

A review of the cost-effectiveness of interventions (specifically point of sales measures and mass media) to prevent the uptake of smoking in young people under 18 years old

M. Raikou, A. McGuire

LSE Health, London School of Economics and Political Science

November 2021: NICE guidelines PH10 (February 2008) and PH14 (July 2008) have been updated and replaced by NG209.

The recommendations labelled [2008] or [2008, amended 2021] in the updated guideline were based on these evidence reviews.

See www.nice.org.uk/guidance/NG209 for all the current recommendations and evidence reviews.

A cost-effectiveness review forming background to the National Institute for Health and Clinical Excellence (NICE) economic appraisal on preventing the uptake of smoking by children and to support the development of guidance.

November 2007

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Evidence Statement

Whilst there is a very limited number of studies assessing the cost-effectiveness of point of sales and mass media interventions aiming at the prevention of the uptake of smoking in young people under 18 years old, all studies reviewed find interventions cost-effective, or even cost saving, thus comparing favourably with smoking cessation strategies and other therapeutic interventions.

1. Introduction

Aims and objectives

It is well recognized that some proportion of children who start smoking become regular adult smokers subject to all the subsequent health risks. The UK Government has consequently identified the reduction in child smoking rates as a major priority to reduce future morbidity and mortality from smoking. Given that mortality rates reflect not only the dangerous nature of the commodity but also the continued high prevalence of consumption, identification of appropriate policies to inhibit up-take is crucial. The Government's targets, set in the 1998 White Paper Smoking Kills, are to reduce the number of children (11-15 year olds) who take-up smoking or smoke regularly from a baseline of 13% in the mid-1990s to 9% by 2010. This seems achievable as the current proportion of 11-15 year olds who smoke seems to be approximately 10%. As part of the strategy to achieve this aim, the Government, as well as considering the raising of the minimum age at which purchase of tobacco products is allowed, is considering a range of smoking prevention policies aimed particularly at younger people.

The aim of this project is to undertake a review of the evidence on cost-effectiveness relating to smoking prevention strategies amongst young people focusing on mass media interventions and point of sale measures and develop an incremental cost-effectiveness model to consider such strategies. This paper presents a review which was undertaken to support the development of guidance by the National Institute for Health and Clinical Excellence (NICE) relating to these prevention strategies.

Research question

The following research question was addressed:

What are the most cost-effective interventions, amongst mass media and point of sales strategies, that aim to prevent smoking uptake in young people under 18 years old?

2. Background

Prevalence of smoking among young people

Approximately two thirds of smokers begin smoking before the age of 18 and a third before the age of 16. Recent statistics show that 10% of school children aged 11-15 smoke regularly (at least one cigarette a week), 6% smoke occasionally and 11% are ex-smokers (Anderson et al., 2002). According to a recent survey conducted by the National Centre for Social Research and the National Foundation for Educational Research on behalf of the Information Centre for health and social care aiming at monitoring smoking, drinking and drug use among secondary school pupils aged 11 to 15, in the autumn term of 2006, 9% of pupils smoked regularly (at least once a week), 39% of pupils had tried smoking at least once while the proportion of pupils who had never smoked was 61%. The results of the survey which was based on data on 8,200 pupils in 288 schools throughout England, also show that girls are more likely to smoke regularly than boys, and older pupils more likely than younger ones with 20% of 15 year olds smoking at least once a week compared with only 1% of 11 year olds. Other findings of the survey were that pupils of black or mixed ethnic origin were less likely to smoke regularly compared with white pupils and that smoking behaviour of families has an impact on pupils' smoking with those who lived with other smokers being more than twice as likely to smoke regularly compared with those living in non-smoking households. The survey also showed that despite the fact that the pupils in this age group were all below the minimum legal age for buying cigarettes, which was 16 years old at the time of the survey, approximately 65% of those who smoked identified shops as one of their usual sources of cigarettes. According to the results of the survey there is a difference in the source of cigarettes between regular (smoking at least one cigarette a week) and occasional smokers with the former mostly purchasing their cigarettes from shops (78%) and from other people (40%) and half being given cigarettes by friends and the latter mainly being given cigarettes by friends (74%). Younger pupils were more likely to be given cigarettes or to have found or taken them compared to older pupils who mainly purchased cigarettes from shops and vending machines (Dept. of Health, Public Health Statistics, 2007. Smoking, drinking and drug use among young people in England in 2006).

Health consequences of smoking

Smoking leads to disabling and fatal diseases including cancers, heart disease and respiratory conditions with half of long-term smokers dying because of smoking. Smoking increases the risk for many types of cancer, including cancers of the lip, oral cavity, pharynx, esophagus, pancreas, larynx (voice box), lung, uterus, cervix, urinary bladder, and kidney. The risk of dying from lung cancer increases by more than 22 times in men and 12 times in women as a direct consequence of smoking. Smokers are 2–4 times more likely to develop coronary heart disease than nonsmokers, twice more likely to have a stroke and more than 10 times as likely as nonsmokers to develop peripheral vascular disease. Smoking leads to a tenfold increase in the risk of dying from chronic obstructive lung disease with approximately 90% of all deaths from chronic obstructive

lung diseases being attributable to smoking. A number of adverse reproductive and early childhood effects are also a direct consequence of smoking, including an increased risk for infertility, premature birth, stillbirth, low birth weight and sudden infant death syndrome (US Department of Health and Human Services, Centers for Disease Control and Prevention, http://www.cdc.gov/tobacco/health_effects/index.htm).

There is evidence that people who start to smoke at an early age tend to smoke more heavily and are less likely to quit than those who start smoking at a later stage. Although the health consequences of smoking are serious at any age, smoking in childhood is associated with impaired lung growth, an increase in respiratory and asthma-related symptoms, and an increase in age-specific cancer rates for all types of smoking-related cancers. The likelihood of someone dying of cancer due to smoking is three times higher if they start smoking at 15 years compared to someone who takes up smoking in their mid-20s (Dept. of Health, Public Health Statistics, 2007. Smoking, drinking and drug use among young people in England in 2006).

Interventions to prevent smoking uptake in young people

The market for tobacco is a heterogeneous one with tobacco companies identifying and targeting different subgroups differentiated by demographic characteristics, lifestyle patterns, aspirations and smoking behaviour. There are two key target groups for tobacco companies in the UK, namely the low-income and the young. It has been estimated that people who start smoking when they are young smoke for an average of 25 years for which the tobacco industry is paid a total of £36,000 over time for each new smoker (Anderson et al., 2002). For new smokers easy access to tobacco is important and there is evidence that 80% of young smokers buy cigarettes from independent retailers although they are under the legal smoking age of 16 years. The legal smoking age was raised in England and Wales from 16 to 18 years, in line with that of consuming alcohol, on 1 October 2007. This had already been implemented in the United States, Canada, Australia and New Zealand. Although this is expected to affect the uptake of smoking amongst young people by restricting access to tobacco, it is also generally acknowledged that such a measure is only going to have a significant impact if it is properly enforced and forms part of a set of strategies aiming at the prevention of smoking uptake in this age group the most important of which include:

- i. School-based interventions
- ii. increasing taxes on tobacco as it has been argued to be the most effective way to prevent the uptake of smoking in young people as children and adolescents are more responsive to price increases than adults
- iii. bans on tobacco advertising and promotion
- iv. mass media counter-advertising, health warning labels on cigarette packs, wide dissemination of the findings on the health consequences of smoking
- v. bans on smoking at schools

- vi. restricting access to tobacco/point of sale measures: Enforcement of laws on tobacco sales to minors, as it has been shown to have some effect on uptake and minors' smoking prevalence.

Of these 6 areas, iv and vi are the subject of this guidance.

3. Methodology

Search strategy

A systematic search of electronic sources and websites was undertaken to identify studies published since 1990 by searching the following databases:

MEDLINE Database coverage dates 1990-2007/Jul wk 2

NHS EED Database coverage dates 1990-2007/06

HEED Database coverage dates 1990-2007/07

EconLit Database coverage dates 1990-2007/06

EMBASE Database coverage dates 1990-2007/wk 28

CINAHL Database coverage dates 1990-2007/Jul wk 2

HMIC Database coverage dates 1990-2007/July

The search strategy for Medline is given in Appendix 1. The search strategies for all other databases are available on request.

Inclusion and exclusion criteria

Population

Studies were eligible for inclusion if

- They included children and young people aged up to 18 years old
- The population consisted of non-smokers at the start of the study
- They reported on the cost and effectiveness of the prevention strategy

Interventions

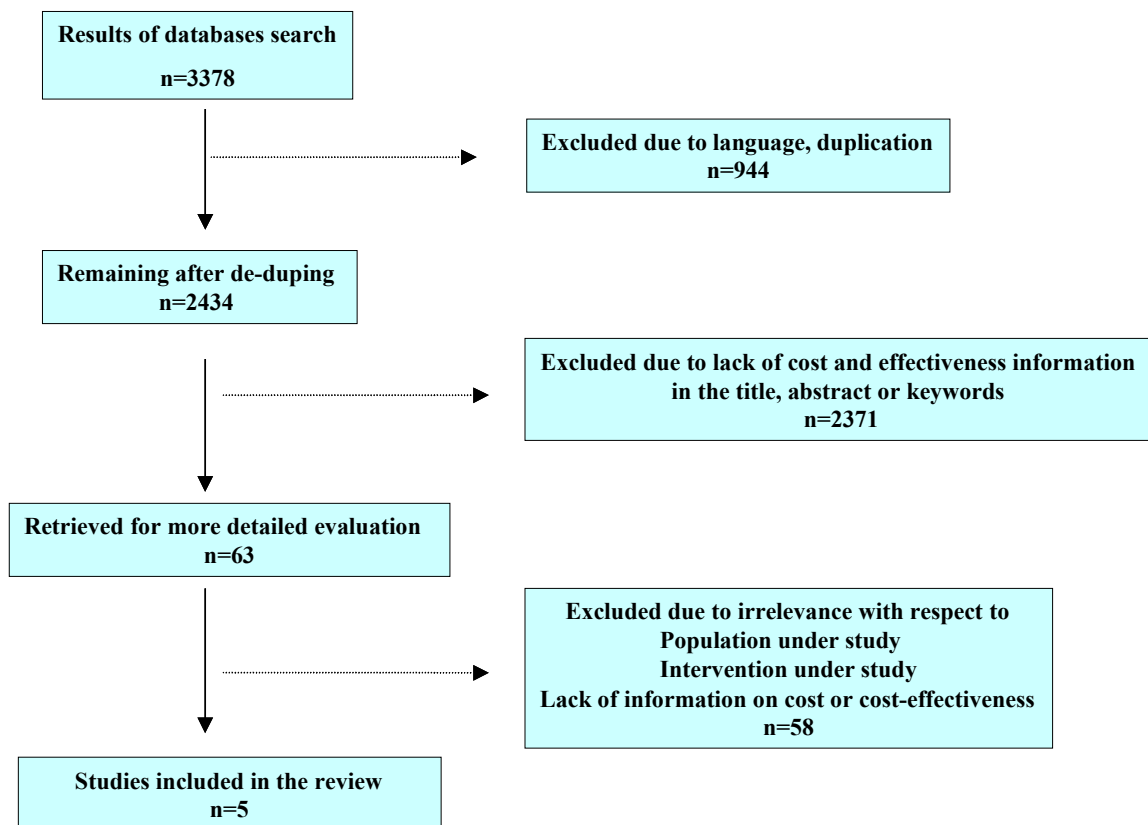
Studies were eligible for inclusion if they examined the cost-effectiveness of mass media interventions or interventions attempting to restrict access to tobacco. Studies that investigated the cost-effectiveness of school-based interventions and tax on tobacco were therefore excluded. One study by Fishman et al. 2005 investigated the combined effect of mass media and tax increase and is included as it was possible to report the results of the mass media strategy alone.

Study selection

A total of 3378 references were identified from the literature searches conducted for the

review of published economic evaluation studies with 2434 references remaining after de-duping. These references were consequently imported into the Reference Manager software package and a further search was conducted based on the search terms “cost” and “effectiveness” to identify 63 publications potentially containing information on cost-effectiveness of smoking uptake prevention programmes. Exclusion due to non-relevance of the population or the intervention under study and lack of information on cost or cost-effectiveness resulted in a total of 5 publications that met the inclusion criteria and formed the basis of this review. The process of study identification is shown in Figure 1.

Figure 1. Flowchart for study selection



Study quality assessment

The studies included in this review were assessed for quality using the Drummond checklist for a critical assessment of published economic evaluations [list is presented in Appendix 2]

4. Results

DiFranza et al. (2001) investigated the cost-effectiveness of the prohibition of tobacco sales as a smoking prevention intervention in adolescents from the perspective of the body implementing the enforcement programme. An enforcement model that allowed quarterly inspections of all tobacco vendors in the US was built. Thus the cost of enforcement consists of pay for personnel who license vendors, supervise inspectors, administer fines and handle legal cases in court, pay for inspectors, liability insurance, transportation costs and overhead associated with maintenance of office space and equipment. Given a substantial variation in the reported enforcement costs, the costs used in the analysis were \$50, \$150, \$250 and \$350 per outlet per year in 1997 prices, (which in 2006 prices are \$61, \$183, \$305 and \$428 respectively)¹. The population was 17 years old students in 1997 and the underlying assumption relating to prevalence was that current smoking and mortality rates would continue into the future in the absence of enforcement. The assumed reductions of tobacco use amongst the young people as a result of the enforcement intervention were 5, 10, 25 and 50%.

At a 3% discount rate, an enforcement strategy that resulted in a 10% decrease in smoking amongst the young would lead to an annual saving of 124,000 discounted life years, a 25% decrease would lead to an annual saving of 310,000 discounted life years, and a 50% decrease would lead to an annual saving of 620,000 discounted life years.

Table 1 reports the resultant cost-effectiveness estimates as cost per life year gained discounted at 3% per year for different levels of smoking reduction and annual costs per vendor. As can be seen the cost-effectiveness ratios are relatively low.

Table 1. Cost per life year gained in 1997 prices (2006 prices)

Cost per vendor outlet	Smoking reduction			
	5%	10%	25%	50%
\$50 (\$61)	\$440 (\$538)	\$220(\$269)	\$88 (\$108)	\$44 (\$54)
\$150 (\$183)	\$1,300 (\$1,588)	\$660 (\$806)	\$260 (\$318)	\$130 (\$159)
\$250 (\$305)	\$2,200 (\$2,688)	\$1,100 (\$1,344)	\$440 (\$538)	\$220 (\$269)
\$350 (\$428)	\$3,100(\$3,788)	\$1,500 (\$1,833)	\$610 (\$745)	\$310 (\$379)

Study limitations include the number of assumptions made relating to smoking initiation and cessation rate as well as the smoking attributable mortality. Additionally the possibility that smoking uptake might just be delayed rather than prohibited would mean this analysis gives an overestimate of the intervention's cost-effectiveness. However at all but one combinations of annual costs per vendor and levels of smoking reduction considered as a result of the enforcement, the intervention compares favourably in cost-effectiveness with smoking cessation interventions, an estimate of which obtained by

¹ All prices were converted to 2006 price levels through the US GDP deflator (all studies were from the U.S.A.). All prices and costs are first given in the year as given in the publication, and then in parentheses following the conversion to 2006 prices has been made.

Cromwell et al. (2007) and reported by the authors is \$2,587 per life year gained discounted at 3% annually (\$3,161 in 2006 prices).

Secker-Walker et al. (1997) investigated the cost-effectiveness of a 4-year mass media campaign aiming at preventing the uptake of smoking using data from a project that was implemented between 1984 and 1991 in two communities in Montana and two in the northeastern US that tested the incremental effectiveness of a mass media programme (television and radio) added to a school-based smoking prevention intervention (curriculum). The intervention group was exposed to a mass media programme consisting of 36 television spots and 17 radio spots in addition to the school-based programme for the duration of four years. The intervention's efficacy was assessed at two points in time, once in 1989 after 4 years of the campaign when the cohort under study was 13-16 years old and a second time in 1991 when the cohort was 15-18 years old. Cost-effectiveness was assessed using a cohort Markov model in order to determine differences in life expectancy between cohorts with difference smoking prevalence rates and the perspective of analysis was this of an organisation developing and implementing a similar mass media campaign in 1996.

The total 4-year programme implementation cost was calculated as \$759,436 in 1996 prices (\$943,287 in \$s2006) and this includes development, production and broadcasting. At an annual discount rate of 3% the cost per life year gained was \$696 [95% CI: \$445-\$1,269] in 1996 prices (\$864 [95% CI: \$553-\$1,576] in \$s2006) for the population under study. Projection of this result to the national level yielded an estimated 4-year national mass media campaign cost of \$84,500,000 (\$104,956,473 in \$s2006). Assuming a smoking reduction amongst students of 5%, slightly under the reduction observed in the study, as a result of the programme the cost per student smoker averted was estimated at \$162 (\$201 in \$s2006) and the cost per LYG was estimated at \$138 [95% CI: \$88-\$252] in 1996 prices (\$171 [95% CI: \$109-\$313] in \$s2006) at a 3% discount rate. The results of the sensitivity analysis indicate that the cost-effectiveness ratio remains low even at a lower smoking reduction level of 3.2% whereas the ratio is sensitive to changes in the costs of developing and broadcasting the campaign and to the difference in life expectancy between smokers and non-smokers.

A limitation of the study might be that the population under study was restricted to the 10-12 year-old-students and a reduction of 5% in the smoking uptake and the effect on other age groups was not assessed. The authors however argue that focusing on this cohort appears to provide conservative estimates for the cost-effectiveness ratio and conclude that the cost-effectiveness estimates of this 4-year campaign in preventing youth smoking uptake shows it to be economically attractive, with a relatively low incremental cost per LYG compared with other preventive and therapeutic strategies and smoking cessation interventions.

Fishman et al. (2005) studied the cost-effectiveness of an anti-smoking media campaign combined with a \$1 tax increase per pack from a societal perspective. The population under study was the cohort of all 18 year olds in the US in the year 2000 and the gain in effectiveness was the lifetime reduction in smoking attributable mortality in this cohort in 2000. The population was exposed to a 4-year mass media campaign and at the end of

this 4-year period the tax increase was imposed. Costs of the intervention consisted of the media campaign development and implementation costs, the smoking attributable healthcare costs (including treatment costs for smoking related diseases and treatment costs for neonate complications due to women who smoke, and costs associated with the treatment of respiratory diseases affecting children born to smokers through exposure to tobacco smoke), and the change in public-sector tax revenue due to the per pack tax increase. The cost-effectiveness of the intervention was assessed in terms of cost per life year gained using a model that followed the cohort of all 18 year olds in the US in the year 2000 until they were aged 85 years old.

Taking into account only the cost of the media campaign and under a range of assumptions relating to the level of this cost, namely \$0.31, \$0.97 and \$2.35 per capita in 2000 prices (\$0.36, \$1.13, \$2.74 in \$s2006 respectively) the cost per LYG ranges from \$528 (\$615 in \$s2006) for the low-cost media campaign and at a discount rate of 3% to \$19,957 (\$23,264 in \$s2006) for the high-cost campaign and at a discount rate of 7%. Results for the combined strategy that includes media campaign costs and changes in health care costs and tax revenue results in cost savings per LYG ranging from \$583,606 (\$680,310 in \$s2006) at a 3% discount rate to \$1,449,894 (\$1,690,141 in \$s2006) at a 7% discount rate with the dominant component in the overall results being the net change in public-sector tax revenue.

One limitation of this study relates to the exclusion of costs of enacting a \$1 per pack tax increase from the analysis due to the difficulty in obtaining such cost estimates but the authors argue that inclusion of these costs would not have significantly altered the overall results. The authors conclude that the results of their analysis reinforce the results of previous research showing that smoking prevention strategies in teens and young adults is not only cost-effective, but also that a relatively small investment generates substantial cost savings.

Ross et al. (2006) investigate the cost-effectiveness of a comprehensive community-based programme that consisted of school-based interventions and a number of community-based interventions such as anti-smoking messages, promotion of a tobacco-free school environment, engagement of members of the community including minors into prevention activities and an enforcement mechanism to reduce youth access to tobacco. The intervention took place in Arizona during 1996-2001 and the original target group was the population of 13-14 year olds in 1996. The effectiveness of the programme was assessed through two surveys administered before (1996) and after (2001) implementation. Under the assumption of no delayed initiation and that smoking reduction occurs among persons who would have otherwise remained smokers over their lifetime, the programme resulted in a reduction in the 30-day smoking prevalence among the 17-18 year olds from 28.6% to 20.8% with even higher reduction achieved in younger age groups. This gain in effectiveness combined with an estimated total programme cost of \$4,000,000 in 2000 prices (\$4,662,800 in \$s2006) resulted in an incremental cost of \$3,942 (\$4,595 in \$s2006) per LYG at 3% discount rate assuming a 0% programme persistence rate after the end of the campaign. Sensitivity analyses were conducted with alternative assumptions for future smoking and quitting behaviour and programme

persistence rates. Assuming that either one third take up smoking or one third would have quit anyway in the absence of the programme increases the discounted cost per LYG to \$5,913 (\$6,893 in \$s2006) at 0% programme persistence rate. If the programme's persistence rate is 5% the ICER is \$2,217 (\$2,584 in \$s2006) and at a 10% persistence rate it becomes \$1,364 (\$1,590 in \$s2006). Under the assumption that one third of the cohort started to smoke again and one third would have quit anyway in the absence of the programme and that the effect of the campaign would be maintained after the campaign had ended at a 5% persistence rate the cost effectiveness ratio is \$3,476 (\$4,052 in \$s2006) per LYG. The respective values change to \$11,825 (\$13,784 in \$s2006) per LYG for a 0% persistence rate and \$2,037 (\$2,375 in \$s2006) per LYG for a 10% programme persistence rate.

One limitation of this study relates to the absence of a control group thus making it impossible to provide accurate estimates of the gain in effectiveness attributed to the project alone. Hence, the investigators were forced to rely on a number of assumptions regarding the reduction in smoking prevalence. The authors conclude that despite its relatively limited scale, this community based tobacco control programme represents a cost-effective investment in public health and it compares favourably with smoking cessation interventions and other prevention and therapeutic strategies. An additional limitation for the purposes of this review is that the specific study evaluates an intervention aimed at preventing smoking uptake among young people that combines a number of components, i.e. mass media campaign, youth and adult involvement in advocating for stronger policies aiming at reducing tobacco use, an enforcement mechanism to reduce youth access to tobacco, and development of effective youth cessation services. As such the results of the analysis do not relate to the cost-effectiveness of a single intervention (mass media campaign) which is of interest in this review but to a multi-facet community intervention that consists of a combination of various interventions.

Ahmad (2005) studied the cost-effectiveness of raising the legal smoking age from 18 to 21 years in California. The analysis used dynamic computer simulation to model the progression of the population in California over a 50-year period in terms of age and smoking behaviour. The evaluation was undertaken from a societal perspective and costs included in the analysis were the cost of law enforcement, health care costs and costs of checking purchaser identification to verify age. The analysis population was the cohort aged 14-17 years old. Two alternative scenarios were considered. The first assumed that raising the legal smoking age would shift the probability distribution of initiation such that an 18-year old would have the initiation rate of a 15-year old, a 17-year old would have the initiation rate of a 14-year old, etc., while 21 year olds or older would retain their current initiation rates. Under the second scenario it was assumed that the change in the law would have a direct impact on the age- and gender-specific probability of smoking initiation resulting in a reduction in this probability of 10% to 50%.

According to the first scenario of the 3-year shift in the probability of smoking initiation as a direct consequence of raising the legal smoking age from 18 to 21 years, the estimated reduction in smoking prevalence in the cohort of 14-17 years old was 82%

(from 13.3% to 2.4%). According to the second scenario of a reduction in the probability of smoking initiation as a result of the change in the law, at a reduction for instance of 30%, the estimated reduction in smoking prevalence was from 13.3% to 5.2%.

Enforcement of the new law under the assumption of a 3-year shift in the probability of smoking initiation would result in a saving of \$24,079 million in 2003 prices (\$26,378 million in \$s2006) in total cumulative costs over 50 years at a 3% discount rate and a gain of 0.51 million life years and 1.47 million QALYs relative to the status quo (i.e. where no change in tobacco use occurs). Under the assumption of a 30% reduction in the probability of smoking initiation as a result of the change in the law, the saving in total cumulative costs is estimated at \$13,106 million (\$14,357 million in \$s2006) and the gain in effectiveness is estimated at 0.29 million life years and 0.80 million QALYs relative to the status quo.

Under all assumptions the intervention was cost saving with the savings ranging from \$8,786 million in 2003 prices (\$9,625 million in \$s2006) to \$24,079 million (\$26,378 million in \$s2006) for the first scenario while under the second scenario the cost savings were estimated at \$4,017 million (\$4,401 million in \$s2006), \$13,106 million (\$14,357 million in \$s2006) and \$22,686 million (\$24,852 million in \$s2006) for a reduction in the probability of smoking initiation of 10%, 30% and 50% respectively.

Study limitations include the mortality distributions used in the model which were obtained from national datasets and not from California alone. Assuming that the California population is healthier on average than the rest of the US the model results might give an overestimate of the reductions in mortality as a result of the law enforcement. Another concern relates to the migration rates used in the model which are typically uncertain especially given the relatively long time period of analysis. Despite these limitations the authors conclude that raising the legal smoking age to 21 years in California will result in important population health gains while at the same time generating no net costs, rather saving the state a total of \$24,000 million (\$26,292 million in \$s2006) over the next 50 years at an associated gain of 1.47 million QALYs compared to the status quo.

Table 2. Evidence on the cost-effectiveness of mass media and point of sale interventions to prevent youth smoking uptake

First author, year, country	Study design	Research quality	Study population	Research question	Year of analysis	Perspective of analysis	Main results	Authors' conclusions	Application to the UK population and settings
DiFranza et al., 2001, US	Model		17-year-old youths	Aim: to evaluate the potential cost-effectiveness of enforcement programmes aiming at prohibiting tobacco sale to youths	1997	Body implementing the enforcement programme	US\$44-\$3,100 per LYG (US \$54-\$3,788 per LYG in \$s2006)	Enforcement of restrictions on tobacco sale to minors is potentially a very cost-effective measure for saving lives	Study carried out in the US
Secker-Walker et al., 1997, US	Cohort Markov model based on a matched control design		Students aged 15-18 years	Aim: to examine costs and cost-effectiveness of a 4 year mass media campaign to prevent the onset of smoking	1996	Organisation developing and implementing a similar mass media campaign in 1996	US\$162 per student smoker averted; US\$138 per LYG (US \$201 per student smoker averted; US\$171 per LYG in \$s2006)	The cost-effectiveness estimates of this 4-year campaign in preventing youth smoking uptake shows it to be economically attractive, with a relatively low incremental cost per LYG compared with other preventive and therapeutic strategies.	Study carried out in the US

Fishman et al., 2005, US	Model		18 year olds	Aim: to estimate the long-term costs of an antismoking mass media campaign and \$1 per pack tax increase on tobacco to achieve decreased smoking-attributable years of potential life lost	2000	Societal	Only media campaign: US\$528-\$19,957 per LYG (US \$615-\$23,264 per LYG in \$s2006) Combined programme: cost saving	Smoking prevention strategies in teens and young adults is not only cost-effective, but also a relatively small investment generates substantial cost savings.	Study carried out in the US
Ross et al., 2006, US	Model		13-14 year olds in 1996	Aim: to evaluate the impact of a community based tobacco control programme implemented between 1996 and 2001: school based +community wide measures such as school free environment, antismoking messages, involving the community in	2000	Not clearly stated but can be inferred	US\$3,942 per LYG (US \$4,595 per LYG in \$s2006)	Despite the relatively limited scale, the community based tobacco control programme represents a cost-effective investment in public health.	Study carried out in the US (Tucson, Arizona)

				prevention activities, enforcement mechanism to reduce youth access to tobacco					
Ahmad et al., 2005, US	Model		14-17 years old	Aim: to estimate the cost-effectiveness of increasing legal smoking age to 21 years in California	2003	Societal	Cost-saving	Raising the legal smoking age to 21 years in California will result in important population health gains while at the same time generating no net costs, rather saving the state a total of \$24,000 million (\$26,292 million \$s2006) over the next 50 years at an associated gain of 1.47 million QALYs compared to the status quo.	Study carried out in the US (California)

5. Conclusions

All studies reviewed find interventions cost-effective, or even cost saving. All interventions compared favourably with smoking cessation strategies and other preventive and therapeutic interventions. The difference in defined outcome measures makes direct comparison impossible, but the general conclusion has to be that such strategies are cost-effective, and often highly so.

While based on a small number of studies these results are particularly encouraging given that there appears to be relatively widespread abuse of the current legislative practices. The survey of Smoking, Drinking and Drug Use Among Young People in England (2006) reports that approximately two-thirds of those under the legal age for purchasing cigarettes identified shops as one of their main sources of cigarettes. Although there was some weak evidence to suggest that such purchases were becoming more difficult, the same survey reports that less than a quarter of the children under the age of 16 who had tried recently to purchase cigarettes from a shop had been refused. A recent Department of Health Statistical Bulletin reported that 12% of premises selling cigarettes allowed volunteer child consumers acting on behalf of local authority trading standards officers to purchase cigarettes across some 78 local authorities within England (Department of Health, 2001). Only 13% of the premises visited displayed warning notices aimed at children and only 40% of local authorities policed cigarette vending machines. It is unclear what impact any intent to reduce such inspections might have -see the Regulatory Impact Assessment: The Children's and Young Person's (Sale of Tobacco etc) Order (2007). Given the existing pattern of behaviour and the demonstrated cost-effectiveness in the small number of studies reviewed, it would appear that implementation of stricter enforcement of even the current legislation at point of sale is warranted. Additionally, if such enforcement was coupled with mass media campaigns targeted at young smokers given the reported effectiveness figures, although again from a remarkably small number of studies, such interventions could help achieve reductions in smoking prevalence in young persons to the government's target levels of 9% by 2010.

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Appendix 1. Search strategy for Medline

Medline/Ovid Web

MedSmokChild econ (20-07-07)

1. exp ECONOMICS/
2. exp "Costs and Cost Analysis"/
3. exp "Cost Allocation"/
4. exp Cost-Benefit Analysis/
5. exp "Cost Control"/
6. exp "Cost Savings"/
7. exp "Cost of Illness"/
8. exp "Cost Sharing"/
9. exp "Deductibles and Coinsurance"/
10. exp Medical Savings Accounts/
11. exp Health Care Costs/
12. exp Direct Service Costs/
13. exp Drug Costs/
14. exp Employer Health Costs/
15. exp Hospital Costs/
16. exp Health Expenditures/
17. exp Capital Expenditures/
18. exp "Value of Life"/
19. exp "Quality of Life"/
20. exp Quality-Adjusted Life Years/
21. QALY.mp.
22. exp Economics, Hospital/
23. exp Economics, Medical/
24. exp Economics, Nursing/
25. exp Economics, Pharmaceutical/
26. exp BUDGETS/
27. exp "Value of Life"/
28. (econom\$ or cost or costs or costly or costing or price or prices or pricing or pharmaeconomic\$).ti,ab.
29. budget\$.ti,ab.
30. (value adj money).ti,ab.
31. ((low or high or health care) adj cost\$).ti,ab.
32. (fiscal or funding or financial or finance).ti,ab.
33. (cost\$ adj (estimate or variable)).ti,ab.
34. (expenditure\$ not energy).ti,ab.
35. (cost adj (effectiveness or utility or minimization or minimisation or benefit) adj analysis).ti,ab.
36. discount\$.ti,ab.
37. preference\$.ti,ab.
38. (risk or risk taking or risk perception).ti,ab.
39. (smoking mortality risk or smoking dangers).ti,ab.

40. or/1-39
41. exp child/
42. exp adolescent/
43. (young adj (person\$ or people or adult\$ or individual\$)).ti,ab.
44. (under 18\$ or underage\$ or under eighteen\$).ti,ab.
45. (boy or boys or girl or girls).ti,ab.
46. (child\$ or adolescen\$ or kid or kids or youth\$ or youngster\$ or minor or minors or teen\$ or juvenile\$ or student\$ or pupil or pupils).ti,ab.
47. or/41-46
48. exp smoking/
49. (smoking or antismoking or anti-smoking).ti,ab.
50. (smoker or smokers).ti,ab.
51. tobacco/ or tobacco.ti,ab.
52. "tobacco use disorder"/
53. (cigar\$ or bidi or bidis or beedi or beedis or kretek or handroll\$ or hand roll\$ or nicotine).ti,ab.
54. tobacco, smokeless/
55. or/48-54
56. exp mass media/
57. cellular phone/
58. electronic mail/
59. radio/ or television/ or telephone/
60. advertising/ or hotlines/
61. information dissemination/
62. persuasive communication/
63. nonverbal communication/
64. motion pictures/
65. multimedia/
66. communications media/
67. exp tape recording/
68. exp serial publications/
69. pamphlets/
70. internet/
71. telecommunications/
72. mass media.ti,ab.
73. ((advert\$ or campaign\$ or program\$ or commerical\$) adj3 (tv or television or cable or satellite or cinema or cinemas or theatre or theatres or theater or theaters or movies or media or newspaper\$ or journal\$ or magazine\$)).ti,ab.
74. ((advert\$ or campaign\$ or program\$ or commercial\$) adj3 (dvd or dvds or video\$ or motion picture\$ or film or films or broadcast\$ or radio or televised or televized)).ti,ab.
75. ((phone or telephone or mobile or cellular) adj3 (counsel\$ or hotline\$ or hot line\$ or quitline\$ or quit line\$ or helpline\$ or help line\$ or adviceline\$ or advice line\$)).ti,ab.
76. ((internet or web\$) adj3 (advert\$ or campaign\$ or information or program\$ or commercial\$)).ti,ab.
77. (text messag\$ or texting or sms or short messag\$ service\$ or instant messag\$ or videomessag\$ or video messag\$ or multimedia messag\$).ti,ab.

78. (e-mail\$ or email\$ or electronic mail\$ or mailing list\$).ti,ab.
79. (pod cast\$ or podcast\$ or blog or blogs or blogging or blogosphere).ti,ab.
80. (digital adj3 (media or device\$ or platform\$ or technolog\$)).ti,ab.
81. (wireless adj3 (media or device\$ or platform\$ or technolog\$)).ti,ab.
82. (online adj3 (forum\$ or communit\$ or discussion\$)).ti,ab.
83. ((digital or interactive or mobile or online or viral or buzz) adj3 (market\$ or campaign\$ or advert\$ or commercial\$)).ti,ab.
84. (open space technolog\$ or social networking or bebo or facebook or myspace or netlog or profileheaven or xanga or yahoo\$).ti,ab.
85. (viral video or internet buzz or buzz device or advergaming or advergaming).ti,ab.
86. or/56-85
87. 47 and 55 and 86
88. commerce/ and (cigar\$ or bidi or bidis or beedi or beedis or kretek or handroll\$ or hand roll\$ or nicotine).ti,ab.
89. tobacco industry/
90. 88 or 89
91. ((sale or sales or sell or selling or sold or supply or supplies or supplied or supply\$) adj3 (tobacco or cigar\$ or bidi or bidis or beedi or beedis or kretek or handroll\$ or hand roll\$ or nicotine)).ti,ab.
92. ((purchase\$ or retail\$) adj3 (tobacco or cigar\$ or bidi or bidis or beedi or beedis or kretek or handroll\$ or hand roll\$ or nicotine)).ti,ab.
93. ((buy or buys or buying or bought) adj3 (tobacco or cigar\$ or bidi or bidis or beedi or beedis or kretek or handroll\$ or hand roll\$ or nicotine)).ti,ab.
94. ((vend or vends or vending) adj3 (tobacco or cigar\$ or bidi or bidis or beedi or beedis or kretek or handroll\$ or hand roll\$ or nicotine)).ti,ab.
95. ((shop or shops or shopping or shopped) adj3 (tobacco or cigar\$ or bidi or bidis or beedi or beedis or kretek or handroll\$ or hand roll\$ or nicotine)).ti,ab.
96. ((store or stores or supermarket\$) adj3 (tobacco or cigar\$ or bidi or bidis or beedi or beedis or kretek or handroll\$ or hand roll\$ or nicotine)).ti,ab.
97. tobacconist\$.ti,ab.
98. or/90-97
99. 47 and 98
100. ((prevent\$ or regulat\$ or control\$ or restrict\$ or prohibit\$ or ban\$ or limit\$ or illegal or law or legislat\$ or policy or policies) adj3 (smoke or smoking or tobacco or cigar\$ or bidi or bidis or beedi or beedis or kretek or handroll\$ or hand roll\$ or nicotine)).ti,ab.
101. exp Smoking/pc [Prevention & Control]
102. 100 or 101
103. 47 and 102
104. 87 or 99 or 103
105. limit 104 to (english language and yr="1990 - 2007")
106. exp asia/ or exp africa/ or exp south america/ or exp developing countries/
107. 105 not 106
108. 40 and 107

Appendix 2. Drummond checklist

	DiFranza et al. (2001)	Secker-Walker et al. (1997)	Fishman et al. (2005)	Ross et al. (2006)	Ahmad (2005)
Drummond	Response/ Score	Response/ Score	Response/ Score	Response/ Score	Response/ Score
1) The research question is stated	Yes	Yes	Yes	Yes	Yes
3) The viewpoint(s) of the analysis are clearly stated and justified	Yes	Yes	Yes	No but can be inferred	Yes
5) The alternatives being compared are clearly described	Yes	Yes	Yes	Yes although absence of a control group	Yes
6) The form of economic evaluation used is stated	Yes	Yes	Yes	Yes	Yes
7) The choice of form of economic evaluation is justified in relation to the questions addressed	Yes	Yes	Yes	Yes	Yes
8) The source(s) of effectiveness estimates used are stated	Yes	Yes	Yes	Yes	Yes
9) Details of the design and results of effectiveness study are given (if based on a single study) ANSWER 9 OR 10	Not appropriate	Yes	Not appropriate	Yes	Not appropriate
10) Details of the method of synthesis or meta-analysis of estimates are given (if based on a overview of a number of effectiveness studies) ANSWER 9 OR 10	Not appropriate	Not appropriate	Not appropriate	Not appropriate	Not appropriate
11) The primary outcome measure(s) for the economic evaluation are clearly stated	Yes	Yes	Yes	Yes	Yes
12) Methods to value health states and other benefits are stated	Not appropriate	Not appropriate	Not appropriate	Not appropriate	No
13) Details of the subjects from whom valuations were obtained are given	Not appropriate	Not appropriate	Not appropriate	Not appropriate	Not appropriate
14) Productivity changes (if included) are reported separately	Not appropriate	Not appropriate	Not appropriate	Not appropriate	Not appropriate
16) Quantities of resources are reported separately	Yes	Yes	Yes	No	Yes

from their unit costs					
17) Methods for the estimation of quantities and unit costs are described	Yes	Yes	Yes	No	Yes
18) Currency and price data are recorded	Yes	Yes	Yes	Yes	Yes
19) Details of currency of price adjustments for inflation or currency conversion are given	Not appropriate	Yes	Yes	Yes	Yes
20) Details of any model used are given	Not clear	Yes	Yes	Not clear	Yes
21) The choice of model used and the key parameters on which it is based are justified	Not clear	Yes	Yes	Yes	Yes
22) Time horizon of costs and benefits is stated	Yes	Yes	Yes	Yes	Yes
23) The discount rate(s) is stated	Yes	Yes	Yes	Yes	Yes
25) An explanation is given if costs or benefits are not discounted	Not appropriate	Not appropriate	Yes	Not appropriate	Not appropriate
26) Details of statistical tests and confidence intervals are given for stochastic data	Not appropriate	Yes	Not appropriate	Not appropriate	Not appropriate
27) The approach to sensitivity analysis is given	Yes	Yes	Yes	Yes	Yes
28) The choice of variables for sensitivity analysis is justified	Yes	Yes	Yes	Yes	Yes
29) The ranges over which the variables are varied are stated	Yes	Yes	Yes	Yes	Yes
30) Relevant alternatives are compared	Yes	Yes	Yes	Yes	Yes
31) Incremental analysis is reported	Yes	Yes	Yes	Yes	Yes
32) Major outcomes are presented in a disaggregated as well as aggregated form	Not appropriate	Not appropriate	Not appropriate	Not appropriate	Not appropriate
33) The answer to the study question is given	Yes	Yes	Yes	Yes	Yes
34) Conclusions follow from the data reported	Yes	Yes	Yes	Yes	Yes
35) Conclusions are accompanied by the appropriate caveats	Yes	No	Yes	Yes	Yes
Relevance to Modelling Score					
Model structure	No	Yes	Yes	No	Yes
Transition probabilities/risks etc	No	No	No	No	No
Resource use	Yes	Yes	No	No	Yes

Cost data	Yes	Yes	Yes	Yes	Yes
Outcomes/effects	Yes	Yes	Yes	Yes	Yes
Utility values	Not appropriate	Not appropriate	Not appropriate	Not appropriate	Yes
Other	No	No	No	No	No
Transferability Score					
1) The target decision maker is stated or can be inferred	Yes	Yes	Yes	Yes	Yes
2) Effectiveness year are recorded	Yes	Yes	Yes	Yes	Yes
3) Details of life expectancy are given	No	Yes	No	No	Yes
4) Details of compliance are given (Compliance with the intervention)	Not appropriate	Not appropriate	Not appropriate	Not appropriate	Not appropriate
5) Resources year are recorded	Yes	Yes	Yes	Yes	Yes
6) Details of technological availability are given	Not appropriate	Not appropriate	Not appropriate	Not appropriate	Not appropriate
7) Details of analysis to transfer to another jurisdiction are stated	Yes	Yes	Not appropriate	No	No
8) Conclusions address the generalisability of results	Yes	Yes	Yes	No	No