despite the adoption of the same overarching methodological standards, there remains room for divergence in the analytical assumptions that can be and are made. Two examples relating to cost measurement and valuation will suffice here. First, as seen in Table 1 and Figure 3, there are quite notable differences in the costs of taxation policies for alcoholic versus tobacco products. These differences, which vary in magnitude across regions, can be accounted for by the fact that the assumed quantity of manpower and other resources needed to administer and enforce tobacco taxation were calculated before the adoption of a more generic set of WHO – CHOICE quantity assumptions for tax enforcement (which were used for the alcohol analysis). Secondly, and owing to the shortage of available data from low- and middle-income countries, opioid maintenance treatment costs are based on a single cost estimate from a cost-effectiveness study undertaken in Australia, subsequently extrapolated and adjusted to the relative price levels pertaining in other regions of the world. Such an approach evidently carries stronger assumptions than one based on a bottom-up analysis of quantities and their respective prices, and may lead to an under-estimation of the actual expected costs that would be incurred in significantly scaling-up the availability of opioid maintenance treatment in settings where this has yet to happen.
Although a sector-wide approach to cost-effectiveness analysis sets out to provide data on a wide range of interventions (including combination strategies), a number of potentially applicable interventions were not covered in this analysis because of lack of evidence. This is especially true for illicit drugs, where not only treatments of non-opioid substances were excluded, but also interventions aimed at preventing drug abuse (due in part to an inexact understanding of what components of a combined policy response have been successful). For example, Switzerland simultaneously witnessed a massive expansion of methadone maintenance treatment, the introduction of heroin-assisted treatment, a massive expansion of needle exchange, the opening of several safe injection facilities as well as changes in the way that repression activities were conducted [46].

A final constraint of sector-wide approaches is its emphasis on whole populations, which may be at the expense of sub-populations that are at particular risk (including adolescents and indigenous populations in countries such as Australia and the United States). There is, of course, nothing from a methodological point of view that precludes such a focus on sub-populations, but there remain gaps in both the epidemiology and intervention effectiveness literature for these selected groups.

Policy implications

The present analysis offers a novel approach to the generation of economic evidence capable of broadly informing substance abuse public health policy in a wide range of epidemiological settings. Resulting estimates of cost-effectiveness—pitched in order-of-magnitude terms—can inform policy-makers, not only in relation to the efficiency of existing strategies (with respect to health outcomes), but also by identifying priorities for substance abuse interventions in the future. In this respect, it should be noted that in each of the sub-regional populations considered, the most efficient interventions for responding to the three risk factors considered here are projected to show a favourable ratio of cost to effect (each DALY averted by these efficient strategies costs less than average annual income per capita, a threshold proposed by the Commission on Macroeconomics and Health for an intervention to be considered very cost-effective [47]). Furthermore, use of a common methodology enables some comparability with cost per DALY estimates for other risk factors or disease entities, which may constitute an important argument in considering priorities in the reallocation of scarce health care resources to increase levels of population health. Of course, if it is possible to achieve better standardisation of cost assessment, the comparability will be further improved.

A primary policy conclusion to be drawn from the analysis is that, in regions with high or moderate rates of tobacco and high-risk alcohol use, there are a number of intervention strategies that can have a notable impact on population health, including both individual-based interventions such as nicotine replacement therapy or brief physician advice as well as population-wide measures such as taxation of alcoholic or tobacco products. Of these, taxation has the most sizeable and least resource-intensive impact on reducing the avertable burden of tobacco and high-risk alcohol use. In regions where high-risk alcohol use represents less of a public health burden, other intervention strategies that restrict the supply or promotion of alcoholic beverages appear to be promising and relatively cost-effective mechanisms, although there is a clear need for greater empirical support for the efficacy of these interventions in these localities before their widespread implementation could be considered.

Another clear conclusion from this analysis is that governments have an important role in encouraging risk reduction strategies for legal substances. Clearly, many of the most cost-effective strategies are linked to government actions; this is not only true for taxation but also for strategies such as bans on advertisement, random breath testing or reduction of access to legal goods. Unfortunately, this often leads to a dilemma in the sense that the described governmental interventions, especially in the area of alcohol control, are often unpopular and face considerable resistance from the respective industries and their lobby groups [48]. As a result, governments faced with considerable harm caused by legal substances have often chosen the ‘way of least resistance’ and implemented less cost-effective measures such as mass-media campaigns [38,48].

In the area of illicit drug use, many of the cost-effective government options for reducing substance-related harm are not specifically relevant for the reason that illegal substances cannot be controlled via mechanisms such as taxation or advertisement bans. That does not mean, however, that governments should not plan interventions in other areas such as developing the most cost-effective repression strategies, nor does it mean that prevention and harm reduction is impossible. However, for future improvements there would be a need for not only more empirical evidence on various options (including consistent assessment of key non-health outcomes), but also a lesser role for ideologically motivated policy decisions.

Overall, substance abuse-related burden of disease and social harm could be further reduced by a considerable degree. This contribution tried to summarise the knowledge on the differential cost-effectiveness of various policy options. While the methodology was shown as promising, its further application to addictions policy is only likely to yield fruit if a wider
evidence base for the implementation of different interventions in less-resourced countries is established.

Disclaimer
The views expressed in this paper are those of the authors and not necessarily those of the World Health Organisation.

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