

A meta-analysis of mediating effects on adolescent psychosocial smoking prevention programs in the United States

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I . Introduction

Tobacco use is the most important single preventable cause of death in the United States (U.S. Dept. of Health and Human Services 1989) and each day in the United States more than 6000 children and adolescents try their first cigarette (National Cancer Institute 1998). The major efforts of tobacco control directed at preventing initiation focused on adolescents have been made since the 1960s. School-based tobacco education have made contributions to

decreasing smoking behaviors among young people in the nation's health and especially, psychosocial models of smoking prevention have been more effective than the traditional (information deficit; affective) models of smoking prevention. Rather than knowledge, attitudes, or beliefs in the previous intervention approaches, psychosocial smoking prevention approaches recognize social influences as the most important determinant of adolescent smoking behavior and focus on the development of social norms and skills to resist peer and/ or the media pressures to smoke. However,

the smoking prevention authorities including researchers, educators, and decision-makers are not satisfied with the impact of the psychosocial approaches due to incompatible results among studies. For instance, Botvin and Eng (1982) found a significant 58% reduction of new smoking behaviors among 7th grade students at 1-year followup while Burke et al. (1987) and Ary et al. (1990) failed to achieve significant results. These contrasting results among studies may come from the different use of psychosocial approaches that emphasize multi-strategies and multi-channels when planned.

It is believed, however, that psychosocial smoking prevention programs hold great promise for decreasing smoking initiation among students when implemented optimally. Researchers have designed and implemented psychosocial smoking interventions with multiple factors that predispose, enable, and reinforce non-smoking behavior in an attempt to identify optimal factors significantly related to increased program effects. Unfortunately, many unanswered questions remain about what psychosocial program components are effective. For example, it is not known if smoking reductions are the results of the students' ability to perform the refusal skills they are taught, or whether they are caused by other variables such as normative shifts or increased awareness that smoking is not the 'in thing to do' (Kats, Robisch, and Telch 1989).

The purpose of this study is to identify

psychosocial smoking prevention program components that are linked to greater program effects. Theoretical formulations in this analysis posit that program impact on knowledge and/ or skills are associated with less smoking behaviors among program participants (Figure 1). For instance, the analysis of skills can lead to a conclusive assumption that the improved levels of skill-use greatly influence the decreased levels of cigarette use among students who receive psychosocial programs. This linear relationship between program impact (knowledge and skills) and outcome (behavior) variables is called mediating effects of the programs for the present study. Therefore, knowledge and skills are mediating outcome variables, not the program's final outcome variable. Investigation was successively conducted on the both mediating outcome variables of knowledge and skills and final outcome variable of behavior used in adolescent psychosocial smoking prevention programs, based on following research questions:

- a) What knowledge and skill factors can be identified for this analysis?
- b) How much do the factors impact the mediating outcomes?
- c) Do the mediating outcomes relate to an impact on the behavioral outcomes?

The second and third questions were to provide the inferential evidence of an impact on smoking behavior accompanied by an

ing programs. While earlier meta-analysis studies were likely to summarize general program effects, this meta-analysis study was to identify program variables associated with program success. The findings of the analysis recommended practical guidelines for psychosocial smoking prevention program designs.

II. Methods

1. Research methods

The present meta-analysis study was conducted using primary research methods: development of specific objectives, identification of population and sampling procedures (criteria inclusion), valid data collection (data retrieval and screening out), codification (coding scheme), data entry and statistical analysis, and result report.

This meta-analysis was specifically designed to identify program factors significantly associated with the reduction of U.S. adolescent smoking behavior. The study population was from the evaluation studies of psychosocial smoking prevention programs for American adolescents in grades of 6th through 12th that have been published 1978 through 1997. The study samples were identified through on-line and ancestry searches, but some of them were deselected unless an evaluation study has met the following criteria: (1) at least one control or comparison group that must have

pretest and/or posttest scores; (2) control group in the program must not receive another type of psychosocial program; and (3) reporting of quantitative measures on behavior and mediating outcome variables with regards to specific constructs in knowledge and/ or skills. For the specific constructs of mediating outcome variables, the studies included in the current meta-analysis were selected if they measure at least two specific knowledge constructs among health effects, social consequences, social influences, and social norms. Individual studies were also included if they measure at least one specific skill construct among affective skill, self-efficacy, assertiveness, self-control, problem-solving, and refusal skills.

The total sample size was 18 programs available for knowledge analysis and 14 programs for skill analysis. An independent psychosocial smoking prevention program was the unit of analysis in the current meta-analysis.

The systematic coding scheme was developed to examine the relationships between program characteristics and study findings (A code book and its descriptions can be requested from the author). Since not every study provided sufficient information to calculate effect sizes, primary researchers were contacted for the problem of missing or incomplete data on their published articles. Ambiguous coding interpretations were resolved in the regular meetings with a panel of four experts, and three studies were finally dropped for this meta-

analysis due to inability of effect size estimation.

Each program effect was measured in terms of effect size, defining as the standardized mean difference between treatment and control group in experimental studies (Hedges 1985). The single unweighted effect size per program was independently estimated for outcomes based on the definition of Hedges' *g*-estimator of effect size (1985):

$$g = \frac{\bar{Y}^E - \bar{Y}^C}{S^P}$$

where *g* is biased effect size, \bar{Y}^E and \bar{Y}^C are the means for the experimental and control group, respectively, and S^P is the pooled standard deviation for both groups.

Various statistical methods available in the meta-analysis literature (Hedges et al. 1989; Hwang 2000; Rooney 1992; Tobler 1994) were used to convert from individual summary statistics in different types to a single estimator of effect size (A manual that includes six cases and sixteen methods can be requested from the author). The unbiased estimator of effect size (*d*) per program was re-computed by multiplying biased estimator of effect size (*g*) by a constant because *g* estimator tends to overestimate population effect size for small sample (Hedges 1985). Then, the effect sizes (*d*) were combined across programs for the summary statistics of the meta-analysis (weighted mean effect size *d*).(Hedges 1985).

Microsoft Excel was used for data entry and the statistical SAS/PC package program (version seven, SAS Institute, Inc. 1998) was used for data analysis.

2. Mediating outcome variables

Psychosocial smoking prevention programs have typical curricula: a) information on the negative social effects and short-term physiological consequences of tobacco use; b) understanding for the social influences to smoke, particularly from peers, parents, siblings, and the mass media; c) development of socially normative expectations; and d) skill-building to resist social pressures using various methods of training, modeling, rehearsing, and reinforcing. Figure 1 provides an overview of the schematic design in this study, including specific constructs in mediating outcome variables to be measured. Four knowledge constructs to classify and measure mediating outcomes were identified through literature and individual study's reporting manner: immediate negative health effects; short-term negative social consequences; information on social influences to smoke, particularly from peers, parents, siblings, and mass media; and development of socially normative expectations. Skill constructs used in psychosocial smoking prevention programs included refusal skills; problem solving; self-control; assertive communication; self-efficacy; and affective skills.

III. Result

1. Knowledge Mediating Effects

Knowledge mediating outcomes were separately measured under the four constructs of sub-knowledge outcomes (Figure 2). The social norms had the highest effect size (ES= .55) while the social influences had the lowest effect size (ES= .32). According to Cohen (1977)'s definition of effect size, all four sub-knowledge outcomes had a medium to large effect and they were effective in about 20% or more relative improvement in knowledge when effect sizes were translated into percentage based on the area under the curve in the Z distribution.

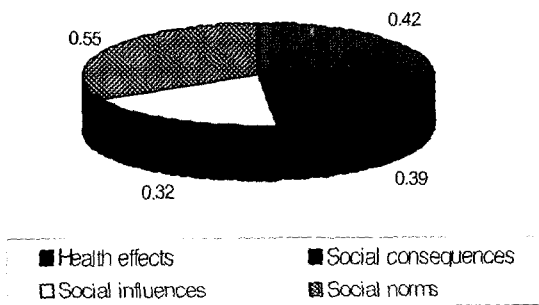


Figure 2. Mean effect sizes by knowledge factor in psychosocial smoking prevention programs evaluated from 1978 to 1997 in the United States

Further investigation was conducted based on the inferential evidence of an impact on smoking behavior accompanied by an impact on knowledge in a manner consistent with the

behavior results. It was assumed that these sub-knowledge outcome variables were consistent with the results of the behavior outcome.

Figure 3 presents the changes in the magnitude of effect sizes between knowledge and behavior outcomes by four knowledge constructs that were separately measured in the previous analysis. The social norms demonstrated the highest knowledge effects among sub-knowledge outcomes were not greatly mediated to the effects of smoking behavior (ES= .28). Rather, the social consequences (the second lowest sub-knowledge outcome effect size) explicated the highest mediating effects to smoking behavior (ES= .36). The immediate health effects (ES= .28) and social influences (ES= .18) did not greatly mediate the behavioral

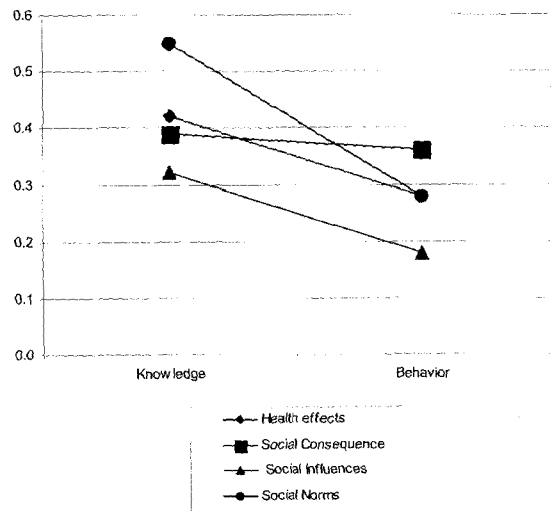


Figure 3. Knowledge and behavior outcomes by knowledge factor in psychosocial smoking prevention programs evaluated from 1978 to 1997 in the United States

effects. The social influences showed the lowest mediating impact on both knowledge and behavior outcomes.

2. Skill Mediating Effects

Skills mediating outcome was separately measured under the six constructs of sub-skill outcomes (Figure 4). The problem solving skills had the highest effect size (ES= .56) while the refusal skills had the lowest effect size (ES= .14). Some biases were found for both variables. For the problem solving skills to measure, this meta-analysis did not include studies using decision making skills due to the lack of availability. The refusal skills demonstrated effect size differences by research groups. Gilchrist and Schinke used oral test and observation to measure refusal skills in their studies. The program participants were videotaped role-playing interactions of smoking situations such as turning down cigarettes and using refusal statements. The effectiveness of students' overt refusal of cigarettes was scored by trained research assistants (interrater agreement =90%). On the other hand, Botvin measured self-reported refusal assertiveness using a 18 item scale with the responses ranging from 'never' to 'almost always' ($r = .70$). Examples of refusal behavior included returning defective merchandise, complaining when someone stepped ahead in line, and saying 'no' in various situations.

The second highest effect size was for

assertive communication (ES= .32) among sub-skills outcomes. Self-control (ES= .24) and self-efficacy (ES= .25) had similar effect sizes for skills outcome. The affective skills had the second lowest effect size (ES= .16) next to refusal skills (ES= .14).

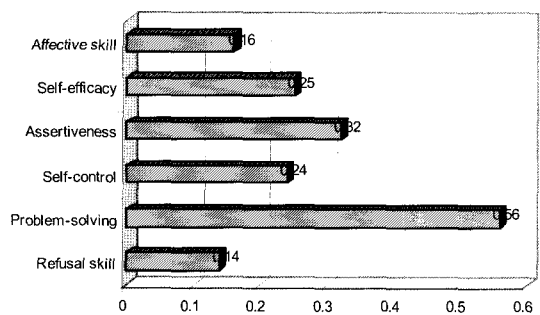


Figure 4. Mean effect sizes by skill factor in psychosocial smoking prevention programs evaluated from 1978 to 1997 in the United States

As demonstrated in Figure 5, the mediating effects were greater for assertiveness (ES= .45), self-control (ES= .37) and self-efficacy (ES= .28) rather than affective (ES= .26), refusal (ES= .22), and problem solving (ES= .20). The problem solving skills had the highest effects in skill outcomes, but the lowest effects in behavior outcome. Other skills demonstrated consistent mediating effects to smoking behaviors in adolescents and especially, assertiveness skills showed the best mediating effects between skill and behavior outcomes.

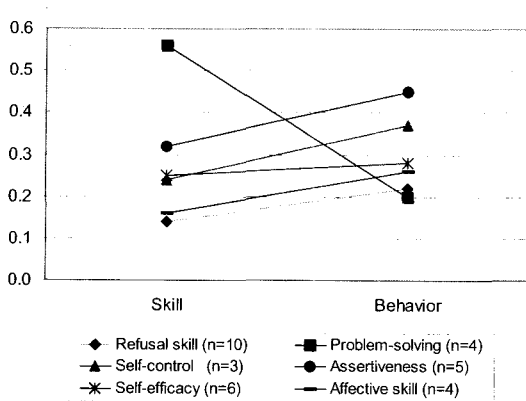


Figure 5. Skill and behavior outcomes by skill factor in the adolescent psychosocial smoking prevention programs evaluated from 1978 to 1997 in the United States

IV. Discussion

Beyond measuring or summarizing overall program effects like other meta-analyses, the present meta-analysis study investigated mediating relations between knowledge and behavior or between skills and behavior in an attempt to identify essential elements of psychosocial smoking prevention programs. The findings from this study highlight the importance of social consequences knowledge factor and assertive communication skill factor in decreasing adolescent smoking behaviors.

Any single variable did not show the presumed evidence of a consistent relationship between smoking behavior and knowledge/ or skills. For example, social norms' higher knowledge effects did not lead to higher

behavioral effects in this meta-analysis. The increase of anti-tobacco norms that students learned in the class might not work well with their smoking behavior initiation in the real world. The social consequences variable, the second lowest knowledge effects, yielded the largest behavioral effects. Therefore, the each knowledge factor impacted differently on knowledge outcome and on the behavior outcome. Knowledge is not sufficient to change behavior, but this meta-analysis found what knowledge factor used in psychosocial smoking prevention programs more correlates to smoking behavior. Short-term negative social or cosmetic consequences of tobacco use was the most influential factor to yield great behavioral effects for the adolescent population. This fact was well documented in smoking prevention literature. Apparently, adolescents were more concerned about social effects such as foul-smelling breath and clothes and stained teeth than health effects.

The skill might be easily learned by students during class activities, but less practical application in resisting tobacco use. Assertiveness skills showed consistent mediating effects between skill and behavior outcomes. Students might be substantially helpful to communicate assertively in resisting peer pressures and refusing tobacco use in the real world. Also, self-control skills might reinforce their maintenance of tobacco-free behavior. Assertive communication skills have been

developed and positively evaluated in a variety of behavioral areas such as aggression and verbal abuse (Rimm et al. 1974) and shyness (Twentyman and McFall 1975). For smoking prevention, the assertiveness mediating effects of this analysis are consistent with Epstein (2000)'s findings of a subsequent relationship between assertiveness skills and less smoking behavior at two year follow up.

Self-efficacy and affective skill factors were related to the higher effects of attitudinal change toward tobacco use from the results of the prior program modality analysis (Hwang 2000), and were also linked to behavioral change from this analysis. Refusal skills have been developed through various methods of modeling, role-playing, rehearsing, reinforcing, direct instruction, and group practice in psychosocial smoking prevention programs. Most studies employed more than one refusal method. However, refusal skill did not demonstrate large mediating effects for behavior change in this meta-analysis. This finding may relate to the selection of refusal skill-building methods employed by individual studies. For example, role- modeling could be a passive learning method by observing other role models rather than being involved in direct experiences. This method was actually used by the majority of the studies (84.6%) in this meta-analysis. Another possible reason was that program planner/ or program leaders have not fully implemented refusal skill techniques

in the programs. For instance, McAlister (2000) provided recommendations in using role-playing in smoking prevention. The technique of role-playing was only appropriate if the student did not take the role of the smoker and if students were not asked to choose the roles they would like to play. Misuse of skill factor techniques could increase or reinforce adolescent smoking behavior.

This meta-analysis recommends careful interpretation of skill variables and generalization of the results. Study limitations can be related to the small number of studies available, effect size variability according to modality and setting levels, and inconsistencies of measuring methods among studies. The number of studies available to estimate effect sizes on each skill factor ranged from 3 to 10. Meta-analysis does not require large number of studies and, in some circumstances, can be usefully applied to as few as two or three study findings (Lipsey and Wilson 2001; Rosenberg et al. 1997). Robust and better meta-analysis statistics with small number of studies, however, should have large-sample approximations (Hedges 1994). According to Rosenberg (1997), Hedges' effect size of 'd' estimated in this meta-analysis works well with large-sample theory when sample sizes are at least 10. For this meta-analysis, the small number of studies do not violate any condition indicating poor analysis.

Beyond the use of different skills among studies, effect sizes were varied by theoretical

orientations and setting levels among psychosocial smoking prevention studies. Effect sizes were likely to have higher effect sizes for the cognitive behavioral (CB) modality programs than for the social influences (SI) or life skills (LS) modality programs. Also, the school-only setting programs tended to have higher effect sizes than the school-community setting programs. Also, the studies used different techniques to measure skills appeared to link with the magnitude of effect sizes. For example, the effect size of refusal skill factor was the highest for the studies using direct observation (Schinke & Gilchrist's CB modality programs) than for the studies using self-report (Botvin's LS modality programs). The qualitative measuring techniques (observation or interview) may be the most practical way to measure skill factors, but be vulnerable to many biases like subjective judgment in scoring program participants' performances. In this analysis, the studies with the CB modality programs using only auditory responses might inflate effect sizes. The studies with the LS modality programs using only questionnaire were likely to have deflated effect sizes which may be due to using many items per skill construct and too detailed fractionation of each concept measured (i.e. life skills efficacy; problem solving confidence; and psychosocial self-efficacy). These differences suggest that individual study should use a combining qualitative and quantitative measuring method.

The problem solving skill factor had the highest effects in skill outcomes, but it demonstrated the lowest effects in behavior outcomes. Such an extreme variable needs to be further analyzed to discover why the mediating effects were inverted. This analysis was to explore mediating effects and provide insight into the relationships between mediating outcome and final behavior outcome in psychosocial smoking prevention studies. Further research needs to investigate the role of mediating variables to smoking behavior outcomes.

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ABSTRACT

Adolescent psychosocial smoking prevention programs have been successful, but limited in the magnitude of program effects on the reduction of smoking behaviors. This is primarily due to the mixed results of independent studies with program variations. This systematic, quantitative research synthesis is designed to identify program key factors that are likely to increase program effects.

The present study examined school-based psychosocial smoking prevention programs (1978-1997) among students in grades 6 to 12 in the United States. Theoretical formulations in this analysis of mediating effects posit that program impact on knowledge and/ or skills is associated with less smoking behaviors among program participants. Knowledge factors investigated in this study included health effects, social consequences, social influences, and social norms. Skill factors included affective skill, self-efficacy, assertiveness, self-control, problem solving, and refusal skill. The findings from this study highlight the importance of social consequences knowledge factor and assertive communication skill factor in decreasing adolescent smoking behaviors.