A mass media programme to prevent smoking among adolescents: costs and cost effectiveness

Roger H Secker-Walker, John K Worden, Robert R Holland, Brian S Flynn, Allan S Detsky

Abstract
Objective—To examine costs and cost-effectiveness ratios of a four-year mass media programme previously shown to prevent the onset of smoking among adolescents.

Design—A matched control design.

Setting—Two cities in Montana, one in New York and one in Vermont, USA.

Subjects—Students in grades 10–12 (ages 15–18).

Intervention—A four-year mass media campaign to prevent the onset of smoking.

Main outcome measures—Cost per student potentially exposed to the mass media campaign; cost per student smoker potentially averted; and cost per life-year gained. Cost estimates were also made for a similar campaign that would be broadcast nationally in the United States.

Results—In 1996 dollars, the cost of developing and broadcasting the mass media campaign was $759 436, and the cost per student potentially exposed to the campaign (n = 18 600) was $41. The cost per student smoker averted (n = 1023) was $754 (95% confidence interval (CI) = $531–$1296). The cost per life-year gained discounted at 3% over the life expectancy for young adult smokers was $696 (95% CI = $445–$1269). The estimated cost of developing and broadcasting a similar four-year mass media campaign in all 209 American media markets would be approximately $84.5 million, at a cost of $8 per student potentially exposed to a national campaign, $162 per student smoker averted, and $138 (95% CI = $88–$252) per life-year gained.

Conclusion—Estimates of the cost-effectiveness ratios of this mass media campaign in preventing the onset of smoking showed it to be economically attractive and to compare favourably with other preventive and therapeutic strategies.

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Keywords: smoking prevention; mass media; cost effectiveness; adolescents

Methods
Our estimates of the costs and cost-effectiveness ratios of a smoking prevention programme are based on a project that took place in 1984 and 1991 in four communities, two in Montana and two in the northeastern United States. The project was designed to test the effect of an intensive mass media programme (television and radio) added to a school smoking prevention curriculum. Two communities, one in Montana and one in the northeastern United States, received the mass media and school programmes, whereas the other two communities received the school programme alone for four years, beginning in grades 5–7 (ages 10–13) and continuing through grades 8–10 (ages 13–16). Both the mass media programme and smoking prevention curriculum had the same educational objectives. Details of the
<table>
<thead>
<tr>
<th>Samples</th>
<th>n</th>
<th>%</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>All students</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass media and school programme</td>
<td>2335</td>
<td>20.4</td>
<td>18.7-22.0</td>
</tr>
<tr>
<td>School programme only</td>
<td>2851</td>
<td>25.9</td>
<td>24.3-27.6</td>
</tr>
<tr>
<td>Difference</td>
<td>555</td>
<td>5.5</td>
<td>3.2-7.8</td>
</tr>
<tr>
<td>Girls*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass media and school programme</td>
<td>1151</td>
<td>21.0</td>
<td>18.7-23.3</td>
</tr>
<tr>
<td>School programme only</td>
<td>1327</td>
<td>28.3</td>
<td>25.9-30.6</td>
</tr>
<tr>
<td>Difference</td>
<td>77</td>
<td>5.5</td>
<td>3.9-10.7</td>
</tr>
<tr>
<td>Boys*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mass media and school programme</td>
<td>1166</td>
<td>19.8</td>
<td>17.5-22.1</td>
</tr>
<tr>
<td>School programme only</td>
<td>1521</td>
<td>23.8</td>
<td>21.7-25.9</td>
</tr>
<tr>
<td>Difference</td>
<td>355</td>
<td>4.0</td>
<td>0.9-7.1</td>
</tr>
</tbody>
</table>

*The sample sizes for girls and boys do not sum to the total sample size because of missing observations for gender.

CI = confidence interval.

The mass media component consisted of 36 television spots and 17 radio spots specifically designed to appeal to students as they passed through adolescence.22-24 The spots aired initially were those prepared for students in grades 5-7. Over the next three years, new spots, designed to appeal to these students as they matured through grades 8-10, were added and some of the earlier ones were dropped. The smoking prevention curriculum, four lessons per year per grade for grades 5-9 (ages 10-15), and three lessons for grade 10 (ages 15-16),22-26 was designed to be typical of smoking prevention curricula that would be available in the United States in the 1990s, and was taught by regular classroom teachers in all four communities. These teachers were trained in the curriculum’s use during day-long workshops each year, starting with grades 5-7 in 1985, and adding a grade each year through 1988.

Students were surveyed in school by the University of Vermont’s Biometry Facility survey team at baseline in May 1985, and then each year for the four years of the interventions (1986-89) and again two years after completion of the interventions (1991), as described previously.21-23 The efficacy of the mass media campaign was determined at two points in time: in 1989, immediately after four years of the mass media campaign, when the target group was in grades 8-10,21 and again in 1991, when the target group was in grades 10-12 (ages 15-18).21

To estimate cost-effectiveness ratios, we used the difference in smoking prevalence in the seventh year of the project between all students in grades 10-12 in the two mass media/school programme communities and all students in these grades in the two school programme communities. The students surveyed in these grades included those who had been at these schools since the inception of the project and thus potentially exposed to the entire campaign, and others who had transferred to them since then, who would have had less potential exposure.

Smoking prevalence in 1991 in the mass media/school programme communities and in the school programme-only communities for all students and for girls and boys separately is shown in Table 1. The differences for all students and for girls and boys separately were all significant, P<0.05. The confidence intervals shown are based on simple random sampling. The significance of these differences, and the sizes of the confidence intervals, were not changed when community, rather than individual, was considered the primary sampling unit because of an estimated negative variance component associated with community.

Because the same smoking prevention curriculum was implemented in the schools in all four communities, the differences in smoking prevalence represent the incremental effect of adding the mass media programme to the school smoking prevention curriculum and serve as our measure of the efficacy of the mass media programme.

**Cost Estimates**

The original development and production costs for the mass media programme were derived from our records.21-22 These costs include: salary and fringe benefits for research staff, consultant fees, travel costs, and costs of data entry and analysis for the diagnostic and formative research; and the preliminary and final production costs of the television and radio spots completed by six media producers. We have inflated these costs by applying the average annual increase in the All Items Consumer Price Index (CPI) between 1980 and 1991, 4.43% per year, to obtain cost estimates for 1996.27 For air-time costs, we estimated the 1996 costs of mounting an identical four-year media campaign directly from 1996 rates quoted by the television and radio stations in the two mass media/school programme communities.

Exposure to the mass media programme. Because far more students were potentially exposed to the mass media programme than were surveyed, we estimated the number of those potentially exposed in the two mass media/school programme communities. This estimate, 18 600 students for the three-year cohort, was derived from area-of-dominant-influence tables,28 which rank the media markets in the United States by number of households reached by each market, and from 1990 United States census data.29

**Cost-effectiveness Ratio**

We estimated the cost-effectiveness ratio for the mass media programme from the perspective of an organisation mounting a similar campaign in 1996. We used a cohort Markov model with annual cycles to determine life expectancy differences between populations with balanced gender ratios but differing prevalence of cigarette smoking.30

Mortality rates were determined from life tables for female and male never-smokers, former smokers, and “light” and “heavy” smokers in five-year age categories from 25-29 years to >75 years, obtained from a published analysis of 18 733 deaths.31 We combined the categories of never-smokers and former smok-
To estimate the costs of broadcasting a national, four-year mass media campaign similar to the one we implemented in 1986–89, we obtained quotes of 1996 rates from advertising managers at television and radio stations in six markets: two of the randomly selected large markets, ranked number 4 with 2 661 800 households and number 27 with 886 600 households; two medium-size markets, ranked number 64 with 407 600 households, and number 93 with 271 300 households; and two small markets, ranked number 135 with 158 400 households and number 182 with 65 800 households.32 We used these rates and the total number of minutes in prime time, early evening “fringe” time, late afternoons, and Saturday mornings purchased in the original campaign to estimate the costs of broadcasting an identical mass media campaign in each of these markets in 1996. We assumed that other markets of similar size would have similar costs. We used the estimate for the market ranked number 4 for the first 20 markets, number 27 for markets 21–40, number 64 for markets 41–60, number 93 for markets 61–80, number 135 for markets 81–120, number 182 for markets 121–160, and number 182 for markets 161–209. We summed these to obtain the 1996 cost for a sample broadcast year. We multiplied this estimate by four to obtain the total cost of broadcasting the four-year mass media campaign.

Results

The message development and production costs of the 36 television spots totalled $373 284, for an average of $10 369 per spot. Total costs for the 17 radio spots were $34 000, for an average of $2000 per spot. Thus, the overall development and production costs for the mass media campaign were $407 284. Of this total, $225 124 was for diagnostic and formative research that went into message development and broadcast planning, and $182 160 was for preliminary and final production of the television and radio spots. Inflated by the average annual increase in the CPI, development and production costs would be $576 102 in 1996.

Air-time was purchased on local television and radio stations to ensure that the spots would be broadcast at times that the target audience was likely to be watching television or listening to the radio, as indicated by the results of our annual school surveys. The total broadcast cost for the two communities receiving the mass media intervention over four years, at 1996 rates, would have been $183 334. Combining the costs of development, production, and broadcasting gave a total four-year programme implementation cost of $759 436 in 1996 dollars.

Costs per smoker averted

As table 1 shows, the prevalence of weekly smoking among 2335 students in grades 10–12 who were surveyed in the two media/school programme communities was 20.4% in 1991. In the school-only communities, the prevalence of weekly smoking was 25.9%, for a
difference of 5.5 percentage points (95% CI = 3.2 to 7.8). This difference represents an estimated 128 (95% CI = 75 to 182) fewer students beginning to smoke among those surveyed in the two media/school programme communities. Thus, from the perspective of the research project, the cost per student fully or partially exposed to the media campaign was $759 436/2335 = $325, and the cost per student smoker averted was $759 436/128 = $5933 (95% CI = $4173 to $10 126).

From the perspective of an organisation mounting a mass media campaign, it is important to estimate the cost for all the students in the targeted grades in the two communities exposed to the media/school programme, not just those surveyed for programme evaluation purposes. The cost per student in grades 5–7 who were potentially exposed to the media programme in these communities would be $759 436/18 600 = $41 for the four-year campaign. Assuming that the media campaign was associated with the same proportional reduction in the onset of smoking among students (5.5 percentage points), there would be 18 600 × 0.055 = 1023 (95% CI 959 to 1451) fewer smokers, for a cost per student smoker averted of $759 436/1023 = $742 (95% CI $523 to $1276).

For an already developed media campaign, the costs would be those required to purchase air-time only, $183 334. Thus, the cost per student in grades 5–7 who were potentially exposed to the media programme would be $183 334/18 600 = $10, and the cost per student smoker averted would be $183 334/1023 = $179 (95% CI = $126 to $308).

Table 3 Cost-effectiveness ratios of the mass media intervention for a range of smoking prevalence

<table>
<thead>
<tr>
<th>Smoking prevalence</th>
<th>Broadcast only</th>
<th>Development and broadcast</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost per life-year gained ($)</td>
<td>95% CI ($)</td>
</tr>
<tr>
<td>0.50</td>
<td>13.0</td>
<td>10.2</td>
</tr>
<tr>
<td>0.75</td>
<td>19.4</td>
<td>15.3</td>
</tr>
<tr>
<td>0.90</td>
<td>23.3</td>
<td>18.4</td>
</tr>
<tr>
<td>1.00</td>
<td>25.9</td>
<td>20.4</td>
</tr>
<tr>
<td>1.10</td>
<td>28.5</td>
<td>22.4</td>
</tr>
<tr>
<td>1.25</td>
<td>32.4</td>
<td>25.5</td>
</tr>
<tr>
<td>1.50</td>
<td>38.9</td>
<td>30.6</td>
</tr>
</tbody>
</table>

Adjustment in smoking prevalence is the multiplier to adjust the observed prevalence, as shown in bold.

Broadcast-only cost in 1996 dollars: $183 334, or $9.86 per student.

Development and broadcast cost in 1996 dollars: $759 436, or $40.83 per student.

1. Life-years gained were discounted at 3%.

CI = confidence interval.

COST-EFFECTIVENESS RATIOS

Our estimates of the cost per life-year gained from the perspective of an organisation mounting a similar campaign in 1996 are shown in table 2. These estimates show the cost per life-year gained without discounting the years, and with the years discounted at 3% and 5% over the life expectancy of young adult smokers. Based on the development and broadcast costs, the estimated cost per life-year gained, discounted at 3%, would be $696, and at 5%, $1732. For broadcast costs alone at these discount rates, the estimated cost per life-year gained would be $167 and $417, respectively. Table 2 also shows how the cost per life-year gained is influenced by the 95% confidence intervals of the observed-effect size of the mass media programme. The cost per life year gained ranges from about two-thirds to almost twice each estimate as the effect size varies from 7.8% to 3.2%.

In addition to the development and broadcast costs, we examined the effect of higher costs. At $100 per student, approximately 2.5 times the development and broadcast costs, the cost per life-year gained, discounted at 3%, would be $1701 (95% CI = $1102 to $2904).

We also examined the effect of reducing the difference in life expectancy between smokers and non-smokers. As would be expected, halving the difference to 2.5 years for young women and 3.16 years for young men, approximately doubles the cost per life-year gained. For development and broadcast costs, the estimated cost per life-year gained, discounted at 3%, would be $1389 (95% CI = $900 to $2420), and for broadcast costs alone, $333 (95% CI = $217 to $598).

The prevalence of smoking increases into early adulthood, although less rapidly than during adolescence. Because our cohort of students became young adults in 1996, we examined the effect of a range of smoking prevalence on the cost-effectiveness ratios. We assumed that prevalence would change by the same proportion in both the mass media/school programme communities and the school programme communities, and examined changes which ranged from 0.5 to 1.5 times the observed prevalence in the mass media/school programme communities. Table 3 shows how the cost-effectiveness ratio, discounted at 3%, falls as the prevalence of smoking increases from 13% to 39%, ranging from $1415 to $464 per life-year gained for developmental and broadcast costs, and from $335 to $111 per life-year gained for broadcast-only costs.

COSTS FOR A NATIONAL PROGRAMME

Table 4 shows the American student population aged 10–12 years in the areas of dominant influence; the costs of broadcasting the four-year media campaign in all large, medium, and small markets in the United States; and the costs per student potentially exposed to the campaign.

We estimate that a four-year national media campaign would cost about $83 300 000 using
Table 4. Population of students, air-time costs and costs per student for a national mass media smoking prevention campaign

<table>
<thead>
<tr>
<th>Size of media markets</th>
<th>Population of students aged 10–12 years</th>
<th>Four-year media campaign air-time costs (€)</th>
<th>Costs per student (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>40</td>
<td>6 410 600</td>
<td>55 247 000</td>
</tr>
<tr>
<td>Medium</td>
<td>80</td>
<td>2 897 600</td>
<td>19 567 000</td>
</tr>
<tr>
<td>Small</td>
<td>89</td>
<td>1 094 400</td>
<td>8 477 000</td>
</tr>
<tr>
<td>Total</td>
<td>209</td>
<td>10 602 600</td>
<td>83 291 000</td>
</tr>
</tbody>
</table>

*n = Number of areas of dominant influence in each size market.

Table 5. Number of student smokers averted, and costs per student smoker averted, by a national mass media smoking prevention campaign

<table>
<thead>
<tr>
<th>Size of media markets</th>
<th>Number of student smokers averted **</th>
<th>Costs per student smoker averted (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large</td>
<td>40</td>
<td>320 530</td>
</tr>
<tr>
<td>Medium</td>
<td>80</td>
<td>144 880</td>
</tr>
<tr>
<td>Small</td>
<td>89</td>
<td>54 720</td>
</tr>
<tr>
<td>Total</td>
<td>209</td>
<td>520 130</td>
</tr>
</tbody>
</table>

*n = Number of areas of dominant influence in each size market.

**An effect size of 5% was used to calculate the number of smokers averted.

Discussion

This study shows that adding the mass media campaign to the school smoking prevention curriculum was economically attractive, that is, the incremental cost per life-year gained was relatively low. At a 3% discount rate over the life expectancy of young adult smokers, a further 50 years for women and 50 years for men, the cost per life-year gained, $696, compares favourably with the cost-effectiveness ratios of several smoking cessation interventions, and even more so when the broadcast costs alone are considered, $167. For example, for brief smoking cessation advice from physicians provided during routine office visits, cost-effectiveness ratios (in 1984 dollars) ranged for different age groups from $705 to $988 per year of life saved for men, and from $1204 to $2058 for women. For nicotine gum as an adjunct to physicians’ advice, cost-effectiveness ratios (in 1984 dollars) ranged for different age groups from $4115 to $6465 per year of life saved for men, and from $6880 to $9473 for women. For the transdermal nicotine patch as an adjunct to physicians’ advice, cost-effectiveness ratios (in 1995 dollars) ranged for different age groups from $4390 to $10 943 per quality-adjusted life years saved for men, and from $4955 to $6983 for women. Our estimates of the cost-effectiveness ratios of this mass media campaign are also less than those of several other preventive and therapeutic measures by up to three orders of magnitude.

The sensitivity analyses show that the incremental cost per life-year gained remains relatively low even with the low estimate for the effect size, 3.2%, especially when considering the cost of broadcasting alone. Increasing the development and broadcasting costs to two and a half times the 1996 estimated cost increases the estimated cost per life-year gained to a similar extent. Halving the estimated difference in life expectancy of smokers compared with non-smokers almost doubles the cost-effectiveness ratio. With the same proportional increases in smoking prevalence into young adulthood in the mass media/school programme and school programme communities, the cost-effectiveness ratios fall because the effect size increases. Most of these cost-effectiveness ratios, especially those related to the cost of broadcasting, are still lower than the cost-effectiveness ratios of the smoking cessation interventions noted above, even without adjusting these estimates to 1996 dollars.

Our estimate of the cost-effectiveness ratio of a four-year national campaign, $138 per life-year gained, is based on our estimate of the number of 10–12-year-old students in all 209 media markets in the United States, and a reduction of five percentage points in the onset of smoking. We have not attempted to estimate the effect on either younger or older students who would also be potentially exposed to the mass media campaign, but it seems likely that our estimate of the cost-effectiveness of such a campaign, by focusing on the cohort of 10–12-year-old students, is conservative.
For our estimates of cost-effectiveness ratios, we used the perspective of organisations interested in developing and implementing a similar mass media campaign. We have not included estimates of the future potential reduction in direct medical costs or indirect costs due to disability or premature death for the non-smokers resulting from our mass media campaign. Nor have we included estimates of the increased future costs of later medical care and for pensions and Social Security payments incurred as these non-smokers live longer. Our reasons for not including these costs spring partly from our perspective for estimating the cost effectiveness of the mass media campaign, but two other factors also played a part. First, there is considerable evidence from work comparing the lifetime costs of smokers and non-smokers that such future savings in direct and indirect costs are likely to be offset by the additional costs incurred as the non-smokers live longer. Second, when these costs have been included in a cost-effectiveness analysis, as they were in Oster and colleagues’ study of the cost-effectiveness of nicotine gum as an adjunct to physicians’ advice against cigarette smoking, they did not alter their results to any appreciable extent. Mass media have been used in four other mass media campaigns aimed at preventing youth smoking, but in one of these, the impact of mass media on adolescent smoking of a successful multi-component drug abuse prevention programme could not be assessed separately from the other components, precluding an estimation of cost effectiveness of the mass media. The other campaigns were unaccompanied by a reduction in youth smoking. The mass media campaign used as the model for the analyses reported here differed from these latter campaigns in several important respects: it used theoretically based educational objectives, targeted message development and delivery to specific audience segments, and resulted in intensive exposure to the messages throughout the period of greatest risk of smoking initiation.

We conclude that estimates of the cost effectiveness of this four-year mass media campaign in preventing the onset of smoking show it to be economically attractive, with a relatively low incremental cost per life-year gained compared with other preventive and therapeutic strategies.

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