Risk Factors Predicting Changes in Marijuana Involvement in Teenagers

Marianne B. M. van den Bree, PhD; Wallace B. Pickworth, PhD

**Background:** Marijuana use during adolescence has various adverse psychological and health outcomes. It is poorly understood whether the same risk factors influence different stages in the development of marijuana involvement.

**Objective:** To establish which risk factors best explain different stages of marijuana involvement.

**Design:** Data were collected at 2 points using computer-assisted personal interview (wave 1 and wave 2 were separated by 1 year). Twenty-one well-established risk factors of adolescent substance use/abuse were used to predict 5 stages of marijuana involvement: (1) initiation of experimental use, (2) initiation of regular use, (3) progression to regular use, (4) failure to discontinue experimental use, and (5) failure to discontinue regular use. Data were analyzed using logistic regression analysis.

**Participants:** Middle school and high school students (N=13718, aged 11-21 years) participating in the National Longitudinal Study of Adolescent Health (Add Health).

**Results:** Three risk factors (own and peer involvement with substances, delinquency, and school problems) were the strongest predictors of all stages. Their combined presence greatly increased risk of initiation of experimental (odds ratio, 20) and regular (odds ratio, 87) marijuana use over the next year. Personality, family, religious, and pastime factors exerted stage-specific, sex-specific, and age-specific influences.

**Conclusions:** Assessment of substance, school, and delinquency factors is important in identifying individuals at high risk for continued involvement with marijuana. Prevention and/or intervention efforts should focus on these areas of risk.

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Marijuana is the most commonly used illicit drug. Approximately 50% of secondary-school students in the United States indicate having used marijuana. It is one of the leading substances reported in arrests, emergency department and treatment admissions, and autopsies. Short-term risks of marijuana use include traffic accidents and unprotected sex. In addition, marijuana use is associated with lack of motivation; greater involvement with and inability to quit other substances; psychiatric problems, including depression, schizophrenia, anxiety, suicide, conduct problems, antisocial behavior, and criminal behavior; and reduced chances of participation and stability in adult roles (eg, not graduating from high school, abortion, unemployment, and divorce). Although most adolescents use marijuana infrequently, without adverse health consequences, a minority progress to harmful use. A better understanding of the risk factors that put adolescents at increased risk for experimentation with marijuana, progression to regular use, and failure to discontinue use can make important contributions to the evidence-based development of prevention and intervention programs.

Previously published studies have indicated that marijuana involvement is associated with a multitude of risk factors, including psychological, family, peer, and school variables. However, most risk factor studies conducted to date have focused on a single aspect of the development of marijuana involvement, usually lifetime use or initiation of experimentation. It is poorly understood to what extent well-established risk factors are associated with different stages of marijuana involvement. The primary aim of our study was to establish and compare the contributions of risk factors to the stages
of initiation, progression, and failure to discontinue experimental and regular marijuana use. Most previous studies have focused on 1 or a few risk factors. Our second aim was to evaluate a wide range of relevant risk factors to provide well-funded evidence for their relative importance in predicting development of marijuana involvement. Third, most previous studies have been cross-sectional in nature. Our study uses a longitudinal design, enabling us to predict developments in marijuana involvement based on risk factors assessed in the previous year.

### METHODS

The National Longitudinal Study of Adolescent Health (Add Health) was established to determine the causes of health-related behaviors of adolescents and their outcomes in young adulthood. The primary sampling frame included all high schools in the United States with an 11th grade and at least 30 enrollles. From this, a systematic random sample of high schools was selected. Overall, 79% of schools contacted agreed to participate (final sample of 134 schools). Among students, a random sample was selected to take part in in-home interviews. Sixteen thousand seven hundred six subjects were selected to be interviewed at 2 points, wave 1 in 1995 (response rate, 78.9%) and wave 2 in 1996 (response rate, 88.2%). Estimates in this sample were not significantly biased by missing data from dropouts and graduates. The Add Health study and sampling procedures are described in detail elsewhere. For the present study (N = 13718), we excluded any nonrandomly selected subsamples, duplicates, and students with missing data on marijuana use. Subjects were aged 11 to 21 years, with a mean (SD) age of 13.4 (1.6) years.

Data were gathered by computer-assisted interview, which yields higher reported prevalences of high-risk behaviors than regular interviews. Interviews took 1 to 2 hours and were administered in the presence of trained assistants. Subjects responded to questions by typing in answers on a laptop computer. Sensitive questions, including those on marijuana involvement, were given on headphones. This avoided the problem of underreporting, which may occur in situations where subjects are face to face with the interviewer. At wave 1, adolescents indicated how many times they had used marijuana during their lives; 1 year later, during wave 2, they reported on their use since wave 1. For both waves, we established the following groups: nonusers, experimental users (used 1-10 times), and regular users (used >10 times). We subsequently assessed changes in marijuana involvement between the 2 waves according to 5 stages: (1) initiation of experimental use (we selected nonusers at wave 1 and compared those who started experimental use at wave 2 with those who had remained nonusers), (2) initiation of regular use (we selected nonusers at wave 1 and compared those who started regular use at wave 2 with those who had remained nonusers), (3) progression to regular use (we selected experimental users at wave 1 and compared those who progressed to regular use at wave 2 with those who had remained experimental users), (4) failure to discontinue experimental use (we selected experimental users at wave 1 and compared those who had discontinued experimental use at wave 2 with those who had remained experimental users), and (5) failure to discontinue regular use (we selected regular users at wave 1 and compared those who had discontinued regular use at wave 2 with those who had remained regular users) (Table 1).

Risk factors were established at wave 1 and were used to predict these 5 stages of marijuana involvement. To establish these risk factors, 8 major risk factor domains were first established a priori from the literature, and variables (total of 238) were selected from the Add Health data set to best represent these domains. Next, factor analysis was used to identify within each domain the presence of subdomains (21 identified altogether). Factor solutions were rotated orthogonally (Varimax rotation) to make individual risk factors within each domain independent from each other. For each subject, for each risk factor, summed risk factor scores were obtained by adding those items with relatively high loadings on a factor (>0.30) and discarding items with lower factor scores. The great majority of the sample had no missing responses for all items making up each risk factor (ie, >95% of the sample had 0 missing values for 18 of the 21 risk factors). Individuals with 10% or more of the responses to a summed score missing were excluded from further analyses. For those with fewer than 10% missing values, an imputation formula was used, based on replacing the missing items by the mean of the nonmissing responses. Prior to further analysis, the scored risk factors were normalized using the Blom transformation. The correlation coefficients between the factors as obtained by factor analysis and normalized summed risk factors were equal to or exceeded 0.90 for 18 of 21 subdomains, illustrating the legitimacy of the procedures used to obtain summed risk factors (ie, excluding items with factor scores >0.30, imputation of missing values, and normalization of the summed scores). We conducted 2 sets of logistic regression analyses. First, in analyses including 1 risk factor at a time, we evaluated their association with each of the stages.

### Table 1. Marijuana Use Development From Wave 1 to Wave 2 *

<table>
<thead>
<tr>
<th>Wave 1</th>
<th>Wave 2</th>
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<tbody>
<tr>
<td></td>
<td>Experimental Use</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Experimental use</td>
<td>10331 (83)</td>
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<tr>
<td>Regular use</td>
<td>2123 (17)</td>
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</table>

*Values are expressed as number (percentage) of subjects. Experimental user, 1-10 times; regular user, >10 times. Five stages were assessed based on comparisons of groups who changed their marijuana use since wave 1 vs those who did not. Stages were initiation of experimental marijuana use (compared groups A and B), initiation of regular marijuana use (compared groups A and C), progression to regular use (compared groups E and F), failure to discontinue experimental use (compared groups E and D), and failure to discontinue regular use (compared groups H and G).
of marijuana involvement. Subsequently, we performed stepwise logistic regression analyses to select the subset of risk factors best predicting the 5 stages of marijuana involvement. Included as independent variables were all risk factors that were significant in the first set of analyses. For all regression analyses, a conservative significance level of $P<.05$ for factors to enter and remain in the model was specified a priori. The influences of age, race, urbanicity, and socioeconomic status (parental educational and occupational status) on the relations between the risk factors and marijuana involvement were taken into account in all analyses. These variables were force-entered into each model before the introduction of the risk factors. Therefore, the associations between the stages of marijuana involvement and the risk factors were corrected for the influences of these 5 variables. Socioeconomic status was assessed by 2 variables: parental level of education and occupation. In the case of a single residential parent, these were the only 2 indicators of socioeconomic status used. In the case of 2 residential parents, the mean level of education and of occupational level was used in regression analyses. Since sex differences have been established in substance use, we performed regression analyses including sex as a covariate and, if significant, the analysis was repeated for males and females separately. Data were missing for 29% of the subjects on the items assessing the relationship and activities undertaken with the father. Therefore, regression analyses were run twice; first, including these 2 factors and establishing their significance on the marijuana variables, and next, on having established that these influences were not significant, the regression analyses were repeated excluding these 2 variables, allowing us to include more subjects in the analyses. The results of the latter analyses are presented. The significance of mean differences between groups was assessed by $t$ test (level of $P<.05$ used). All analyses were performed using SAS (SAS Institute Inc, Cary, NC).

### RESULTS

The majority of adolescents had not tried marijuana, and among those who had, experimental use was more common than regular use. However, most adolescents who had used marijuana at wave 1 continued to do so 1 year later (Table 1).

All risk factor information was gathered at wave 1, allowing us to establish the influences on the development of marijuana involvement over the next year. Boys had significantly higher mean scores on most risk factors, except somatic symptoms, depressive symptoms, self-doubt, irrational decision making, activities with mother, and religious involvement, for which girls scored higher (Table 2). There were no significant sex differences for activities with father and extent to which the parents allow the adolescent to make independent decisions.

Most risk factors contributed significantly to at least some of the stages of marijuana involvement (Table 3). However, 3 risk factors were stronger predictors than others and influenced all stages of marijuana development: own and peer involvement with substances; delinquency; and school-related problems. Other risk factors had smaller effects and tended to be stage and/or sex specific. Considerably more risk factors significantly influenced initiation of experimental and regular marijuana use than progression to regular use or failure to continue experimental and regular use.

Stepwise regression analyses were performed to establish the set of variables best predicting each stage of marijuana involvement. The results (Table 4) further confirmed the importance and global influence of these 3 risk factors. “Own and peer involvement with substances” predicted initiation of experimental marijuana use (odds ratio [OR], 1.79 for boys and 2.94 for girls), initiation of regular use (OR, 2.72 for boys and girls combined), failure to discontinue experimental use (OR, 0.65 for girls), and failure to discontinue regular marijuana use (OR, 0.62 for boys and girls combined). Delinquency predicted initiation of experimental marijuana use (OR, 1.30 for boys and 1.34 for girls), initiation of regular use (OR, 1.36 for boys and girls combined), progression to regular use (OR, 1.35 for boys), failure to discontinue experimental use (OR, 0.71 for boys), and failure to discontinue regular use (OR, 0.77 for boys and girls combined). School variables predicted initiation of experimental marijuana use (OR, 1.17 for boys and 1.21 for girls), initiation of regular use (OR, 1.57 for boys and girls combined), and progression to regular use for girls (OR, 1.60). Other risk factors exerted stage-specific and sex-specific influences: low religiosity predicted initiation of experimental marijuana use in girls (OR, 0.78) and initiation of regular use in boys and girls combined (OR, 0.83); independent decision making predicted progression to regular use in boys (OR, 1.30), and activities with the mother predicted failure to discontinue regular marijuana use for boys and girls combined (OR, 1.17).

We divided the sample into age groups 11 to 15 years (n=7334) and 16 to 21 years (n=6999) and conducted age-specific analyses for the 3 stages of marijuana involvement in Table 3 for which significant age differences were found. For initiation of experimental use in girls, 4 risk factors were significant for the younger age group (own and peer involvement with substances, OR, 3.12 [95% confidence interval (CI), 2.50-3.90]; delinquency, OR, 1.39 [95% CI, 1.15-1.67]; unhappy in school, OR, 1.25 [95% CI, 1.08-1.44]; and religion, OR, 0.76 [95% CI, 0.66-0.87]), while only own and peer involvement with substances (OR, 3.12 [95% CI, 2.42-4.02]) and religion (OR, 0.81 [95% CI, 0.68-0.97]) were significant in the older group. For initiation of regular use for boys and girls combined, own and peer involvement with substances and trouble in school were significant in both the younger (OR, 2.94 [95% CI, 2.11-4.09] and OR, 1.61 [95% CI, 1.20-2.16], respectively) and older age groups (OR, 2.87 [95% CI, 2.10-3.94] and OR, 1.63 [95% CI, 1.20-2.23], respectively). In addition, delinquency (OR, 1.42 [95% CI, 1.06-1.89]) and irrational decision making (OR, 1.36 [95% CI, 1.08-1.71]) were significant in the younger age group, while inactive pastimes was significant for the older age group (OR, 1.35 [95% CI, 1.05-1.75]). Finally, failure to discontinue experimental use for girls was explained by religion only in the younger age group (OR, 1.34 [95% CI, 1.05-1.72]) and own and peer involvement with substances only in the older age group (OR, 0.54 [95% CI, 0.36-0.82]).

To further establish the influences of the 3 strongest risk factors on marijuana involvement (combining the factors “trouble in school” and “happy in school”), we divided the sample in a high-risk group who scored in the upper 33% for each of the 3 risk factors (n=1386) and a low-risk group who scored in the lower 33%
method.27 However, the neighborhood, and being happy in neighborhood.

Delinquency includes shoplifting, stealing worth more than $50, causing property damage, painting graffiti, burglary, selling drugs, someone, using a weapon in a fight, seeing a shooting or stabbing, being jumped or stabbed, carrying a weapon to school, getting into physical fights, and being seriously injured from a fight. Delinquency includes shoplifting, stealing worth more than $50, causing property damage, painting graffiti, burglary, selling drugs.

School situation: Dissatisfaction with school, Trouble in school. Dissatisfaction with school includes being happy at school, part of school, close to people at school; feeling teachers treat students fairly, safe in school, students prejudiced, and teachers care about me; and having no trouble with homework. Trouble in school includes having trouble with teachers, having trouble paying attention, frequently skipping school, being suspended, repeating a grade, having trouble with homework, being expelled, not wanting to attend college, having a low grade point average, and being unlikely to attend college.

Family relations: Relations with mother, Relations with father. Relations with mother includes having a good relationship with mother, good communication with mother, mother is warm and loving, discussing ethics with mother, mother encourages independence, having few arguments about behavior, feeling mother cares, and being close to mother. Activities with mother includes talking about grades, school issues, personal problems, and life; working on school projects; going shopping, to the movies, concerts, plays, or sporting events; and doing things. Relations with father includes a good relationship with father, good communication with father, father is warm and loving, feeling father cares, and being close to father. Activities with father includes talking about grades and school issues; working on school projects; talking about life; working on school projects; going shopping, to the movies, concerts, plays, or sporting events; father disappointed if didn’t graduate from college; going to the movies, concerts, plays, or sporting events; father disappointed if didn’t graduate from high school; and doing things. Family relations includes family paying attention to you, having fun together, understanding you, caring about you, and not wanting you to leave home.

Independent decision making includes making own choices on television and videos, playing video and computer games, and listening to the radio. Solutions, irrational decision making, not evaluating outcome of decision, and not believing in accomplishment through hard work. Problem avoidance includes never arguing with anyone, never criticizing others, never feeling sad, avoiding confronting problems, and relying on gut feelings.

Depressive symptoms include feeling depressed, sad, the blues, lonely, bothered by things, people dislike you, life is a failure, fearful, feeling hot; frequent stomachaches; feeling fearful; poor appetite; chest pains; headaches; aches and/or pains; cold sweats; painful urination; too sick for social activities, sore throat and/or cough; acne; and being too sick for school. Positive emotions include feeling hopeful about the future, enjoying life, and feeling happy and just as good as others. Depressive symptoms include feeling depressed, sad, the blues, lonely, bothered by things, people dislike you, life is a failure, fearful, too tired to do things, it’s hard to get going, life is not worth living, people are unfriendly to you, poor appetite, and talking less than usual.

Dissatisfaction with school includes being happy at school, part of school, and close to people at school; feeling teachers treat students fairly, safe in school, students prejudiced, and teachers care about me; and having no trouble with homework. Trouble in school includes having trouble with teachers, having trouble paying attention, frequently skipping school, being suspended, repeating a grade, having trouble with homework, being expelled, not wanting to attend college, having a low grade point average, and being unlikely to attend college.

Domain Boys, Mean (SD) Girls, Mean (SD) P Value

<table>
<thead>
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<th>Domain</th>
<th>Boys, Mean (SD)</th>
<th>Girls, Mean (SD)</th>
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<td>Passive pastime</td>
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<td>Positive emotions</td>
<td>8.15 (2.63)</td>
<td>7.84 (2.75)</td>
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</tr>
<tr>
<td>Depressive symptoms</td>
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<td>7.97 (6.40)</td>
<td>&lt;.001</td>
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<td>10.85 (2.86)</td>
<td>10.95 (2.91)</td>
<td>.047</td>
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<tr>
<td>Problem avoidance</td>
<td>11.44 (2.58)</td>
<td>10.98 (2.46)</td>
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<tr>
<td>Neighborhood††</td>
<td>13.69 (2.40)</td>
<td>13.50 (2.56)</td>
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</table>

* Analyses are based on the full sample regardless of the status of marijuana use. To facilitate interpretation, the means are given for the nonnormalized risk factors. However, the t tests are based on the normalized risk factors. In the case of unequal variances for the 2 groups, t tests are based on the Satterthwaite method.27
†† Neighborhood includes neighbors looking out for others, being unhappy to move, knowing most neighbors, stopping and talking to neighbors, feeling safe in neighborhood, and being happy in neighborhood.

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In this large population-based sample, 13% of nonusers at wave 1 had become involved with marijuana 1 year later (at wave 2, 10% experimentally and 3% regularly). More than half (55%) of adolescents who had experimented with marijuana at wave 1 continued to use marijuana either experimentally (37%) or regularly (18%). The great majority of regular users at wave 1 remained involved with marijuana (53% on a regular basis and 20% experimentally). These numbers indicate that initiation tends to result in continuation.

The risk factors that have been most consistently related to marijuana use in the literature include the following: (1) Low levels of engagement in prosocial activities are associated with marijuana use28,29; (2) Psychological health. Marijuana use is associated with interpersonal difficulty,30 poor control of emotions,30 and depression and anxiety31,32; (3) Personality. Risk of marijuana use may be increased in those with limited inner resources to cope with psychological stress33 and poor self-concept.34-36 Other personality traits associated with increased risk include deviance,57 rebelliousness,23 being unempathetic,38 and unconventionality30,36; (4) School situation. School-related risk factors include poor academic performance,29,31 low connectedness to school,6 low achievement,39-43 low connectedness to school,44 and academic performance,39; (7) Religiosity and conservative beliefs may protect against marijuana use61; and (8) Risk of substance use may be greater in disadvantaged neighborhoods62,63.

Our analyses indicated that, when analyzed individually, most of these risk factors predicted at least some stages of marijuana involvement. However, the strongest predictors were substance use by adolescents themselves and their peers, delinquency, and school-related problems. These factors also influenced most stages of marijuana involvement, suggesting that intervention efforts aimed at these risk factors may be broadly applicable. In addition, when

<table>
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<th>Risk Factor</th>
<th>Initiation of Experimental Use</th>
<th>Initiation of Regular Use</th>
<th>Progression to Regular Use</th>
<th>Failure to Discontinue Experimental Use</th>
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<tr>
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*Values are expressed as odds ratios. Analyses are based on normalized, summed risk factor scores. Significant odds ratios were obtained from regression analyses run for each of the individual risk factors separately. Covariates age, race, urban status, and parental educational and occupational status were force-entered into each model before the introduction of the risk factors. A significance level of P=.03 for factors to enter and remain in the model was specified a priori. See Table 2 for explanation of risk factors.

†Odds ratios of highest value (<0.67 or ≥1.50).
we performed analyses on the younger (11-15 years) and older (16-21 years) age groups separately, these risk factors remained the strongest predictors.

Our results confirm previous reports of the importance of the risk factors “substance use by self and substance involvement of peers,” and “delinquency.” Use of alcohol or drugs during adolescence increases the risk of substance dependence in adulthood. Marijuana use has been related to failure to quit other substances. Peers may influence adolescent substance use by changing personal attitudes, serving as role models, and being a source of information and providing access, encouragement, and a social setting for experimentation with substances. De-
related risk factors influenced marijuana involvement; independent decision making (eg, freedom in choosing what to wear, eat, when to go to bed, television time and programs) predicted progression to regular use for boys, and activities with the mother (eg, discussing school grades and personal problems) predicted discontinuation of regular marijuana use for boys and girls combined. Both parental monitoring and parent-child attachment have been previously related to adolescent substance involvement.\(^{77,78}\) In our study, these influences were found to exert stage-specific and sex-specific influences. Possibly, family-related factors become less influential once the impact of other mediating factors (for example, socioeconomic status) and peer influences have been statistically accounted for, as in the analysis used in this study.

Two other factors were only significant in age-specific analyses: irrational decision making predicted initiation of regular marijuana use for boys and girls combined and inactive pastimes predicted the same variable for the older age cohort. Irrational decision making is characterized by the inability to make rational decisions, to research solutions, to evaluate outcomes of decisions, and to believe things can be accomplished through hard work. It reflects a lack of responsibility and self-efficacy, personality traits that have been previously related to marijuana involvement.\(^ {79}\) Inactive pastimes (hours spent watching television, playing computer and video games, listening to the radio) have also been related to risk of substance use.\(^ {28,29}\)

Most risk factor studies have focused on the initiation of marijuana use. The few studies that have also focused on discontinuation of use have indicated that use of other licit and illicit drugs, deviance, selection of social settings favorable for use, increased risk of victimization, and self-medicating to improve mood are important risk factors.\(^ {80-82}\) These findings are in agreement with our results. In addition, we found the progression and failure to discontinue (ie, of experimental and regular initiation) stages were influenced by considerably fewer risk factors than the initiation stages, and the 3 risk factors with the strongest associations with marijuana use were also the strongest predictors of failure to discontinue.

Adolescents with the highest scores on all 3 risk factors had considerably increased risks of initiating experimental (20 times) and regular marijuana use (87 times). When selecting the highest and lowest scoring groups for each risk factor individually, rather than combined, ORs ranged between 1.6 and 4.0, strongly indicating that the presence of multiple risk factors makes adolescents especially vulnerable for marijuana use and abuse. Therefore, directing intensive prevention and intervention efforts at those groups at greatest risk may be more successful than programs aimed at all students in a school, many of whom will never consider trying marijuana. The percentages of adolescents who were increasingly involved with marijuana were in the high-risk group more frequently than the low-risk group (28% vs 2% for experimental initiation; 16% vs 0.3% for regular initiation; 39% vs 0% for progression; 52% vs 0% for continued experimental use; and 60% vs 0% for continued regular use). This indicates that successful prevention and/or intervention efforts based on these combined risk factors may have an effect on a large proportion of adolescents at risk.

Identification of individuals at risk should take place in any setting where the 3 most important risk factors can be assessed, for example, in schools, medical practices, the judicial system, and substance treatment centers. Prevention and intervention should incorporate strategies to address other substance use and the peer group, delinquent activities, and the school situation. In addition, our finding of fewer risk factors influencing the progression and failure to discontinue use stages suggests that the greatest opportunities for intervention are during earlier stages of marijuana involvement. During later stages, genetic and other biological factors involved in habituation and dependence may become increasingly important\(^ {83}\) and treatment, more difficult.

Although we evaluated many carefully selected risk factors, not all relevant aspects of risk were assessed (for example, genetic factors\(^ {26,29}\) or attitudes toward drug use\(^ {84}\) ). Despite the advantages of a longitudinal design, we cannot rule out the possibility that other factors at wave 1 influenced both risk factors as well as marijuana involvement. In addition, the analytical methods used cannot account for complex interactions between risk factors. Sample sizes were lower for analyses of the progression and failure to discontinue use stages. This could have influenced our finding of fewer significant risk factors and should be taken into account when evaluating our conclusions. Many comparisons between behaviors and marijuana involvement were made in this study, and it is therefore possible that significant findings have arisen owing to chance. Reassuringly, however, all associations were in the expected directions and agree with results obtained in previous studies. In addition, a conservative approach was adopted by presenting the results in terms of the strongest findings (P values of \( \leq .03 \) for the regression analyses). Additional research, also including clinical populations, is needed to confirm the results and to further enhance their practical implications.

Our study indicates that the assessment of licit substance use, information on peers, delinquency, and how adolescents experience their school environment strongly predict risk of involvement with marijuana. Therefore, these risk factors can be used to identify adolescents who may require early and intensive prevention efforts and to address these factors in efforts to help them.

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