

# Predictors of smoking onset over two years

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The objective of this analysis was to identify variables that predict the initiation of smoking among adolescents, and the development of susceptibility to smoking, over a 2-year period. We assessed variables that might predict later smoking among nonsmoking students in grades 7 and 9 and assessed their smoking status 2 years later, when they were in grades 9 and 11, thus receiving data from 4,130 students at two time points. Initiation of weekly smoking over the 2 years was associated with having a parent, sibling, or close friend who smokes; low school grades; higher levels of deviant behavior; susceptibility to smoking; use of smokeless tobacco; and for 7th graders, perception of higher levels of normative smoking. Susceptibility, defined as not being able to rule out the idea of smoking a year after the survey, was identified as a strong predictor of smoking and a valuable intermediary measure. We also assessed factors associated with the prediction of susceptibility 2 years post-test. Susceptibility to smoking was associated with deviant behavior, low grades, lower parental monitoring, relaxed parental attitude toward youth smoking, ease of access to tobacco, and lower exposure to anti-tobacco messages. This study provides support for the idea that susceptibility to smoking could be a useful outcome variable for tobacco research, as an intermediary to the initiation of smoking. In addition, evidence indicates that theoretically manipulable variables, including access to tobacco and exposure to anti-tobacco information, have the potential to influence susceptibility to smoking over a time.

## Introduction

This paper presents an analysis of predictors of adolescent smoking among northwestern U.S. adolescents over a 2-year period. It then examines the factors that predict changes in smoking susceptibility over 2 years. The analyses were conducted in an effort to pinpoint modifiable influences on the development of adolescent smoking and susceptibility to smoking, and to guide the tailoring of anti-tobacco messages according to the unique risk profile of individual adolescents (Strecher, 1999). The study adds to existing evidence by examining social and intrapersonal influences on smoking uptake in a rural sample and by analyzing the factors that contribute to the development of susceptibility to smoke.

Increasingly, the onset of adolescent smoking is understood to be a function of social and marketing influences (Biglan, 2004). It is well established that parent, sibling, and peer smoking influence

adolescent smoking (e.g., Epstein, Williams, Botvin, Diaz, & Ifill-Williams, 1999; O'Loughlin, Paradis, Renaud, & Gomez, 1998; Tyas & Pederson, 1998; U.S. Department of Health & Human Services [USDHHS], 1994; Wen, Tsai, Cheng, Hsu, & Lin, 2005). Evidence indicates that adolescent smoking is associated with poorer academic performance (Pierce, Choi, Gilpin, Farkas, & Merritt, 1996; USDHHS, 1994) and with engagement in other problem behaviors (Biglan et al., 2004). However, few longitudinal studies have examined the degree to which these factors predict smoking uptake over and above social and marketing influences. The association between smoking and other problem behaviors may be related simply to adolescents' associations with deviant peers influencing them to engage in a variety of problem behaviors. In this case, one would not expect engagement in other problem behaviors to account for smoking onset, over and above peer influences to smoke. With respect to poor grades, it seems plausible that adolescents doing poorly in school may consider smoking as a way to improve their image. However, whether poor grades account for variance in smoking onset over and above social influences needs to be explored. If poor grades are an independent predictor of smoking onset, it would

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point to the value of promoting academic success for the prevention of smoking.

Growing evidence indicates that adolescents' stated intentions about the possibility of future smoking can predict later smoking. Pierce and colleagues (Pierce, Evans, & Farkas, 1994; Pierce, Farkas, & Evans, 1993; Pierce & Gilpin, 1995) have shown that adolescents who do not definitely rule out the possibility of future smoking are more susceptible to commencing smoking. The finding is important to replicate because, if susceptibility is a reliable predictor of smoking onset, we may be able to evaluate more precisely and efficiently preventive interventions by testing their impact on susceptibility as well as on actual tobacco use.

Little is known about the factors that influence the development of susceptibility and whether those factors are the same as or different from the factors that influence smoking onset. To the extent that we can identify unique factors that influence the development of susceptibility, it will pinpoint targets for prevention that occur early in the developmental sequence leading to smoking onset. In the present study we attempted to replicate the finding that susceptibility predicts smoking onset and then examined factors that predict changes in susceptibility over a 2-year period among adolescents who were not smoking at the outset.

A shortcoming of the present study is that it does not include predictors involving exposure to cigarette marketing. The data for this study were collected prior to the publication of a large body of evidence showing that exposure to such marketing has an influence on smoking onset that is independent of social influences (National Cancer Institute, in press).

The study used dichotomous predictors because of their value in developing tailored messages for adolescent groups differing in smoking risk. Research on tailoring of health messages suggests the possibility of creating anti-tobacco messages for teens based on a profile of risk factors (Strecher, 1999). For example, those whose friends smoke may receive different messages than those whose friends do not smoke. Analysis of dichotomous measures of predictors helps to distinguish groups of adolescents based on risk of smoking and facilitates creating messages tailored to subgroups defined by these dichotomies. Our analyses also tested whether the predictive relationships differed depending on the adolescents' grade in school.

## Method

### *Design overview*

We collected data in an experimental evaluation of a community intervention to prevent adolescent tobacco use (Biglan, Ary, Smolkowski, Duncan, &

Black, 2000). The project randomly assigned 16 small Oregon communities to receive or not receive a comprehensive intervention with school curricula, media promoting tobacco use prevention, family communications about tobacco, youth anti-tobacco activities, and access reduction. Eight communities received only the school-based curriculum. Participants in the present study were from both control and intervention communities.

The main outcome of the original intervention study showed that 30-day smoking prevalence was lower in community-based intervention communities than in communities receiving only the school-based curriculum (Biglan et al., 2000). The present study examined predictors in the uptake of smoking at the individual rather than the community level. Students completed surveys in grades 7 and 9 and again in grades 9 and 11, allowing us to examine the proportion of nonsmokers in grades 7 and 9 who smoked 2 years later. To be included in this analysis, subjects had to have data at both time points.

We identified 5,152 nonsmokers at Time 1 for whom we had data at Time 2. Because of missing data on one or more predictors and the use of listwise deletion, we had useable data for predicting smoking uptake for 4,130 adolescents. To ensure that a student was a nonsmoker at Time 1, we used multiple measures, described below.

Analysis of predictors of change in susceptibility over 2 years included 3,641 students. In analyzing predictors of smoking susceptibility over 2 years, we excluded smokers at Time 2. Thus the analysis more clearly assessed influences on early stages in the progression toward smoking.

A brief examination showed that cases eliminated because of missing data at follow-up differed somewhat from cases used in the analysis. Subjects who were eliminated because of missing data were slightly more likely to have a parent, sibling, or friend who smokes; slightly more likely to have lower school grades; and more likely to be susceptible to smoking at baseline. The sample that remained for analysis thus constituted a somewhat lower-risk population for the study of factors influencing the uptake of smoking.

### *Measures*

Table 1 lists variables used to predict smoking and shows coefficient alphas where appropriate. In preliminary analyses, we tested three other family influences but eliminated them because of collinearity with model variables.

**Outcome.** The primary outcome variable of interest was smoking. To operationalize the smoking dependent variable at Time 2, we constructed a

**Table 1.** Items and scales.

| Influences                                   | Item description                                                                                                   | Alpha |
|----------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-------|
| Parental smoking                             | Dichotomous; 1=at least one parent smokes/smoked                                                                   |       |
| Sibling smoking                              | Dichotomous; 1=at least one sibling smokes                                                                         |       |
| Friends smoking                              | Dichotomous; 1=at least one close friend smokes                                                                    |       |
| Low school achievement                       | Dichotomous; 1=self-reported grades of C or below                                                                  |       |
| Deviant behavior                             | Scale mean of 6 self-report items (never to often)                                                                 | .7295 |
| Alcohol use                                  | Dichotomous; 1=used in past month                                                                                  |       |
| Susceptibility to smoking                    | Dichotomous; 1=susceptible to smoking                                                                              |       |
| Smokeless tobacco use                        | Dichotomous; 1=used in past month                                                                                  |       |
| Parental monitoring                          | Scale mean of 5 items (never to almost always)                                                                     | .5869 |
| Perceived smoking norms                      | 5-point scale; perceived percentage of smoking by same-aged peers                                                  |       |
| Relaxed parent attitude toward youth smoking | Dichotomous, from "How does your mother/father feel about you using tobacco products?" 1=not "strongly against it" |       |
| Access to tobacco                            | Single item 5-point scale (very hard to very easy)                                                                 |       |
| Exposure to anti-tobacco messages            | Scale mean of 9 items (very often to never)                                                                        | .8329 |
| Youth involvement in outside activities      | Scale mean of 5 items (never to often)                                                                             | .7631 |

dichotomous indicator from a weekly smoking index (WSI) of four questions. We patterned the measure after one we used in prior smoking prevention research (Biglan et al., 2000). On one question, respondents rated their smoking level (e.g., "never" to "a pack or more/day"). On three others, they indicated smoking level in past 30 days, 7 days, and 24 hr. To construct a WSI, we transformed answers for each question into estimated weekly rates averaged across four measures. We considered a student with a WSI of zero to be a nonsmoker at Time 1 and included only initial nonsmokers. Thus, to achieve a zero WSI, respondents indicated they never smoked or had not smoked in the past 12 months and confirmed they had not even taken a puff in the past 24 hr, 7 days, and 30 days.

A dichotomous variable identified weekly smokers at Time 2. We considered those who smoked, on average, one or more cigarettes in the past week to be smokers. Precisely 11.8% of original nonsmokers were weekly smokers 2 years later ( $n=489$ ).

**Predictors.** We tested 16 scale variables and composites in the prediction-of-smoking model (Table 1). To control for possible differences related to grade level and gender, we entered these two variables first into the models. The predictors of interest included parental, sibling, and friends' smoking; low academic grades; deviant behavior; alcohol use; smokeless tobacco use; susceptibility to smoking; parental monitoring; perceived smoking norms among same-age youth; parental attitude toward youth smoking; perceived ease of access to tobacco products; exposure to anti-tobacco activities; and youth involvement in outside activities.

Given the practical goal of identifying groups of adolescents differing in smoking risk, we constructed many variables as dichotomous predictors. We are currently developing a system of tailoring intervention messages to fit student characteristics. Tailoring could involve mailings to adolescents susceptible to

smoking, targeted messages for teens whose parents smoke, or personalized advice for those who have tried smokeless tobacco or alcohol.

It is important to identify dichotomous variables that consistently predict smoking to determine whether they can help effectively divide adolescents into groups specific for a targeted intervention. Grade is a dummy variable for 9th graders at Time 1; 7th graders are the default. Other dummy variables include a parent, sibling, or close friend smoking or the student reporting alcohol or smokeless tobacco use in the past 30 days. We constructed a dichotomous indicator of low grades, with a self-report of average school grade as C, D, or F.

We created a measure of susceptibility to smoking, using procedures defined by Pierce et al. (1996). Adolescents were considered susceptible if they answered anything except "definitely not" to the question "How likely do you think it is that you will be smoking a year from now?" We counted "probably not" and "probably will" as susceptible, since neither response completely ruled out smoking.

This study offers a new measure of perceptions of parents' attitudes toward teen smoking. If parents are not strongly against teen tobacco use, they are unlikely to be a barrier to its use. Answering separately for each parent, adolescents answered the question "How does your (mother/father) feel about you using tobacco products?" We collapsed categories so that any answer except "strongly against it" was considered "relaxed" and coded as a 1, whereas "strongly against it" was coded 0. When both parents were available and differed in attitude (one strongly against and one not), parental attitude was considered ambiguous and was coded as 1 (relaxed). Parents differed in attitudes for less than 8% of cases (baseline 7.8%; follow-up 7.5%).

#### *Data analyses*

Because these data came from an intervention study, and subjects from both intervention and control

communities were included in the analyses, we tested whether using a community-grouping variable would have a strong impact on the model. Calculated intraclass correlation coefficients varied from .002 (sibling smokes) to .02 (low grades), so the anticipated impact on the model was small. Because both the dependent variable and the covariates were at an individual level, the design effect was lower than expected (Scott & Holt, 1982). Calculated adjusted design effects ranged from 1.008 to 1.071; the effect of not including community as a grouping variable should change the overall model only minimally.

After entering gender and grade into the model, we tested hypothesized predictors for smoking initiation in three blocks in a logistic regression model. Block 1 consisted of six well-established peer, parental, and intrapersonal smoking predictors: parental smoking, sibling smoking, friends' smoking, self-reported deviant behavior, low academic grades, and alcohol use. We included these variables to replicate previous studies and to control for them in analyzing the predictive power of additional variables.

Block 2 consisted of five parental or intrapersonal variables less frequently tested as predictors of smoking: susceptibility to smoking, smokeless tobacco use, parental monitoring of adolescent behavior, perceived smoking norms among same-age peers, and relaxed parental attitude toward smoking. If these variables were found to account for a significant amount of variance in later smoking, over and above that explained by the covariates in block 1, it would provide particularly strong evidence of their importance in preventing adolescent smoking.

Less evidence seems available for the block 3 variables, which included perceived ease of access to tobacco, exposure to anti-tobacco messages, and involvement in after-school activities. To explore the ability of this block of experimental variables to predict smoking initiation, over and above the variance accounted for by other predictors, we entered this block into the model in the last step.

We tested for difference between grades in the prediction of smoking initiation using interaction terms. After entering each major block of variables, we created an interaction term with school grade for each variable and stepped blocks of interaction terms into the model after each block of main effect terms. We tested the significance of these interaction blocks in adding to the overall model, and examined individual interaction variables for significance. We examined gender interactions with each variable separately but did not include them in the final model because the small sample size in subgroups would make the model unstable when attempting to calculate three-way interactions between predictors, grade, and gender.

## Results

### *Predictors of smoking*

Table 2 presents univariate correlations between predictors at Time 1 and adolescent smoking 2 years later, whereas Table 3 presents odds ratios for all variables in the final logistic regression model. With all 16 variables and 13 interaction terms entered into the model, we found that 7 variables were significant predictors of smoking 2 years later. These were (a) parental smoking, (b) sibling smoking, (c) close friend smoking, (d) having average grades of C or lower, (e) susceptibility or intention to smoke, (f) smokeless tobacco use, and (g) the interaction of grade with perception of a high normative level of smoking by same-age peers. The strongest predictors in the final model were smokeless tobacco use, susceptibility, sibling smoking, low grades, and parent smoking at Time 1.

Having a close friend who smokes was a moderately strong predictor of smoking before adding block 2 variables ( $OR=1.74$ , 95%  $CI$  1.35–2.24), but its effect diminished after adding the variable representing perceived normative smoking among same-age peers, making it a relatively weak predictor of later smoking ( $OR=1.39$ , 95%  $CI$  1.16–1.68). Although measures of deviant behavior and alcohol use were significantly related to smoking in the stepwise model, neither of these variables was a significant predictor after adding the block of variables containing parental monitoring.

One interaction term was significant in the final model. It indicated that perceived normative smoking predicted smoking differently in 7th versus 9th grades. For 7th graders the risk of smoking 2 years later increased with the perception that more peers smoke ( $OR=1.3876$ , 95%  $CI$  1.21–1.59,  $B=.3276$ ), whereas for 9th graders smoking risk 2 years later

**Table 2.** Univariate correlations with weekly smoking at Time 2.

| Variable                                     | Univariate correlation<br>(significance) |
|----------------------------------------------|------------------------------------------|
| Gender                                       | .0143 (.304)                             |
| Grade                                        | .0130 (.349)                             |
| Parent smoking                               | .1291 (.000)                             |
| Sibling smoking                              | .1247 (.000)                             |
| Friends smoking                              | .1469 (.000)                             |
| Deviant behaviors                            | .1757 (.000)                             |
| Low grades                                   | .1535 (.000)                             |
| Alcohol use                                  | .1130 (.000)                             |
| Susceptibility                               | .1912 (.000)                             |
| Smokeless tobacco use                        | .0994 (.000)                             |
| Parental monitoring                          | -.1029 (.000)                            |
| Perceived smoking norm                       | .1216 (.000)                             |
| Relaxed parent attitude toward youth smoking | .1082 (.000)                             |
| Access to tobacco                            | .0702 (.000)                             |
| Youth outside activities                     | .0066 (.639)                             |
| Anti-tobacco exposure                        | .0128 (.362)                             |

**Table 3.** Odds ratios and confidence intervals for predictors of smoking at Time 2, baseline nonsmokers.

| Predictor                                    | <i>B</i> | <i>OR</i> | Significance | 95% <i>CI</i> |        |
|----------------------------------------------|----------|-----------|--------------|---------------|--------|
|                                              |          |           |              | Lower         | Upper  |
| Grade (9th=1)                                | −0.3104  | 0.7332    | .7825        | 0.0809        | 6.6447 |
| Gender (male=1)                              | −0.0789  | 0.9241    | .5352        | 0.7202        | 1.1858 |
| Block 1                                      |          |           |              |               |        |
| Parent smokes (1=yes)                        | 0.6019   | 1.8256    | .0003        | 1.3196        | 2.5256 |
| Sibling smokes (1=yes)                       | 0.6422   | 1.9007    | .0008        | 1.3059        | 2.7664 |
| A close friend smokes (1=yes)                | 0.4608   | 1.5853    | .0137        | 1.0991        | 2.2867 |
| Deviant behavior (scale)                     | 0.236    | 1.2662    | .2598        | 0.8399        | 1.9087 |
| Low GPA (1=C or below)                       | 0.6354   | 1.8878    | .0006        | 1.3129        | 2.7144 |
| Alcohol use (30-day 1=yes)                   | 0.2531   | 1.288     | .3943        | 0.7195        | 2.3058 |
| Block 1 interactions                         |          |           |              |               |        |
| Grade × parent smokes                        | −0.103   | 0.9021    | .6733        | 0.559         | 1.4559 |
| Grade × sibling smokes                       | −0.2775  | 0.7577    | .3264        | 0.4354        | 1.3186 |
| Grade × friend smokes                        | −0.281   | 0.755     | .2977        | 0.4449        | 1.2812 |
| Grade × deviant behavior                     | 0.3929   | 1.4813    | .1854        | 0.8281        | 2.6497 |
| Grade × low GPA                              | 0.0095   | 1.0095    | .9712        | 0.602         | 1.6931 |
| Grade × alcohol use                          | 0.2052   | 1.2278    | .5904        | 0.5816        | 2.5918 |
| Block 2                                      |          |           |              |               |        |
| Susceptibility (1=can't rule out)            | 0.7301   | 2.0753    | .0001        | 1.4563        | 2.9573 |
| Smokeless tobacco use (1=yes)                | 0.9316   | 2.5386    | .0014        | 1.4326        | 4.4984 |
| Monitoring (scale)                           | −0.1683  | 0.8451    | .2033        | 0.6521        | 1.0953 |
| Perceived norm (percent smoking)             | 0.3276   | 1.3876    | .0000        | 1.2081        | 1.5939 |
| Relaxed parent attitude toward youth smoking | 0.1611   | 1.1748    | .3373        | 0.8455        | 1.6323 |
| Block 2 interactions                         |          |           |              |               |        |
| Grade × susceptibility                       | 0.0405   | 1.0413    | .8814        | 0.6113        | 1.774  |
| Grade × monitoring                           | 0.0854   | 1.0892    | .6638        | 0.7412        | 1.6005 |
| Grade × norm                                 | −0.341   | 0.7111    | .0034        | 0.566         | 0.8933 |
| Grade × parent attitude                      | −0.0117  | 0.9884    | .9625        | 0.6066        | 1.6105 |
| Block 3                                      |          |           |              |               |        |
| Access to tobacco                            | 0.0917   | 1.096     | .1170        | 0.9773        | 1.2292 |
| Anti-tobacco exposure                        | −0.063   | 0.9389    | .5209        | 0.7747        | 1.138  |
| Outside activities                           | 0.0356   | 1.0362    | .7071        | 0.8604        | 1.2481 |
| Block 3 interactions                         |          |           |              |               |        |
| Grade × access to tobacco                    | −0.0631  | 0.9388    | .5140        | 0.7768        | 1.1348 |
| Grade × anti-tobacco                         | 0.1352   | 1.1448    | .3701        | 0.8517        | 1.5387 |
| Grade × activities                           | 0.045    | 1.046     | .7533        | 0.7902        | 1.3847 |

Note. GPA, grade point average.

decreased with an increase in perceived peer smoking ( $OR=0.71$ , 95%  $CI$  0.566–0.893,  $B=-.341$ ). Although the one interaction term was significant, the inclusion of interaction terms for blocks 1 and 3 did not improve the overall model at the .05 level of significance. The inclusion of interaction terms for block 2 was only marginally significant in adding to the fit of the model ( $p=.058$ ). Overall, differences in relationships of predictor variables to smoking between grades 7 and 9 were not strong.

#### *Predictors of susceptibility*

Given that this analysis and others (Pierce et al., 1996) indicate the importance of susceptibility for predicting smoking onset, we analyzed predictors of the development of susceptibility. In theory, youth about to begin smoking become open to the idea before they actually start. Analyzing predictors of susceptibility reveals more about the factors influencing its development.

We also tested the model for predicting susceptibility with a hierarchical logistic regression analysis, predicting susceptibility after 2 years from

hypothesized predictors at baseline. To test the prediction of susceptibility rather than smoking itself, 489 respondents who reported at Time 2 that they had smoked in the last week came out of the analysis. However, those subjects who reported that they were susceptible to smoking at Time 1 remained part of the sample. As in the above analysis, we entered variables into the logistic regression model in blocks followed by interaction terms involving grade.

Table 4 presents results for the final model of the prediction of susceptibility, with all 15 predictors and 13 grade-interaction terms. Six variables significantly predicted susceptibility: (a) gender, (b) deviant behavior, (c) low grade point average (GPA), (d) parental monitoring, (e) access to tobacco, and (f) exposure to anti-tobacco messages. Several significant predictors of smoking (parents, siblings, or friends) did not significantly predict susceptibility.

Nonsmoking males, compared with females, had lower odds of susceptibility to smoking at follow-up. Involvement in deviant behavior at baseline was significantly associated with increased susceptibility 2 years later. Perceived easy access to tobacco was associated with increasing susceptibility 2 years later,

**Table 4.** Odds ratios and confidence intervals for predictors of susceptibility at T2, baseline nonsmokers.

| Predictor (excluding T2 smokers)             | <i>B</i> | <i>OR</i> | Significance | 95% <i>CI</i> |        |
|----------------------------------------------|----------|-----------|--------------|---------------|--------|
|                                              |          |           |              | Lower         | Upper  |
| Grade (9th=1)                                | −0.3619  | 0.6964    | .6553        | 0.1422        | 3.4112 |
| Gender (male=1)                              | −0.411   | 0.663     | .0000        | 0.5614        | 0.783  |
| Block 1                                      |          |           |              |               |        |
| Parent smokes (1=yes)                        | 0.1661   | 1.1807    | .1301        | 0.9523        | 1.4639 |
| Sibling smokes (1=yes)                       | 0.2404   | 1.2718    | .1188        | 0.9402        | 1.7202 |
| A close friend smokes (1=yes)                | 0.2489   | 1.2826    | .0833        | 0.9678        | 1.6999 |
| Deviant behavior (scale)                     | 0.3398   | 1.4047    | .0379        | 1.0191        | 1.9361 |
| Low GPA (1=C or below)                       | 0.439    | 1.5512    | .0014        | 1.1856        | 2.0294 |
| Alcohol use (30-day 1=yes)                   | 0.385    | 1.4696    | .1389        | 0.8827        | 2.4468 |
| Block 1 interactions                         |          |           |              |               |        |
| Grade × parent smokes                        | −0.186   | 0.8303    | .3066        | 0.5813        | 1.1859 |
| Grade × sibling smokes                       | 0.0965   | 1.1013    | .6791        | 0.6971        | 1.7398 |
| Grade × friend smokes                        | 0.0086   | 1.0086    | .9674        | 0.6675        | 1.5241 |
| Grade × deviant behavior                     | 0.1291   | 1.1378    | .6046        | 0.6981        | 1.8543 |
| Grade × low GPA                              | −0.1718  | 0.8421    | .4200        | 0.5547        | 1.2785 |
| Grade × alcohol use                          | −0.1994  | 0.8192    | .5666        | 0.4142        | 1.6204 |
| Block 2                                      |          |           |              |               |        |
| Smokeless tobacco use (1=yes)                | 0.5898   | 1.8036    | .0562        | 0.9845        | 3.3044 |
| Monitoring (scale)                           | −0.1921  | 0.8252    | .0295        | 0.6941        | 0.9811 |
| Perceived norm (percent smoking)             | 0.0909   | 1.0952    | .0629        | 0.9951        | 1.2053 |
| Relaxed parent attitude toward youth smoking | 0.2703   | 1.3104    | .0123        | 1.0604        | 1.6193 |
| Block 2 interactions                         |          |           |              |               |        |
| Grade × monitoring                           | −0.047   | 0.9541    | .7397        | 0.723         | 1.259  |
| Grade × norm                                 | 0.0571   | 1.0588    | .4989        | 0.8973        | 1.2492 |
| Grade × parent attitude                      | −0.2393  | 0.7872    | .1886        | 0.551         | 1.1246 |
| Block 3                                      |          |           |              |               |        |
| Access to tobacco                            | 0.1128   | 1.1194    | .0020        | 1.0423        | 1.2022 |
| Anti-tobacco exposure                        | −0.1451  | 0.8649    | .0221        | 0.7639        | 0.9794 |
| Outside activities                           | 0.0718   | 1.0744    | .2216        | 0.9577        | 1.2054 |
| Block 3 interactions                         |          |           |              |               |        |
| Grade × access to tobacco                    | −0.1053  | 0.9001    | .1106        | 0.7908        | 1.0244 |
| Grade × anti-tobacco                         | 0.1428   | 1.1535    | .1821        | 0.9353        | 1.4226 |
| Grade × activities                           | −0.1046  | 0.9007    | .2859        | 0.7433        | 1.0914 |

Note. GPA, grade point average.

but self-reported exposure to anti-tobacco media was associated with a lower level of susceptibility at follow-up. Both lower parental monitoring and relaxed parental attitudes toward youth smoking predicted increased susceptibility. Odds ratios for smokeless tobacco use and perceived normative youth smoking approached statistical significance. We found no significant interactions involving grade, indicating that predictions did not differ according to grade.

## Discussion

The results indicate that a number of family, peer, intrapersonal, and community factors affect initiation of regular adolescent smoking. They also show that the variables predicting smoking susceptibility differ somewhat from those predicting smoking.

### *Prediction of initiation of regular weekly smoking*

Six well-established predictors of smoking were included in the logistic regression model predicting weekly smoking 2 years later. Consistent with other

studies (Buller et al., 2003; O'Loughlin et al., 1998; Pierce et al., 1996; Tyas & Pederson, 1998; Wen et al., 2005), parental, sibling, and friends' smoking predicted the onset of smoking, even when controlling for other variables. In addition, as other studies have shown (Pierce et al., 1996; USDHHS, 1994), low academic performance predicted later smoking, even when controlling for social influences. Two other common correlates of adolescent smoking—alcohol use and engagement in deviant behavior—had strong bivariate associations with later smoking but did not significantly predict smoking onset when included in the model with social influences and poor grades.

Even after controlling for these well-established predictors, the measure of susceptibility or intention to smoke was a significant predictor of smoking 2 years later. Young people who cannot definitely rule out the possibility of smoking are significantly more likely to start. The result is robust, since the odds ratio remained sizable ( $OR=2.08$ , 95%  $CI$  1.46–2.96,  $p<.001$ ), even after controlling for other common smoking predictors. This finding is important for at least two reasons. First, it indicates we can detect smoking susceptibility even among those with no obvious social influences to smoke. This finding is of

practical value, since susceptibility could be useful to measure the immediate impact of preventive interventions and to tailor interventions to youth based on susceptibility level (Strecher, 1999). Second, it validates the measure of susceptibility, providing further support for the value of studies showing influences on susceptibility (Pierce et al., 1996). For example, a number of studies show that cigarette advertising affects susceptibility (Evans, Farkas, Gilpin, Berry, & Pierce, 1995; Feighery, Borzekowski, Schooler, & Flora, 1998). These results strengthen confidence that those studies bear on the ultimate impact of cigarette advertising on actual smoking.

It is unfortunate that this data set had no measures of adolescent exposure to cigarette advertising. A growing body of research, most conducted since this study was designed, has found measures of exposure to cigarette marketing to predict later youth smoking (Siegel & Biener, 2000). Typically these studies show that measures of exposure to cigarette advertising account for adolescent smoking, even when controlling for social influences (Sargent et al., 2000; Siegel & Biener, 2000). The present results may be relevant to this line of research in finding that susceptibility predicts later smoking, even after controlling for parental, sibling, and friends' smoking, pointing to the fact that variance in susceptibility is related to something besides these influences. Given evidence of the influence of cigarette marketing on adolescent susceptibility (Evans et al., 1995), it is likely that a model containing measures of exposure to cigarette marketing would account for variance in susceptibility.

Grades of C or lower significantly predicted smoking onset 2 years later, even after controlling for well-established social influences; thus, failure to excel academically appears to increase smoking. Tobacco marketing practices along with research and studies of psychological needs associated with adolescent smoking suggest that academically unsuccessful adolescents seek other ways to achieve a fulfilling self-image and social success. Cigarette marketing communicates that one can gain success and peer approval by smoking youth-popular brands. Chassin, Presson, Sherman, and Edwards (1991) studied smoking prediction over a 1-year period among middle school students and found expectations for academic success to correlate strongly and negatively with smoking initiation. That is, those expecting to do poorly in school were more likely to start smoking. Academic failure may prompt adolescents to redefine themselves. Given the images of smokers they see, they adopt an image that, although not good in school, is tough and sociable (Aloise-Young, Hennigan, & Graham, 1996; Chassin, Presson, Sherman, & Margolis, 1988). Thus

smoking helps some youth cope with academic failure by helping them define a new and satisfying self-image.

Consistent with Severson, Forrester, and Biglan (in press), the present analysis showed monthly smokeless tobacco use to strongly predict later smoking for boys ( $OR=2.54$ , 95%  $CI$  1.43–4.50,  $p<.001$ ). The sample did not have enough smokeless-tobacco-using girls to test this effect for both genders.

The perception that many peers smoke was associated with smoking onset 2 years later among those assessed initially in 7th grade but not among those assessed in 9th grade. This was one of few significant grade interactions. It may be useful to provide normative feedback to 7th graders about how few of their peers smoke.

The sample came entirely from small Oregon communities. Whether the results will be similar with an urban sample is unclear. Certainly the role of social influences on smoking uptake has been replicated across a large and diverse set of samples. The same cannot be said for susceptibility. To our knowledge, this is the first study of the prediction of smoking conducted with an entirely rural sample and it is the first examining the predictors of susceptibility. We suspect that the relationships we found in predicting susceptibility will be the same in urban samples, but that remains to be investigated.

#### *Prediction of susceptibility to smoking*

Often over the relatively short time of an experimental study, the proportion of subjects who become regular smokers is small. Out of these 4,130 subjects, 489 (11.8%) became regular smokers over the 2 years. It appears that the initiation of smoking does not happen suddenly. Instead, youth become susceptible to the idea of smoking at some future time and experiment before beginning to smoke regularly (Pierce et al., 1996). Using an intermediary variable such as smoking susceptibility as a measurable outcome may help identify subjects at high risk of smoking and may serve as a useful proxy for actual smoking in studies that are evaluating the short-term impact of preventive interventions. This suggestion is consistent with the requirement that smoking prevention programs ultimately must seem to affect actual smoking.

The multivariate analysis of the factors predicting increases in susceptibility included only those who had not become smokers by follow-up. The analysis identified six variables that predicted greater susceptibility over 2 years. Only one of those (low GPA) also predicted actual smoking onset. Adolescents were more likely to become susceptible to smoking if they were female, engaged in deviant behavior at Time 1,

had a low GPA, had parents who did not monitor their behavior and had relaxed attitudes toward their tobacco use, and perceived that it was easy to get tobacco. Moreover, they were less likely to become susceptible if they reported exposure to anti-tobacco information. Unlike prediction of smoking, multivariate analysis for predicting susceptibility did not show that parental, sibling, or friends' smoking were significant predictors of the development of susceptibility. In contrast, Epstein et al. (1999) found that intention to smoke was associated with friends' and sibling smoking, as well as with resistance to advertising and anti-smoking attitudes. However, the relationships were concurrent rather than longitudinal.

Having a C average or below was the only variable predicting both smoking and susceptibility 2 years later, underscoring the significance of academic problems in motivating young people to smoke and the likely value of more effective instruction in contributing to lower smoking rates.

The finding that perceived access to tobacco predicts increased susceptibility is noteworthy, given the mixed evidence on efficacy of access reduction efforts as ways to prevent adolescent smoking (Fichtenberg & Glantz, 2002; Forster, Wolfson, Murray, Wagenaar, & Claxton, 1997). Although the relationship is small, it suggests that communities that allow adolescents easy access to tobacco will have more young people who become susceptible to smoking.

Despite a low-scale alpha, the relationship of lower parental monitoring to increased susceptibility is important. The significant association between smoking susceptibility and parental monitoring, parental attitudes toward smoking, access to tobacco, and exposure to anti-tobacco information should be relevant to both researchers and prevention specialists, because each is manipulable. Although it is laudable to decrease parental smoking in an effort to decrease youth tobacco use, it would be difficult to achieve large enough effects on parental smoking to affect adolescent smoking significantly. However, it is possible to decrease youth access to tobacco (Biglan et al., 1995; Biglan et al., 1996), increase youth exposure to anti-tobacco information (Farrelly et al., 2002), increase parental monitoring, or encourage parents to be unambiguously strict in their attitudes toward their child using tobacco (Dishion & McMahon, 1998). Over the course of a 2- to 5-year study, a change in these variables might decrease susceptibility to smoking and subsequently decrease the incidence of regular cigarette smoking. Evaluating the effect of changing variables that predict susceptibility to smoking should be a future research goal.

In sum, different variables are related to the onset of smoking and the susceptibility of smoking for

youth. One implication is that prevention programs should be assessed in terms of their impact on both smoking behavior and susceptibility to smoking. Research and practice in tobacco prevention would benefit from assessing variables related to changes in susceptibility as a mediating variable in the progression toward smoking, since the onset of smoking is modest at this age level, and measures of program effectiveness may be more sensitive to changes in susceptibility than to actual smoking. Future research could further delineate the impact of a program on the variables that predict susceptibility and thereby increase the effectiveness of prevention programs.

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