

Original article

A systematic review of school-based smoking prevention trials with long-term follow-up

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Abstract

Background: Several systematic reviews of school-based smoking prevention trials have shown short-term decreases in smoking prevalence but have not examined long-term follow-up evaluation. The purpose of this study was to conduct a systematic review of rigorously evaluated interventions for school-based smoking prevention with long-term follow-up data.

Methods: We searched online bibliographic databases and reference lists from review articles and selected studies. We included all school-based, randomized, controlled trials of smoking prevention with follow-up evaluation to age 18 or 12th grade and at least 1 year after intervention ended, and that had smoking prevalence as a primary outcome. The primary outcome was current smoking prevalence (defined as at least 1 cigarette in the past month).

Results: The abstracts or full-text articles of 177 relevant studies were examined, of which 8 met the selection criteria. The 8 articles included studies differing in intervention intensity, presence of booster sessions, follow-up periods, and attrition rates. Only one study showed decreased smoking prevalence in the intervention group.

Conclusions: Few studies have evaluated the long-term impact of school-based smoking prevention programs rigorously. Among the 8 programs that have follow-up data to age 18 or 12th grade, we found little to no evidence of long-term effectiveness. © 2005 Society for Adolescent Medicine. All rights reserved.

Keywords: Smoking prevention; School; Youth

Smoking is the leading cause of preventable death in the United States [1]. More than three quarters of cigarette smokers have their first cigarette before 18 years of age [2]. School-based interventions aimed either at prevention or cessation are particularly appealing because they reach a captive audience, and both intervention exposure and outcomes can be measured effectively. A federal mandate dic-

tates that all schools have a drug education program, and that it be evidence based [3].

Numerous school-based smoking prevention trials have found short-term decreases in smoking prevalence of 30% to 70% [4–8]. Review articles and meta-analyses show modest impact with effect sizes (a standardized measure of program outcome: the average difference between the treatment and control groups on the outcome variable divided by the SD of the control group) of .1 to .3 [9–13]. Many of these studies consider follow-up duration or exclude studies with inadequate follow-up evaluation. The long-term effect of interventions is important, given the suggested decayed

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Table 1
Summary of behavior change models

| Model | Development | Background/rational | Constructs/components |
|---|--------------------|---|--|
| Health belief/information deficit | 1960s | If adequate information shows that smoking causes serious harm to the body, adolescents would refrain from smoking | Increase awareness and comprehension of health effects through lectures, demonstrations, films, posters, and books |
| Social competence/affective information | 1970s | Cigarette smoking is associated with negative or antisocial patterns of behavior, reflecting decreased levels of perceived self-worth and poor attitudes toward family, school, and community | Clarify values, build self-esteem, develop general skills for decision making, communication, and assertiveness |
| Social influence | mid-1970s to 1990s | Peer smoking, smoking by others in immediate social environment, and other social and psychological factors are associated with smoking initiation (conceptualized as a social contagion) | Develop social skills to resist direct and indirect social influences that encourage smoking (generally also includes short-term consequences of smoking and development of social competencies) |

Adapted from Reducing Tobacco Use: A Report of the Surgeon General [14].

effectiveness of such programs [14] and the fact that tobacco use at age 18 better predicts adult smoking than does smoking at younger ages [15–17]. The current article presents a systematic review of randomized, controlled, school-based smoking prevention trials with follow-up smoking prevalence data through at least 12th grade or age 18.

Methods

Data sources

We conducted searches on the MEDLINE database (January 1966 to July 2003), the Cochrane Clinical Trials Registry (as of July 2003), as well as CINAHL, Embase, ERIC, and PsycInfo (all as of July 2003). Search terms used included: (smok* OR cigarette* OR tobacco) AND (school* OR class* OR teach*) AND (adolescen* OR minor OR student* OR child* OR teen* OR girl OR boy OR juvenile*). All searches were limited to randomized controlled trials. In addition, the bibliographies of relevant review articles, meta-analyses, and selected articles were examined for pertinent studies. The abstracts or full-text articles from these searches then were reviewed to determine whether they met the inclusion criteria for our review. Authors of the articles were contacted for additional information when necessary. Searches for unpublished trials were limited to the Medical Editors Trial Amnesty. Given that unpublished trials are more likely not to find an intervention effect, not including these studies in this review would potentially bias the results in this analysis away from the null.

Study selection

For inclusion, a study needed to allocate randomly the unit of evaluation (student, classroom, school, or district) to intervention and control groups and follow-up students from the time of intervention to at least 12th grade or age 18, at

least 1 year after the intervention ended. Studies were included if they measured smoking prevalence as a primary outcome.

Data extraction

Three investigators, 2 of whom were blinded to the journal citation and article text other than the methods section, reviewed the articles. The methodology and findings of all retrieved articles were evaluated critically. Each article was analyzed to determine the study method, intervention components, outcomes measured, and results. The intervention components were described using program descriptors included in the article text. A summary of established health behavior change models are shown in Table 1. The primary outcome was current smoking prevalence, defined as at least 1 cigarette in the past month, because this definition was used most frequently by included articles. For studies that did not measure or report current smoking prevalence, an alternative smoking outcome was used.

There was no assessment of quality in choosing or evaluating study outcomes beyond the inclusion criteria. We did not exclude or discount studies based on baseline similarities among treatment groups, study power, retention rates, or program intensity because these characteristics are not associated definitively with the strength of treatment effects [18].

Data are reported as prevalence ratios and risk differences of smoking in the intervention group compared with the control group, based on data reported in the publication or by the authors of the article.

Meta-analysis

By using the data extracted from studies meeting inclusion criteria, we performed a random-effects meta-analysis. A fixed-effects meta-analysis was not pursued because of a priori knowledge of clinical heterogeneity among the in-

Table 2
Characteristics of included trials

| Study | Number of subjects | Number of random groups* | Grade level | Retention | Length of follow-up evaluation | Program type | Program intensity |
|-----------------------|--------------------|--------------------------|-------------|-----------|---|---|---|
| Botvin et al. [25] | 5,954 | 56 | 7th–9th | 60% | 6 y/12th grade | Drug resistance, personal self-management, and generic social skills | 15 sessions in 7th grade with 10 and 5 sessions in 9th and 10th grades (30 total) |
| Dent et al. [26] | 332† | 26 | 11th subset | 63% | 1 y/12th grade | Dependency consequences and coping alternatives, skills development | 9 sessions over 3 weeks schoolwide |
| Ellickson et al. [27] | 6,527 | 30 | 7th–8th | 57% | 5 y/12th grade | Health belief model and self-efficacy theory of behavior change | 8 lessons in 7th grade with 3 booster sessions in 8th grade |
| Flay et al. [28] | 560 | 22 | 6th–8th | 81% | 6 y/12th grade | Social influences | 6 1-hour sessions in 6th grade with booster sessions in 7th/8th grades |
| Lynam et al. [29] | 2,071 | 31 | 6th | 48% | 10 y/19–21 years old | DARE curriculum with informational, affective, and social influence approaches | 17 1-hour sessions in 6th grade |
| Peterson et al. [30] | 7,865 | 40 | 3rd–10th | 94% | 9–11 y/12th grade, 2 years post-high school | Social influences plus motivational, self-confidence, family influence components | 9 sessions in 3rd–5th, 10 sessions in 6th–7th, 8 sessions in 8th, 5 sessions in 9th–10th grades (65 sessions total) |
| Shean et al. [31] | 2,366 | 45 | 7th | 37% | 7 y/12th grade | Social influences plus health effects | 5 sessions in 7th grade |
| Sussman [32] | 782† | 21 | 11th subset | 67% | 1 y/12th grade | Health motivation, social skills, decision-making approach | 9 sessions over 3 weeks schoolwide |

* Number of total randomized groups (including intervention and control arms).

† Number of 11th grade students at follow-up evaluation (total number of students enrolled is 1,208 in study by Dent et al. and 2,001 in study by Sussman et al.).

cluded studies and risk for publication bias among school-based interventions [19,20]. Risk differences reported in published studies or data obtained directly from the authors of the study were pooled. Given the limited number of studies meeting inclusion criteria and the significant variability in study methods and content, we were unable to stratify analyses by program type or intensity, duration of follow-up, or age of study participants. Analyses were performed both by pooling data within each study to generate weighted-average study-specific risk estimates, even if stratified by gender or baseline smoking status (e.g., only 1 risk estimate used per included study), and by using each stratum-specific category as a separate risk estimate (e.g., including several risk estimates per included study if results were published stratified by baseline characteristic). Analyses were performed using Stata 8.2 (College Station, Texas) [21–24].

Results

Results of literature search

The online MEDLINE search yielded 255 articles. Searches of CINAHL, Embase, ERIC, and PsycINFO

yielded 9,270 articles. No additional studies were located from the Cochrane Controlled Trials Registry or the Medical Editors Trial Amnesty. The most common reasons for exclusion were that follow-up was inadequate or the study was not randomized. Eight studies met all inclusion criteria [25–32].

Characteristics of included studies

There were variations in study populations, type and intensity of interventions, and outcome measures (Table 2). Most interventions targeted middle school students, but 2 interventions focused on high school students [26,32]. One included middle and high school students, but started intervention activities in the 3rd grade [30]. The intervention intensity varied from 5 to 65 sessions, and the duration ranged from 1 to 8 years. Attrition rates for follow-up evaluation varied from 6% to 63% (median, 38.5%). The majority of interventions were based on the social influences model, but some added social competence components as well. None of the study interventions included community or media programs.

The Life Skills Program study by Botvin et al. [25] involved 56 schools that were block-randomized to 1 of 2

Table 3
Smoking prevalence at study follow-up evaluation in 12th grade or age 18

| Study | Intervention arm | Prevalence definition | Intervention prevalence | Control prevalence | Risk difference | Prevalence ratio | |
|-----------------------|-------------------------------|---|-------------------------|--------------------|-----------------|------------------|--|
| Botvin et al. [25] | Full training intervention | Monthly | 27* | 33* | -6† | .82‡ | |
| | Limited training intervention | | 26* | 33* | -7† | .79‡ | |
| Dent et al. [26] | Class | Current | 39.2‡ | 52.2‡ | -13 | .75 | |
| | School as community | | 52.2‡ | 52.2‡ | 0 | 1 | |
| Ellickson et al. [27] | Teen-led intervention | Current | | | | | |
| | Baseline nonsmoker | | 15.8‡ | 15.1‡ | .7 | 1.05 | |
| | Baseline experimental smoker | | 30.7‡ | 29.8‡ | .9 | 1.03 | |
| | Baseline smoker | | 54.5‡ | 49‡ | 5.5 | 1.11 | |
| | Adult-led intervention | | | | | | |
| | Baseline nonsmoker | | 14.7‡ | 15.1‡ | -.4 | .97 | |
| Flay et al. [28] | Full intervention | Experimenter (smokes less than once/week) | 41 | 44 | -3 | .93 | |
| | | | | | | | |
| | | | | | | | |
| Lynam et al. [29] | Full intervention | Current | 42.5‡ | 37.8‡ | 4.7 | 1.12 | |
| Peterson et al. [30] | Full intervention | Current | 34.7 | 34 | .7 | 1.02 | |
| Shean et al. [31] | Peer-led | Daily | | | | | |
| | Male nonsmokers | | 19 | 18 | 1 | 1.06 | |
| | Female nonsmokers | | 16 | 28 | -12 | .57 | |
| | Male smokers | | 46 | 47 | -1 | .98 | |
| | Female smokers | | 52 | 39 | 13 | 1.33 | |
| | Teacher-led | | | | | | |
| | Male nonsmokers | | 16 | 19 | -3 | .84 | |
| | Female nonsmokers | | 17 | 28 | -11 | .61 | |
| | Male smokers | | 43 | 47 | -4 | .91 | |
| | Female smokers | | 51 | 39 | 12 | 1.31 | |
| Sussman et al. [32] | Class | Current | 34.5 | 30.7 | 3.8 | 1.12 | |
| | School-as-community | | 33.1 | 30.7 | 2.4 | 1.08 | |

* Prevalences adjusted for baseline smoking status and assignment group (geographic area).

† $p < .05$.

‡ Based on individual level data.

intervention groups (varying only in the training of the intervention staff) or a control group. The intervention was based on a model stressing recognition of social influences and development of social competence. There was a high intensity program in the 7th grade with booster sessions in the 8th and 9th grades. At 12th grade, the monthly smoking prevalence among the control group was 33% and among the 2 intervention groups were 26% and 27% after adjusting for baseline smoking levels, representing a statistically significant decrease among the intervention groups ($p < .05$).

Dent et al. [26] randomized 26 classrooms from 3 high schools to intervention or control groups. A total of 1,208 students from 9th to 11th grade completed a baseline survey, and 1 year later 679 students completed a follow-up survey, 332 of whom were 12th graders and were included in this analysis. The intervention consisted of 9 sessions over 3 weeks and emphasized health motivation, social skills, and good decision making. The target outcome was a decrease in all drug use, including tobacco. No statistically significant differences were found in monthly smoking prevalence among 12th graders (or among the total student population) at 1 year follow-up.

In the Project Alert study by Ellickson et al. [27], 30 schools were block-randomized to either an intervention by an adult health educator, or an adult and peer health educator, or a control group. A health belief model and self-efficacy theory of behavior change was used. Saliva samples on consenting subjects were collected to improve self-reported smoking status. Statistical analysis was performed using individual level data, although randomization was performed at the school level. Annual surveys were performed to assess intermediate outcomes and indicated intervention effects on smoking prevalence decayed by the 10th grade, although cognitive effects persisted longer. There were no statistically significant differences in current smoking prevalence in the teen-led or the adult-led intervention compared with the control group at grade 12 follow-up evaluation. Even when stratified by baseline smoking status, significant differences in smoking prevalence were not observed. Similarly, there were no decreases in monthly, weekly, or daily smoking in the intervention groups at long-term follow-up evaluation.

The earliest study to report long-term results of a school-based smoking prevention trial was by Flay et al. [28] in

1989. In this study, 22 schools were randomized to intervention or control groups. There were 6 sessions in the 6th grade, with 2 booster sessions in the 6th grade, 2 in the 7th grade, and 1 in the 8th grade. The program adhered to the social influences model. A variety of smoking outcomes, including never smoker, experimenter, regular smoker, and quitter were assessed. Students were asked to give saliva samples to improve self-reported measures. By the 12th grade, regular smoking status did not significantly differ between the intervention and control groups, after controlling for baseline smoking status, social environmental risk, and original school district (odds ratio, 1.22; 95% confidence interval, .83–1.80).

Lynam et al. [29] studied the long-term effectiveness of Project DARE (Drug Abuse Resistance Education). This study included 31 middle schools, of which 23 were randomized to the intervention condition. The intervention consisted of 17 weekly sessions, emphasizing peer-pressure resistance, drug education, decision-making skills, and self-esteem. Yearly follow-up surveys were conducted through the 10th grade, at which point no statistically significant differences in self-reported tobacco use were found [33]. An additional follow-up survey was performed 10 years after the intervention, when the subjects were between 19 and 21 years old. By using hierarchic linear models, they found no statistically significant association between DARE exposure (intervention or control subject) and frequency of past-month cigarette use, after controlling for baseline cigarette use (β coefficient .101, $p > .05$).

The Hutchinson Smoking Prevention Project by Peterson et al. [30] is the most intensive and rigorously implemented school-based study conducted to date. Forty school districts were randomized by matched pairs to an intervention or control group. A total of 56 intervention sessions focusing on the Centers for Disease Control–recommended social influences approach occurred in the 3rd through 10th grades. Monthly smoking prevalence at 12th grade was 34.0% in the control districts and 34.7% in the intervention districts (–.7% difference; 95% confidence interval, –4.6 to 2.9). There were no significant differences in current, daily, or cumulative smoking between intervention and control students, even in subgroup analyses by gender or various risk factors.

Shean et al. [31] studied the differences between teacher-led versus peer-led (same age and selected by their classes) intervention programs by block-randomizing 45 Australian schools to 1 of 2 interventions or a control group. There were 2,366 students in the 7th grade who took a baseline survey and then took part in 5 sessions based on the social consequences curriculum. The outcome measure was whether the subject usually smoked daily. There were no differences in daily smoking prevalence between the intervention and control groups in the 12th grade.

In the study by Sussman et al. [32], 21 alternative high schools were block-randomized to 1 of 2 intervention

groups or a control group. These schools included only high-risk students and had a baseline current smoking prevalence of 57%. A total of 2,001 students ages 14 to 19 years completed a baseline survey, and 1 year later 1,341 students completed a follow-up survey, 782 of whom were 12th graders or at least 18 years old and were included in this analysis. The intervention groups were a classroom program (similar in content and intensity to that described in the Dent et al. [26] study) or classroom plus school-as-community component. School-as-community was an interactive program that involved weekly meetings (6% participation), several events during the school year (approximately 20% participation), and a community newsletter that promoted drug abuse prevention. No significant difference was seen between the intervention and control groups.

Comparison of included studies

Smoking prevalence as reported in each study at 12th grade or age 18 follow-up evaluation varied from 15% to 58% in the intervention groups and from 15% to 52% in the control groups (Table 3). Five studies used current smoking as a primary outcome. None of the differences were statistically significant in any individual study except for Botvin et al. [25] (risk difference of a 6–7 decrease in the intervention compared with control groups, and prevalence ratio of .82–.79).

The pooled risk difference estimate from the random-effects meta-analysis was –.61 (95% confidence interval, –4.22 to 3.00). Measures of statistical heterogeneity mirrored evidence of clinical heterogeneity ($Q = 5.031$, $p < .001$), suggesting the summary measure is difficult to interpret due to the large, unexplained between-study variability [20,34,35].

Discussion

Few randomized controlled studies have evaluated the long-term impact of school-based smoking prevention programs rigorously. Among the 8 studies we analyzed, only 1 showed statistically significant results, suggesting that school-based intervention effects resulted in decreased monthly smoking prevalence at 12th grade or age 18 [25]. It is possible that the Life Skills Program is effective and others are not because it used a relatively high degree of interaction and participation. Because there are a limited number of studies with long-term follow-up data and considerable variation in their intervention methodology, we were unable to conclude whether differences in study outcomes are the result of differences in program content, program intensity, program delivery, or the methodologic rigor of analysis.

Our findings differ from those of previous systematic reviews and meta-analyses of school-based smoking prevention efforts, which suggested these efforts are effective in the short term [11–13,36,37]. Our analysis, in contrast

with prior efforts, focused exclusively on studies with long-term follow-up evaluation. The Surgeon General's Report, "Reducing Tobacco Use," did distinguish between studies with long- and short-term follow-up data and concluded the former showed decaying effectiveness [14]. Based on non-randomized studies, it maintained that school-based smoking prevention efforts are useful in conjunction with community and media interventions. It offered no evidence, however, for long-term effectiveness of school-based prevention independent of community or media interventions beyond the study by Botvin et al. [25] cited earlier. Additionally, "Reducing Tobacco Use" preceded more recent studies showing no long-term effects.

If there is only tenuous evidence for long-term effects of school-based prevention programs but relatively strong indicators of positive short-term effects, how may this discrepancy be explained? One hypothesis is that the only intervention effect is to sensitize students to responses desired by the researchers (i.e., experimental demand characteristics). Although some studies used bogus pipeline techniques to improve survey validity [27,28,30], smoking prevalence may be underreported significantly, particularly when evaluation closely follows the intervention effort. A second possibility is that prevention efforts have positive but short-lived effects. If so, the absence of long-term effects need not imply that such interventions have no value. They may provide a critical window of opportunity in which students might be enticed to participate in further programs to increase long-term resistance to smoking. To date, little evidence exists suggesting which program components could create such a window—or what type of programs could reinforce and expand initial inclinations to avoid consumption of tobacco products. Further, we lack the means to measure how quickly programmatic effects decay independent of differences in demand characteristics. Although it may be true that current school-based prevention efforts have no strong impact on the likelihood of being a current smoker at age 18 or at some later date, it is possible such programs may increase chances significantly that exposed adolescents will quit or smoke less heavily as an adult [38].

A final consideration is the duration of follow-up evaluation needed to predict a long-term decrease in smoking adequately. From a public health standpoint, the primary interest is nonsmoking in adolescence that continues into adulthood. Although cigarettes do have detrimental immediate effects in adolescence, the larger public health impact on morbidity and mortality accrue after decades of smoking. Several longitudinal studies suggest that smoking at age 18 is a better predictor of adult smoking patterns than smoking at younger ages [15–17], and, given the lack of data on adult smoking outcomes for school-based interventions, smoking at age 18 is an appropriate measure of intervention effectiveness.

One possible criticism of this review is that the inclusion

criteria are too rigorous and omit worthwhile interventions. Specifically, requiring follow-up evaluation to 12th grade or age 18 might eliminate sound research that supports various prevention programs. To examine this possibility, we looked at studies that met the other criteria for inclusion but that had no follow-up evaluation beyond the 10th or 11th grades. In none of these cases were there statistically significant decreases in smoking [33,39–41]. More recent interventions with promising innovative approaches, including involvement of families and the community both during and after school, do not yet have long-term follow-up data and therefore were not included in this analysis [42–44].

In addition, given the necessary time and financial resources needed to perform large community-based interventions with long-term follow-up evaluation, few investigators are capable or willing to undergo such studies. This also would limit the data available to evaluate long-term effectiveness.

Other factors may affect our ability to estimate the impact of smoking interventions. An intervention effect may be underestimated because of the lack of true nonintervention controls. Because there is a federal mandate that all school districts seeking Title IV funds must have a scientifically based substance abuse prevention program that includes tobacco control, there are few public schools in the United States with no prevention efforts. Study results may be overestimated if schools or districts were randomized to treatment conditions, but students were evaluated as the unit of analysis. The unit of analysis problem could result in a higher type I error if intraclass correlation is not taken into account [12]. Finally, student attrition may result in underestimation or overestimation of a program's impact. If a particular program is effective in a high-risk population and this high-risk population is underrepresented in the follow-up data, then even with nondifferential attrition, as would be expected using a randomized design, the study's effectiveness may be underestimated. Conversely, if the program is less effective with a high-risk population, the effectiveness may be overestimated.

This review does not address other potentially effective interventions aimed to curb youth smoking prevalence. There is evidence that cigarette price increases [45] and antismoking multimedia campaigns [46–50] are associated with decreased smoking prevalence. The effect of price increases on smoking prevalence in adolescents is substantial, according to ecologic analyses, with an average price elasticity (percent decrease in prevalence for each percent increase in price) of $-.6$. In other words, a 10% increase in price would result in a 6% decrease in smoking prevalence. Experimental trials of tobacco taxes are not feasible and have not been performed.

Both statewide and experimental studies at the community level have been performed to evaluate smoking prevention media campaigns [51–61]. Most states have some kind of tobacco control program in place, particularly since the

Master Settlement Agreement in 1998, and media interventions have been an integral part of successful comprehensive programs [52,61]. Analyses of statewide programs, including those adopting increased tobacco taxes and media campaigns, have difficulty determining the independent effect of each component [47,62,63].

Conclusion

Based on the available data in 1999, the Centers for Disease Control and Prevention recommended a comprehensive tobacco control program [64] that included a school-based component. In addition, Congress mandated that schools seeking Title IV funds use research-based prevention programs. Despite this, as shown in this systematic review, there is little evidence to suggest that existing programs produce long-term decreases in smoking prevalence.

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References

- [1] McGinnis JM, Foege WH. Actual causes of death in the United States. *JAMA* 1993;270:2207–12.
- [2] U.S. Department of Health and Human Services. Preventing Tobacco Use Among Young People: Report of the Surgeon General. Atlanta, Georgia: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1994.
- [3] Strengthening and Improvement of Elementary and Secondary Schools. Safe and Drug-free Schools and Communities. In: US Code: Section 7144.
- [4] Dent CW, Sussman S, Stacy AW, et al. Two-year behavior outcomes of project towards no tobacco use. *J Consult Clin Psychol* 1995;63: 676–7.
- [5] Eckhardt L, Woodruff SI, Elder JP. Related effectiveness of continued, lapsed, and delayed smoking prevention intervention in senior high school students. *Am J Health Promot* 1997;11:418–21.
- [6] Elder JP, Wildey M, de Moor C, et al. The long-term prevention of tobacco use among junior high school students: classroom and telephone interventions. *Am J Public Health* 1993;83:1239–44.
- [7] Sussman S, Dent CW, Stacy AW, et al. Project towards no tobacco use: 1-year behavior outcomes. *Am J Public Health* 1993;83:1245–50.
- [8] Walter HJ. Primary prevention of chronic disease among children: the school-based “Know Your Body” intervention trials. *Health Educ Q* 1989;16:201–14.
- [9] Rundall TG, Bruvold WH. A meta-analysis of school-based smoking and alcohol use prevention programs. *Health Educ Q* 1988;15:317–34.
- [10] Ennett ST, Tobler NS, Ringwalt CL, Flewelling RL. How effective is drug abuse resistance education? A meta-analysis of Project DARE outcome evaluations. *Am J Public Health* 1994;84:1394–401.
- [11] Bruvold WH. A meta-analysis of adolescent smoking prevention programs. *Am J Public Health* 1993;83:872–80.
- [12] Rooney BL, Murray DM. A meta-analysis of smoking prevention programs after adjustment for errors in the unit of analysis. *Health Educ Q* 1996;23:48–64.
- [13] Tobler NS. Meta-analysis of adolescent drug prevention programs: results of the 1993 meta-analysis. *NIDA Res Monogr* 1997;170:5–68.
- [14] Reducing Tobacco Use. A Report of the Surgeon General. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2000.
- [15] Chassin L, Presson CC, Sherman SJ, Edwards DA. The natural history of cigarette smoking: predicting young-adult smoking outcomes from adolescent smoking patterns. *Health Psychol* 1990;9: 701–16.
- [16] Chassin L, Presson CC, Pitts SC, Sherman SJ. The natural history of cigarette smoking from adolescence to adulthood in a midwestern community sample: multiple trajectories and their psychosocial correlates. *Health Psychol* 2000;19:223–31.
- [17] Janson H. Longitudinal patterns of tobacco smoking from childhood to middle age. *Addict Behav* 1999;24:239–49.
- [18] Balk EM, Bonis PA, Moskowitz H, et al. Correlation of quality measures with estimates of treatment effect in meta-analyses of randomized controlled trials. *JAMA* 2002;287:2973–82.
- [19] Petitti D. Meta-analysis, decision analysis, and cost-effectiveness analysis, 2nd ed. New York: Oxford University Press, 2000.
- [20] Thompson SG. Systematic review: why sources of heterogeneity in meta-analysis should be investigated. *BMJ* 1994;309:1351–5.
- [21] Sharp S. Meta-analysis. *Stata Technical Bull* 1998;7:148–55.
- [22] Sharp S, Sterne J. New syntax and output for the meta-analysis command. *Stata Technical Bull* 1998;7:106–8.
- [23] Sharp S, Sterne J. Corrections to the meta-analysis command. *Stata Technical Bull* 1999;8:84.
- [24] StataCorp. *Stata Statistical Software: Release 8.0*. College Station, TX: Stata Corporation, 2003.
- [25] Botvin GJ, Baker E, Dusenbury L, et al. Long-term follow-up results of a randomized drug abuse prevention trial in a white middle-class population. *JAMA* 1995;273:1106–12.
- [26] Dent CW, Sussman S, Stacy AW. Project Towards No Drug Abuse: generalizability to a general high school sample. *Prev Med* 2001;32: 514–20.
- [27] Ellickson PL, Bell RM, McGuigan K. Preventing adolescent drug use: long-term results of a junior high program. *Am J Public Health* 1993;83:856–61.
- [28] Flay BR, Koepke D, Thomson SJ, et al. Six-year follow-up of the first Waterloo school smoking prevention trial. *Am J Public Health* 1989; 79:1371–6.
- [29] Lynam DR, Milich R, Zimmerman R, et al. Project DARE: no effects at 10-year follow-up. *J Consult Clin Psychol* 1999;67:590–3.
- [30] Peterson AV Jr, Kealey KA, Mann SL, et al. Hutchinson Smoking Prevention Project: long-term randomized trial in school-based tobacco use prevention—results on smoking. *J Natl Cancer Inst* 2000; 92:1979–91.
- [31] Shean RE, de Klerk NH, Armstrong BK, Walker NR. Seven-year follow-up of a smoking-prevention program for children. *Aust J Public Health* 1994;18:205–8.
- [32] Sussman S, Dent CW, Stacy AW, Craig S. One-year outcomes of Project Towards No Drug Abuse. *Prev Med* 1998;27:632–42.
- [33] Clayton R, Cattarello A, Johnstone B. The effectiveness of drug abuse resistance education (Project DARE): 5-year follow-up results. *Prev Med* 1996;25:307–18.

- [34] Engels EA, Schmid CH, Terrin N, et al. Heterogeneity and statistical significance in meta-analysis: an empirical study of 125 meta-analyses. *Stat Med* 2000;19:1707–28.
- [35] Petitti D. Statistical methods in meta-analysis. In: Kelsey JL, Marmot MG, Stolley PD, Vessey MP. *Meta-Analysis, Decision Analysis, and Cost-Effectiveness Analysis*. New York: Oxford University Press, 2000;7, 99, 115.
- [36] Botvin GJ. Preventing drug abuse in schools: social and competence enhancement approaches targeting individual-level etiologic factors. *Addict Behav* 2000;25:887–97.
- [37] Bangert-Drowns RL. The effects of school-based substance abuse education—meta-analysis. *J Drug Educ* 1988;18:243–64.
- [38] Caulkins JP, Pacula RL, Paddock S, Chiesa J. School-based drug prevention: what kind of drug use does it prevent? *RAND* 2002;73–8.
- [39] Aveyard P, Sherratt E, Almond J, et al. The change-in-stage and updated smoking status results from a cluster-randomized trial of smoking prevention and cessation using the transtheoretical model among British adolescents. *Prev Med* 2001;33:313–24.
- [40] Dijkstra M, Mesters I, De Vries H, et al. Effectiveness of a social influence approach and boosters to smoking prevention. *Health Educ Res* 1999;14:791–802.
- [41] Biglan A, Glasgow R, Ary D, et al. How generalizable are the effects of smoking prevention programs? Refusal skills training and parent messages in a teacher-administered program. *J Behav Med* 1987;10: 613–28.
- [42] Spoth RL, Redmond C, Trudeau L, Shin C. Longitudinal substance initiation outcomes for a universal preventive intervention combining family and school programs. *Psychol Addict Behav* 2002;16:129–34.
- [43] Storr CL, Ialongo NS, Kellam SG, Anthony JC. A randomized controlled trial of two primary school intervention strategies to prevent early onset tobacco smoking. *Drug Alcohol Depend* 2002;66:51–60.
- [44] Brown KS, Cameron R, Madill C, et al. Outcome evaluation of a high school smoking reduction intervention based on extracurricular activities. *Prev Med* 2002;35:506–10.
- [45] Lewit EM, Hyland A, Kerrebrock N, Cummings KM. Price, public policy, and smoking in young people. *Tob Control* 1997;6:S17–24 (suppl 2).
- [46] Hu TW, Sung HY, Keeler TE. Reducing cigarette consumption in California: tobacco taxes vs an anti-smoking media campaign. *Am J Public Health* 1995;85:1218–22.
- [47] Sowden AJ, Arblaster L. Mass media interventions for preventing smoking in young people. *Cochrane Database Syst Rev* 2000;2: CD001006.
- [48] Kaplan RM, Ake CF, Emery SL, Navarro AM. Simulated effect of tobacco tax variation on population health in California. *Am J Public Health* 2001;91:239–44.
- [49] Keeler TE, Hu TW, Barnett PG, Manning WG. Taxation, regulation, and addiction: a demand function for cigarettes based on time-series evidence. *J Health Econ* 1993;12:1–18.
- [50] Liang L, Chaloupka FJ. Differential effects of cigarette price on youth smoking intensity. *Nicotine Tob Res* 2002;4:109–14.
- [51] Biener L. Adult and youth response to the Massachusetts anti-tobacco television campaign. *J Public Health Manag Pract* 2000;6:40–4.
- [52] Siegel M. The effectiveness of state-level tobacco control interventions: a review of program implementation and behavioral outcomes. *Annu Rev Public Health* 2002;23:45–71.
- [53] Crawford MA. Cigarette smoking and adolescents: messages they see and hear. *Public Health Rep* 2001;116:203–15 (suppl 1).
- [54] DeJong W, Hoffman KD. A content analysis of television advertising for the Massachusetts Tobacco Control Program media campaign, 1993–1996. *J Public Health Manag Pract* 2000;6:27–39.
- [55] Elder JP, Edwards CC, Conway TL, et al. Independent evaluation of the California Tobacco Education Program. *Public Health Rep* 1996; 111:353–8.
- [56] Farrelly MC, Heaton CG, Davis KC, et al. Getting to the truth: evaluating national tobacco countermarketing campaigns. *Am J Public Health* 2002;92:901–7.
- [57] Riester T, Linton M. Designing an effective counteradvertising campaign—Arizona. *Cancer* 1998;83:2746–51 (suppl 12).
- [58] Sly DF, Heald GR, Ray S. The Florida “truth” anti-tobacco media evaluation: design, first year results, and implications for planning future state media evaluations. *Tob Control* 2001;10:9–15.
- [59] Sly DF, Hopkins RS, Trapido E, Ray S. Influence of a counteradvertising media campaign on initiation of smoking: the Florida “truth” campaign. *Am J Public Health* 2001;91:233–8.
- [60] Zucker D, Hopkins RS, Sly DF, et al. Florida’s “truth” campaign: a counter-marketing, anti-tobacco media campaign. *J Public Health Manag Pract* 2000;6:1–6.
- [61] Friend K, Levy DT. Reductions in smoking prevalence and cigarette consumption associated with mass-media campaigns. *Health Educ Res* 2002;17:85–98.
- [62] Hafstad A, Aaro LE, Engeland A, et al. Provocative appeals in anti-smoking mass media campaigns targeting adolescents—the accumulated effect of multiple exposures. *Health Educ Res* 1997;12: 227–36.
- [63] Flynn B, Worden J, Secker-Walker R, et al. Cigarette smoking prevention effects of mass media and school interventions targeted to gender and age groups. *J Health-Educ* 1995;26:S45–51.
- [64] CDC. *Best Practices for Comprehensive Tobacco Control Programs—August 1999*. Atlanta, GA: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1999.