

Valuing intermediate outcomes: economic evaluation of young peoples' interventions

Kevin Marsh, Matrix RCL, August 2008.

kevin.marsh@matrixrcl.co.uk

Abstract

Rationale: The economic evaluation of young peoples' substance misuse interventions suffers from a number of challenges. Among these is the fact that the value of the intervention occurs in the long-term, beyond the period over which economic evaluations are normally conducted. In order to evaluate the value for money of interventions that target at risk youth, we need to know more about the value of alleviating young people's risk factors.

Objective: This paper attempts to model the long-term economic benefit due to the improved health, reduced criminal activity, and improved employment prospects that result from alleviating a range of young people's risk factors.

Method: Secondary data is used to construct a model that predicts the likelihood that young people with different risk factors will become problematic substance users later in life and will thus experience the health, crime and employment problems associated with being a problematic substance user. The value of alleviating young people's risk factors is then calculated by applying these probabilities to the impact that these outcomes have on quality of life (QALY) and the cost to the public sector of responding to these problems.

Results: The economic benefit to alleviating a number of risk factors are modelled, including various measures of substance misuse (including alcohol and tobacco use), negative family relationships, poor educational attainment, negative peer relationships, and other behavioural problems. The greatest value is obtained through stopping a young person from smoking cannabis more than 51 times per year, which results in a discounted public sector cost saving of c£14,000.

Conclusion: The paper establishes the value of alleviating a range of young peoples' risk factors. However, a number of simplifying assumptions are required in the process of constructing the model that tend to underestimate this value. Furthermore, the model is applied to a limited number of risk factors. Further research is required to improve the estimates produced by the model and expand the number of risk factors modelled.

Introduction

Young people aged between 16 and 24 years show the highest prevalence of illicit drug use in the UK, with 28% having used at least one illicit drug in the previous year¹. Misuse of substances is also increasingly common in younger people. In 2003, 8% of 11–15 year olds reported having taken volatile substances (gas / glue) in the preceding year².

Vulnerable young people aged 10–24 years report higher levels of illicit drug and substance misuse than their non-vulnerable peers and account for a disproportionate percentage of illicit drug users³. In the 2003 Crime and Justice Survey⁴, 24% of vulnerable young people reported using illicit drugs frequently during the preceding 12 months, compared to 5% of those who were not vulnerable. There were significantly higher levels of drugs use among young people who belonged to more than one vulnerable group compared to those belonging to just one vulnerable group.

There are significant direct and indirect health risks associated with the use of all psychoactive substances. The former range from nausea and anxiety to coma and death. Volatile substance misuse, in particular, carries a risk of sudden death. The latter include an increased risk of hepatitis or HIV infection (particularly with injecting drug use). Non-health costs associated with problematic substance misuse among young people include poor school attendance and educational attainment, social exclusion and disruption of the family or community.

The National Institute for Health and Clinical Excellence ('NICE' or 'the Institute') was asked by the Department of Health to develop guidance on public health interventions aimed at reducing substance misuse among vulnerable and disadvantaged young people. As part of the guidance development the economics team at Matrix RCL was commissioned to review the economic literature, and Liverpool John Moores University (LJMU) was commissioned to review the effectiveness literature⁵. The literature identified suffered from a number of limitations that reduced its ability to conclude regarding the cost-effectiveness of young peoples' interventions:

1 Chivite-Matthews N, Richardson A, O'Shea J et al. (2005) Drug misuse declared: Findings from the 2003/04 British Crime Survey. London: Home Office.

2 Department of Health (2005) Out of sight? Not out of mind: Children, young people and volatile substance abuse (VSA). London: Department of Health.

3 The 2003 Crime and Justice Survey (Becker & Roe 2005 – see below) identifies five vulnerable groups of young people: 'those who have ever been in care, those who have ever been homeless, truants, those excluded from school and serious or frequent offenders'.

4 Becker J, Roe S (2005) Drug use among vulnerable groups of young people: findings from the 2003 Crime and Justice Survey. London: Home Office.

5 NICE (2006), Rapid review of economic evidence of community-based substance misuse interventions for vulnerable young people; and NICE (2006), Community-based interventions for the reduction of substance misuse among vulnerable and disadvantaged young people. A rapid review.

- Multiple outcomes: community-based interventions aimed at vulnerable young people have a range of outcomes and outcome measures. It is difficult to determine which intervention is the most efficient when each intervention is measured using a different parameter.
- Natural units: it is difficult to conclude whether a policy is value for money using natural units, such as the number of young people at risk of exclusion from school, as it is difficult to know how much money we can justify spending in achieving this outcome.
- Intermediate outcomes: the timeframe of evaluations are generally much shorter than the timeframe over which the impact of policies are felt. For instance, substance misuse prevention may reduce the risk of school exclusion in the timeframe of the effectiveness study. This impact will in turn reduce the chance of substance misuse, which will reduce the chance that the young person will experience negative health outcomes, commit crimes and be unemployed. However, this longer-term impact will not be measured in the timeframe of the effectiveness study.

In order to overcome these challenges and facilitate the estimation of the cost-effectiveness of young peoples' interventions, Matrix RCL was commissioned to construct an economic model that predicted the long-term economic benefits resulting from short-term changes in a range of young person behaviours and risk factors. This paper presents the results of this modelling exercise. The next section outlines the structure of the model and the dataset employed to populate the model. The following section describes the results of the model. The final section discusses the limitations of the model.

The analysis presented in this paper was carried out by a team from Matrix Research & Consultancy ("Matrix"), with advice from Paul Dolan, Mike Drummond and Jenny McWhirter.

Method

A. Conceptual framework

Figure one outlines the conceptual model employed to assess the cost-effectiveness of interventions aimed at improving young peoples' behaviour and alleviating their risk factors. The model describes five steps in delivering economic benefit from such interventions:

- a. Vulnerable young people receive an intervention, which impacts on their risk factors ($P_{t1} - P_{c1}$).
- b. Such risk factors are associated with the likelihood that young people use substances (rr_{ypsm}).
- c. Using substances as young people is associated with problematic substance misuse in later life (rr_{psm}).

- d. Problematic substance misuse is associated with a range of negative health effects (rr_{hiv} , rr_{hepB} , rr_{hepC} , rr_{mh}), criminal activity (rr_{off}), unemployment (rr_{emp}) and use of treatment services (rr_{tr}).
- e. Each of these health, criminological and social welfare outcomes is associated with a public sector cost (C_{hiv} , C_{hepB} , C_{hepC} , C_{mh} , C_{emp} , C_{off} and C_{tr}) and an impact on the substance misusers quality of life (Q_{hiv} , Q_{hepB} , Q_{hepC} , Q_{mh} and Q_{off}).

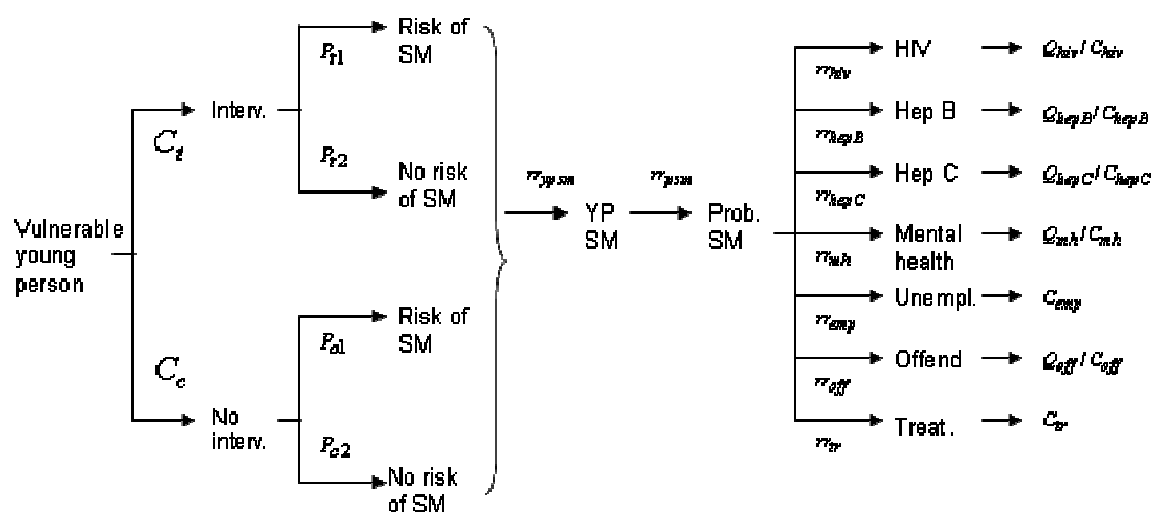


Figure 1: conceptual model of the cost-effectiveness of young peoples' substance misuse interventions

The review of effectiveness undertaken by LJMU measured the change in risk factors resulting from young people attending interventions. This paper focuses on the economic model element of the research, which attempted to model the long-term economic benefits of these changes in risk factors. The remainder of this methods section outlines the process undertaken to populate the above model.

B. Identification of data on the relationship between risk factors and problematic substance use

The literature cites a myriad of factors that are related to an increased risk of substance misuse amongst young people⁶. The most obvious of these is that misusing substances today makes someone more likely to do so again in the

⁶ See for example Harrison, P.A (2001), Sullivan, T.N & Farrell, A.D (2002) and Toumbourou, J.W & Catalano, R.F (2005).

future. The remaining factors can be broadly captured under the following three headings:

- **Biological factors:**
 - substance misuse in the family is a significant risk factor, and addictions tend to be clustered within certain families;
 - attention deficit/hyperactivity disorder (ADHD) is associated with substance misuse in later life. If a young person also suffers from conduct disorder then the risk is greater still;
 - young people with mental health difficulties are a high risk group. Depression, post-traumatic stress disorder, anxiety, psychopathology and bulimia have all been linked to substance misuse; and
 - men are more at risk than women, but it is not clear if this is because of biological or social reasons.

- **Psychological factors:**
 - those with low self esteem are more predisposed to abusing substances;
 - young people with a 'difficult' temperament (e.g. those with short spans of attention, withdrawn, easily distracted) have a higher chance of misusing substances as they mature. Similarly, those with less executive cognitive functioning are at risk;
 - sensation-seekers and risk-takers tend to misuse substances more than their peers.

- **Socio-environmental factors**
 - the level of substance misuse amongst an adolescent's peers has been linked to the likelihood of that young person moving on to more dangerous substances;
 - the relationship between young people and their parents is also important. Turbulent households, a weak attachment to their parents, a lack of warmth from parents, inconsistent discipline, and one parent families have all be related to a higher probability of misusing substances;
 - children performing poorly at school, who are frequently absent or have dropped out of school are at risk of misusing substances; and
 - traumatic events make a young person more likely to misuse substances. For instance, physical or sexual abuse, witnessing violence, the arrest or incarceration of parents, failing at school, parental unemployment and serious family illness have all be related to an increased chance of substance misuse.

In line with the definition adopted by Godfrey et al (2002)⁷, for the purposes of this analysis, problematic substance use is defined as heroin use, crack use, and heavy cocaine use, as it is expected that it is the use of these substances that will have the greatest cost to society⁸. The model therefore focuses on predicting the impact of changes in young person's risk factors on heroin, crack and heavy cocaine use. This simplification leads to the underestimation of the economic impact of improving young people's risk factors. For instance, it ignores solvent use.

The project did not have sufficient scope to systematically search the literature on the risk factors that predict problematic substance misuse. Instead, the following strategy was used to identify data:

- A number of key websites were searched:
 - Websites: Drugscope, Home Office, and the National Institute on Drug Abuse;
 - Terms used: adolescen* or child* or youth or teenage* or student* or young
- The knowledge of the team and other Matrix consultants, as well as the experts advisors to the project were used to identify other relevant papers and studies; and
- A snowballing strategy was used to identify relevant papers from the references in those already obtained.

Epidemiological data was extracted from the literature, as long as it met one methodological criteria: the studies had to involve the use of multiple regression modelling techniques to control for the influence of factors that might confound the relationship between youth substance misuse / risk of substance misuse and problematic substance misuse. A summary of the data identified is available in appendix one.

Whilst the epidemiological studies are selected based on the quality of their methodology, there is still likely to be methodological differences between the studies used. In using data from different studies, it is therefore necessary to assume that the estimates of the chance of problematic substance use extracted from the studies are comparable.

The result of the literature search was the identification of two categories of epidemiological studies:

7 Godfrey, C. et al. (2002) The economic and social costs of Class A drug use in England and Wales, 2000, Home Office Research Study 249

8 This definition of problematic substance use differs from that used in the effectiveness review (NICE (2006), Community-based interventions for the reduction of substance misuse among vulnerable and disadvantaged young people. A rapid review.). The reason for the adoption of this definition is that it is the definition used by Godfrey et al (2002) in their analysis of the economic and social costs of substance use. The analysis drew heavily on this source, as this was the most advanced source of data on the economic costs of substance use available. It therefore made sense to adopt Godfrey et al's definition of problematic substance use.

- Studies relating youth risk factors (education, family relationships) with youth substance misuse; and
- Studies relating youth substance misuse and problematic substance misuse.

Figure two summarises the data on the predicted probability of being a problematic substance user as a result of changes in youth risks and behaviours.

The majority of the data on the chance of problematic substance use identified in the epidemiological studies related to heavy cocaine use. In the absence of data on the factors that predict heroin or crack use (the other substances that make up our definition of problematic substance misuse), it was necessary to assume that the chance of heavy cocaine use can be used as a proxy for the chance of problematic substance use more generally (heroin, crack and heavy cocaine use).

If we assume that the chance of heroin use, crack use, and heavy cocaine use is to some extent independent of each other, using heavy cocaine use as a proxy for problematic substance use likely underestimates the chance of problematic substance use.

Change in risk factor / youth substance misuse	Increase probability of being a heavy cocaine user
Smoke cannabis 51+ times in last yr v. not smoke cannabis	0.1149
Smoke cannabis 11-50 times in last yr v not smoke cannabis	0.0702
Smoke cannabis 3-10 times in last yr v not smoke cannabis	0.0503
Smoke cannabis 1-2 times in last yr v not smoke cannabis	0.0233
Low vs middle level schooling	0.0076
Middle v high level schooling	0.0089
Grade point average <8 v >9	0.0052
First use alcohol before 13 v after 13	0.0017
Use alcohol versus not use alcohol	0.0106
Delinquency v not	0.0184
First use cannabis before 16 v after	0.0083
First use cigarettes before 13 v after	0.0032
Smoke cigarettes v not	0.0227
Mother use cannabis v not	0.0558
Father use cannabis v not	0.0270
Mother smoke cigarettes v not	0.0080
Mother not affectionate	0.0085
Father not discipline young person v does	0.0058
Mother not live at home v does	0.0235
Depressed v not	0.0043
Peers smoke cigarettes	0.0136
Peers use cannabis	0.0212
Peers deviant v not	0.0130
Rebellious v not	0.0150
Sensation seeking v not	0.0125

Figure 2: predicted probability of problematic substance misuse⁹

C. Identification of data on the consequences of problematic substance use

Problematic substance use is associated with a range of consequences that infer costs to society. Culyer et al (2002), distinguish between the direct and indirect costs of problematic substance misuse¹⁰:

- Direct costs:
 - costs for users: health, alienation, dependency, poverty; and
 - reactive costs: health care, social care, social security, CJS.

⁹ Youth risk factors are used to predict the likelihood of cannabis use. This likelihood is then combined with the likelihood of being a heavy cocaine user to estimate the impact of risk factors on the likelihood of being a heavy cocaine user. In order to combine these two sets of data, it is assumed that the cannabis use predicted to result from changes in risk factors is from not smoking cannabis to smoking cannabis 11-50 times a year.

¹⁰ Culyer, A. et al (2002), Economic and Social Cost of Substance Misuse in the United Kingdom. University of York: Centre for Criminal Justice Economics and Psychology.

- Indirect costs:
 - costs for users: work / productivity, education, driving, crime
 - costs for family and carers: financial, time spent caring, communicable diseases, anxiety and stress, poor parenting, lifestyle transmission; and
 - costs for wider society: property crime, crime against the person, communicable disease, forced lifestyle changes, perceived insecurity.

A review of the literature on the economic impact (quality of life and public sector cost impact) of the list of consequences was undertaken. The project did not have the scope to allow a systematic review of the literature. Instead, the following sources were used:

- The knowledge of the team and other Matrix consultants, as well as the experts advisors to the project; and
- A request for data was posted to the Health Economic Study Group email list.

D. Calculation of the quality of life impact of the consequences of problematic substance misuse

The QALY gained from avoiding a particular event was defined as:

$$Q = \sum_{t_i} \frac{U_{t_i}}{(1+r)^{t_i}}$$

Where:

Q = discounted QALY gained;

U_{t_i} = quality of life (utility) gained at time point t_i as the result of intervention;

r = discount rate (3.5%)

Figure three summarises the utility scores used to calculate the QALY impact of problematic substance use. Utility scores were not identified for unemployment or for all other crime types associated with substance misuse. This will result in an underestimation of the economic value of the effect of improving young people’s risk factors, but it is not anticipated that this underestimation is large.

Impact	Impact sub-groups	Utility
HIV/AIDS	Asymptomatic HIV	0.90
	Symptomatic HIV	0.85
	CD4 cells/cubic-mm >500	0.83
	CD4 cells/cubic-mm 200 - 500	0.81

	CD4 cells/cubic-mm < 200	0.68
	HIV with treatment	0.86
	AIDS	0.51
Hepatitis	Mild chronic hepatitis	0.93
	Moderate chronic hepatitis	0.87
	Chronic hepatitis	0.87
	Treatment for chronic hep	0.74
Depression	Severe depression	0.27
	Major depression	0.61
	Moderate depression	0.68
	Mild Depression	0.86
	Major depression with treatment	0.77
Crime	Robbery	0.97

Figure 3: Utility scores for the consequences of problematic substance use¹¹

In order to turn the utility scores into estimates of the QALY loss associated with each of the consequences of problematic substance use, the utility scores need to be combined with estimates of number of years in different health states. The following estimates and assumptions are used to perform this calculation:

- the average age of model participants is 20 years old¹²;
- the average life expectancy of the general population is 75 years old¹³;
- all impact of problematic substance misuse begins at an average age of 25 years old;
- those suffering from HIV/AIDs are assumed to suffer from HIV for 10 years, and then AIDs for 10 years if they receive treatment, but only 2 years if they don't receive treatment¹⁴;
- those who suffer from Hepatitis B are assumed to do so for 45 years¹⁵;
- those who suffer from Hepatitis C are assumed to do so for 25 years¹⁶;
- those who experience mental health problems do so for a period of five years; and
- all other effects last for a period of ten years.

¹¹ The utility scores are constructed by averaging the range of preference weights (utility scores) identified in the Tufts-New England Medical Centre, Catalogue of Preference Weights 1998-2000 (<http://www.tufts-nemc.org/cearegistry/links.html>). The exception to this rule is the utility loss associated with robbery, which is taken from Dubourg et al (2005), The economic and social costs of crime against individuals and households 2003/04. London: Home Office. By definition, utility has a maximum value of 1 (full health); death has a utility of 0.

¹² 20 years old was chosen as it is the mid-point in the age range in the definition of young people in the scope of the project.

¹³ The average age of mortality in the UK for people aged 0-34 years old is 73.8 for men and 78.2 for women (<http://www.statistics.gov.uk/>)

¹⁴ Centre for HIV information (<http://hivinsite.ucsf.edu/insite?page=ask-06-02-07>)

¹⁵ <http://www.hivandhepatitis.com/doctor/topics/hbv1.html>

¹⁶ <http://www.hepcentre.org.uk/Documents/UK%20HEP%20C%20INFO%20PACK%20Sept%2004.pdf>

E. Calculation of the public sector cost impact of the consequences of problematic substance misuse

Figure four summarises the annual cost data collected to value the impact of problematic substance use on the public sector. These figures were applied using the same timing estimates and discount rate as employed for QALY calculation to determine the public sector cost implications of problematic substance use.

Consequence of problematic substance use		Annual public sector costs (£)	Source
HIV/AIDS		16,800	Mandilia et al (2006) ¹⁷
Hepatitis B		5,960	Steinke et al (2002) ¹⁸
Hepatitis C		5,918	Shepherd et al (2005) ¹⁹
GP visits		80	Godfrey et al (2002) ²⁰
A+E visits (often involving overdose)		209	
Mental health	Outpatient visits	64	
	Inpatient days	202	
Unemployment		2,714 ²¹	
Crime	Arrests	4,368	
	Custody	115	
	Court	1,328	
	Prison	2,496	
Drug treatment costs		2,791	Gossop et al (2001) ²²

Figure 4: annual public sector cost of problematic substance use consequences

¹⁷ Mandilia S et al. (2006) Cause and time to treatment failure of HAART and cost of care in UK NPMS-HHC clinics, 1996 – 2002. HIV Med 7.

¹⁸ Steinke, D. T. et al (2002): Epidemiology and economic burden of viral hepatitis: an observational population based study.

<http://gut.bmjournals.com/cgi/content/full/50/1/100#SEC1>

¹⁹ Shepherd J, Brodin H F T, Cave C B, Waugh N R, Price A, Gabbay J. (2005), Clinical- and cost-effectiveness of pegylated interferon alfa in the treatment of chronic hepatitis C: a systematic review and economic evaluation. International Journal of Technology Assessment in Health Care 21(1):47-54.

²⁰ Godfrey, C. et al. (2002) The economic and social costs of Class A drug use in England and Wales, 2000, Home Office Research Study 249.

Godfrey et al used data from the National Treatment Outcome Research Study (NTORS), Gossop et al. (1996) to measure the economic consequences of problematic substance use. This study consists of a cohort study of 1,075 drug users entering treatment in 1995. The study used a large number of providers spread throughout England, but there was no sampling basis to ensure those attenders were representative of the total population of those attending treatment in that year. However, the findings of NTORS have been found to be similar to comparable US and UK studies. These NTORS patients were asked about a number of consequences before entering treatment and one year and two years after treatment.

²¹ The estimate of the cost of unemployment consists of the cost of employment benefits. No estimate is made of the lost tax revenue due to reduced employment.

²² Gossop et al, (2001), NTORS After Five Years: report average number of robberies per substance misuser.

F. Identification of data on the chance that problematic substance use results in economic costs

For those outcomes for which economic values estimates were available, a basic web search was undertaken to determine the probability that a problematic substance user would experience the consequence. Figure five summarises the data collected on the probability that a problematic substance user will experience the economic costs outlined in the previous two sections.

Impact	Impact of problematic substance use
HIV/AIDS	1.6% of problematic substance users have HIV compared to 0.2% of the general population ²³ .
Hepatitis B	16.8% of problematic substance users have Hepatitis B compared to 0% of the general population ²⁴ .
Hepatitis C	30.4% of problematic substance users have Hepatitis C compared to 0.5% of the general population ²⁵ .
Overdose/acute hospital episodes	23% of problematic substance users are admitted to A&E as a result of overdoses compared with 0% of the general population ²⁶ .
Depression	4% of problematic substance users suffer from depression compared with 2.5% of the general population ²⁷ .
Unemployment	80% of problematic substance users are unemployed, compared with 5.4% of the general population ²⁸ .
Drug treatment	33.3% of problematic substance users receive treatment for their substance use ²⁹ .

23 Godfrey, C. et al. (2002) The economic and social costs of Class A drug use in England and Wales, 2000, Home Office Research Study 249. Only 1,850 new transmissions of HIV were reported in the UK in 2002, representing a very small fraction of the population

(<http://www.aidsmap.com/en/news/E9008EAF-591B-474C-9898-4DE68C60396D.asp>). Assuming that this rate is maintained and can be applied as a person's chance of contracting HIV between the ages of 16 years old and 50 years old, and that the population of this group is 28 million, then the chance of contracting HIV during this period is 0.126% (<http://www.statistics.gov.uk/statbase/Expodata/Spreadsheets/D9081.xls>)

24 Godfrey, C. et al. (2002) The economic and social costs of Class A drug use in England and Wales, 2000, Home Office Research Study 249. The annual incidence of Hepatitis B was only 7.4 people per 100,000 between 1995 and 2000 (<http://www.patient.co.uk/showdoc/40000893>). Assuming that this rate is maintained and can be applied as a person's chance of contracting Hepatitis B between the ages of 16 years old and 50 years old, then the chance of contracting Hepatitis during this period is 0.25%

25 Godfrey, C. et al. (2002) The economic and social costs of Class A drug use in England and Wales, 2000, Home Office Research Study 249 + <http://www.patient.co.uk/showdoc/40002422>

26 Coid, J. et. al. (2000), Opiates, criminal behaviour and methadone treatment. London: Research study, Home office.

27 Coid, J. et. al. (2000), Opiates, criminal behaviour and methadone treatment. London: Research study, Home office; and Centre for Economic Performance (2006), The Depression Report: A New Deal for Depression and Anxiety Disorders. http://cep.lse.ac.uk/textonly/research/mentalhealth/DEPRESSION_REPORT_LAYARD.pdf

28 Godfrey, C. et al. (2002) The economic and social costs of Class A drug use in England and Wales, 2000, Home Office Research Study 249; and <http://www.statistics.gov.uk/cci/nugget.asp?id=12>

29 Godfrey, C. et al. (2002) The economic and social costs of Class A drug use in England and Wales, 2000, Home Office Research Study 249

Impact	Impact of problematic substance use
GP visits	On average, problematic substance users visit 4.47 times per annum ³⁰
Arrests	On average, problematic substance user are arrested 1.23 times per annum ³¹
Custody	On average, problematic substance user spend 1.67 nights in police custody per annum ³²
Court appearances	On average, problematic substance user appear in court 1.9 times per annum ³³
Prison	On average, problematic substance user spend 36.17 days in prison per annum ³⁴

Figure 5: the prevalence of health, crime and unemployment consequences of problematic substance use

Results

The model described in this paper estimates two economic variables:

1. The quality of life improvements resulting from the reduced chance of becoming a problematic substance user as a result of changes in a young person's risk factors and behaviours.
2. The public cost savings resulting from the reduced chance of becoming a problematic substance user as a result of changes in a young person's risk factors and behaviours.

Figure six summarises the results of the first of these models. It demonstrates that, of the risk factors analysed, heavy cannabis use caused the greatest loss of quality of life and the greatest cost to the public sector. Another factor associated with high quality of life losses and public sector costs are parental cannabis use. Risk factors that have the least impact on young peoples' long-term quality of life and public sector costs include early alcohol and cigarette use, and education factors.

30 Godfrey, C. et al. (2002) The economic and social costs of Class A drug use in England and Wales, 2000, Home Office Research Study 249

31 ibid

32 ibid

33 ibid

34 ibid

Change in young person's risk factor	Discounted QALY gained per person	Discounted public sector costs saved per person (£)
not smoke cannabis v smoke cannabis 51+ times in the last year	0.4349	14294
not smoke cannabis v smoke cannabis 11-50 times in the last year	0.2655	8726
mother use cannabis v not	0.2112	6943
not smoke cannabis v smoke cannabis 3-10 times in the last year	0.1903	6253
father use cannabis v not	0.1023	3363
mother not live at home v does	0.0889	2922
not smoke cannabis v smoke cannabis 1-2 times in the last year	0.0882	2900
smoke cigarettes v not	0.086	2827
peers use cannabis	0.0802	2636
delinquency v not	0.0695	2284
rebellious v not	0.0567	1863
peers smoke cigarettes	0.0514	1689
peers deviant v not	0.0493	1622
sensation seeking v not	0.0474	1556
use alcohol versus not use alcohol	0.04	1314
middle v high level schooling	0.0335	1101
mother not affectionate	0.0321	1055
first use cannabis before 16 v after	0.0313	1028
mother smoke cigarettes v not	0.0305	1001
low vs middle level schooling	0.0286	941
father not discipline young person v does	0.0221	727
grade point average <8 v >9	0.0196	645
depressed v not	0.0163	536
first use cigarettes before 13 v after	0.0122	402
first use alcohol before 13 v after 13	0.0065	213

Figure 6: quality of life and public sector cost impact of changes in young people's risk factors

The public sector costs saved as a result of reducing the factors that cause young people to use substances are the result of avoided adverse health states, crime and unemployment. Figure seven shows the distribution of the public sector costs saved. It demonstrates that criminal justice costs make up the majority of the costs associated with problematic substance misuse.

Cost type	Proportion of public sector costs
Infectious diseases	27%
Other health costs	4%
Criminal justice costs	50%
Drug treatment	6%
Unemployment	13%

Figure 7: distribution of the public sector costs associated with problematic substance use

Conclusion and discussion

The model described in this paper provides estimates of the long-term quality of life loss and public sector costs associated with a range of young persons' behaviours and risk factors. These estimates have a number of uses. First, they can be used to prioritise the allocation of resources to young peoples' interventions. For instance, assuming a constant cost to alleviating young peoples' risk factors, the greatest value for money would be gained from targeting young peoples' heavy cannabis use and their parents' cannabis use.

Second, the estimates can be used to determine the cost-effectiveness of young peoples' substance misuse interventions, defining the maximum cost per avoided risk factor before an intervention is no longer value for money. For instance, we can say that interventions that target cannabis smoking amongst mothers will be cost-effective as long as each mother they stop smoking cannabis costs less than c£13,300³⁵.

However, the complexity of the pathway between the risk factors faced by young people and the costs to society of problematic substance use, the limited availability of data, and the limited scope of the analysis meant that the following assumptions had to be made, which suggest that the model tends to underestimate the long-term costs of young peoples' risk factors:

- The model defines problematic substance use as heroin use, crack use or heavy cocaine use. The model thus ignores a number of other substances, such as solvents, and thus underestimates the cost of young peoples' risk factors.
- It is assumed that vulnerable young people have the same baseline risk of problematic substance misuse as the general population of young people (as used in the risk literature). As the risk of problematic substance misuse is likely to be higher among the participants, this assumption underestimates the cost of young peoples' risk factors.
- The model estimates the impact of heavy cocaine use on quality of life and public sector costs. As the chance of using other substances is likely to be independent from the chance of using cocaine, this will underestimate the quality of life and public sector cost impact of young peoples' risk factors.
- Data is only available to measure and value the impact of problematic substance use on a number of the consequences associated with it. This will cause the model to underestimate the cost of problematic substance misuse.

35 0.2112 QALYs @ £30,000 per QALY + £6,943 public sector cost

Furthermore, the model is only able to estimate the economic cost of a limited number of risk factors. Further research is required to improve the estimates produced by the model and expand the number of risk factors modelled.

Appendix 1: data on the risk of problematic substance use

This appendix summarises the data identified from the epidemiological models to measure the relationship between young people's risk factors and the likelihood of becoming a problematic substance user.

The relationship between risk factors and youth substance misuse

Independent variable	Dependent variable	Relationship	Source
academic achievement	heavy party drug use	Dependent (heavy v moderate party drug use:low v middle level schooling OR 1.10 (0.61 - 2.00)	Baumeister and Tossman (2005)
academic achievement	heavy party drug use	Dependent (heavy v moderate party drug use:high v middle level schooling OR 0.70 (0.47 - 0.97)	Baumeister and Tossman (2005)
academic achievement	heavy cannabis use	Dependent (heavy v moderate cannabis use: low v middle level schooling OR 1.50 (0.98 - 2.29)	Baumeister and Tossman (2005)
academic achievement	heavy cannabis use	Dependent (heavy v moderate cannabis use: high v middle level schooling OR 0.56 (0.45 - 0.70)	Baumeister and Tossman (2005)
Academic achievement	cannabis use	Dependent (ever used cannabis): grade point average <8 (compared to >9) OR 1.35 (0.67 - 2.74)	Poikolainen, K. et al (2001)
academic achievement	Illicit drug	Predictors of illicit drug use: perceived low academic acheivement odds ratio 1.3 (p<0.03)	Sutherland and Shephard (2001).
alcohol use	Illicit drug	Predictors of illicit drug use: alcohol use odds ratio 13.0 (p<0.0001)	Sutherland and Shephard (2001).
alcohol use	heavy party drug use	Dependent (heavy v moderate party drug use:onset of alcohol use before 13 years old OR 1.20 (0.83 - 1.73)	Baumeister and Tossman (2005)
alcohol use	heavy cannabis use	Dependent (heavy v moderate cannabis use: onset of alcohol use before 13 years old OR 1.10 (0.97 – 1.39)	Baumeister and Tossman (2005)
alcohol use	cannabis use	marijuana use: alcohol use OR 2.24, (C.I 1.90 - 2.65 p<0.001)	Judith Brook (2001)
behaviour	cannabis use	marijuana use: delinquency OR 2.32, (C.I 1.96 - 2.75 p < 0.001)	Judith Brook (2001)
cannabis use	heavy party drug use	Dependent (heavy v moderate party drug use:onset of cannabis use before 16 years old OR 1.30 (0.89 - 1.87)	Baumeister and Tossman (2005)

cannabis use	heavy cannabis use	Dependent (heavy v moderate cannabis use: onset of cannabis use before 16 years old OR 1.57 (1.25 - 1.96)	Baumeister and Tossman (2005)
Cigarette use	party drug use	Heavy use of ecstasy, amphetamines, hallucinogens and cocaine is associated with use of cigarettes before 13 (OR = 1.9). For males, the odds ratio was 2.2 and for women 1.9.	Baumeister, S. E. et al (2005)
Cigarette use	Illicit drug	Predictors of illicit drug use: cigarette use: odds ratio 8.6 (p<0.0001)	Sutherland and Shephard (2001).
Cigarette use	heavy party drug use	Dependent (heavy v moderate party drug use: onset of cigarette use before 13 years old OR 1.99 (1.34 - 2.95)	Baumeister and Tossman (2005)
Cigarette use	heavy cannabis use	Dependent (heavy v moderate cannabis use: onset of cigarette use before 13 years old OR 1.19 (0.92 - 1.54)	Baumeister and Tossman (2005)
Cigarette use	cannabis use	marijuana use: smoking OR 3.35, (C.I 2.82 - 3.99 p<0.001)	Judith Brook (2001)
Family	cannabis use	marijuana use: mother marijuana smoking OR 4.55, (C.I 3.20 - 6.47 p<0.001)	Judith Brook (2001)
Family	cannabis use	marijuana use: father marijuana smoking OR 2.63, (C.I 2.04 - 3.38 p<0.001)	Judith Brook (2001)
Family	cannabis use	marijuana use: father's discipline OR 1.36 (1.14 - 1.61, p<0.001)	Judith Brook (2001)
Family	cannabis use	marijuana use: mothers affection OR 0.65 (0.54 - 0.77, p<0.001)	Judith Brook (2001)
Family	cannabis use	marijuana use: mother smoking OR 1.54 (1.32 - 1.80, p<0.001)	Judith Brook (2001)
Family	cannabis use	Dependent (ever used cannabis): mother not living at home OR 2.85 (1.09 - 7.47)	Poikolainen, K. et al (2001)
Mental health	cannabis use	marijuana use: depression OR 1.25 (CI 1.05 - 1.48, p<0.01)	Judith Brook (2001)
offending	Illicit drug	Predictors of illicit drug use: police contact odds ratio 3.0 (p<0.0001)	Sutherland and Shephard (2001).
peer influence	Illicit drug	Predictors of illicit drug use: peer influence odds ratio 1.7 (p<0.0001)	Sutherland and Shephard (2001).
peer influence	cannabis use	marijuana use: peer smoking OR 2.28, (C.I 1.94 - 2.69)	Judith Brook (2001)
peer influence	cannabis use	marijuana use: Peer marijuana use OR 2.92, (C.I 2.49 - 3.44 p<0.001)	Judith Brook (2001)
peer influence	cannabis use	marijuana use: peer deviance OR 1.81 (1.53 - 2.13, p<0.001)	Judith Brook (2001)
peer influence	cannabis use	marijuana use: peer achievement OR 0.53 (0.5-0.69, p<0.001)	Judith Brook (2001)

personality	cannabis use	marijuana use: rebelliousness OR 2.04 (CI 1.73 - 2.40 p< 0.001)	Judith Brook (2001)
personality	cannabis use	marijuana use: sensation seeking OR 1.84 (CI 1.55 - 2.19, p<0.001)	Judith Brook (2001)
soft drug use	Solvent use	Removal of all soft drugs predicts a reduction in solvent use from 8.3% to 7.4% (non-heterogeneous model)	Pudney, S (2003)
soft drug use	Solvent use	Removal of all soft drugs predicts an increase in solvent use from 8.2% to 8.9% (heterogeneous model)	Pudney, S (2003)
soft drug use	Cocaine/ ecstasy use	Removal of all soft drugs predicts a reduction in cocaine/ecstasy use from 11.7% to 3.4% (non-heterogeneous model)	Pudney, S (2003)
soft drug use	Cocaine/ ecstasy use	Removal of all soft drugs predicts a reduction in cocaine/ecstasy use from 11.7% to 7.9% (heterogeneous model)	Pudney, S (2003)
solvent use	Cocaine/ ecstasy use	Removal of solvents predicts an increase in cocaine/ecstasy use from 11.7% to 10.8% (non-heterogeneous model)	Pudney, S (2003)
solvent use	Cocaine/ ecstasy use	Removal of solvents predicts an increase in cocaine/ecstasy use from 11.7% to 12.8% (heterogeneous model)	Pudney, S (2003)
suspension	Illicit drug	Predictors of illicit drug use: suspension from school odds ratio 2.1 (p<0.0001)	Sutherland and Shephard (2001).

The relationship between youth substance misuse and problematic substance misuse

Independent variable	Dependent variable	Relationship	Source
cannabis use	heavy cocaine use	heavy cocaine use (p<0.05): smoke cannabis 51+ times in the last year OR 6.67	Schildhaus, S. et al (2004)
cannabis use	heavy cocaine use	heavy cocaine use (p<0.05): smoke cannabis 11-50 times in the last year OR 3.23	Schildhaus, S. et al (2004)
cannabis use	heavy cocaine use	heavy cocaine use (p<0.05): smoke cannabis 3-10 times in the last year OR 2.38	Schildhaus, S. et al (2004)
cannabis use	heavy cocaine use	heavy cocaine use (p<0.05): smoke cannabis 1-2 times in the last year OR 1.54	Schildhaus, S. et al (2004)
Cigarette use	heavy cocaine use	heavy cocaine use (p<0.05): smoked cigaratte in last 6 months OR 1.41	Schildhaus, S. et al (2004)

offending	heavy cocaine use	heavy cocaine use (p<0.05): significant amount of illegal income in last year OR 2.63	Schildhaus, S. et al (2004)
offending	heavy cocaine use	heavy cocaine use (p<0.05): small amount of illegal income in last year OR 1.37	Schildhaus, S. et al (2004)
offending	heavy cocaine use	heavy cocaine use (p<0.05): sold hard drugs in last year OR 2.00	Schildhaus, S. et al (2004)
religious belief	heavy cocaine use	heavy cocaine use (p<0.05): attend church in last month OR 0.67	Schildhaus, S. et al (2004)
soft drug use	Hard drug use	Removal of all soft drugs predicts a reduction in hard drug use from 1.9% to 1.8% (non-heterogeneous model)	Pudney, S (2003)
soft drug use	Hard drug use	Removal of all soft drugs predicts a reduction in hard drug use from 2.5% to 2.3% (heterogeneous model)	Pudney, S (2003)
solvent use	Hard drug use	Removal of solvents predicts an increase in hard drug use from 1.9% to 1.6% (non-heterogeneous model)	Pudney, S (2003)
solvent use	Hard drug use	Removal of solvents predicts an increase in hard drug use from 2.5% to 3.1% (heterogeneous model)	Pudney, S (2003)
suspension	heavy cocaine use	heavy cocaine use (p<0.05): suspended from school OR 1.56	Schildhaus, S. et al (2004)

Epidemiology references

Baumeister, S.E. and Tossman, P. (2005), Association between Early Onset of Cigarette, Alcohol and Cannabis Use and Later Drug Use Patterns: An Analysis of a Survey in European Metropolises. *Addiction*, Vol. 11, No. 2.

Brook, J. (2001) Risk factors for adolescent Marijuana use across cultures and across time. *Journal of genetic psychology*, 162 (3), 357 - 374

Poikolainen, K. et al (2001), Correlates of initiation to cannabis use: a 5-year follow-up of 15-19 year old adolescents. *Drug and Alcohol Dependence* 62 (2001) 175–180

Pudney, S (2003), The road to ruin? Sequences of initiation to drugs and crime in Britain. *The Economic Journal*, 113 (march)

Schildhaus, S., Shaw-Taylor, Y., Pedlow, S. and Pergamit, M.R. (2004): Predicting Heavy Drug Use: Results of a Longitudinal Study, Youth Characteristics Describing and Predicting Heavy Drug Use by Adults. Washington D.C., Office of National Drug Control Policy.

http://www.whitehousedrugpolicy.gov/publications/predict_drug_use/predict_drug_use.pdf

Sutherland and Shephard (2001): Social dimensions of adolescent substance abuse. *Journal of addiction* 96, 445 - 458.