Trend Analysis of Cigarette Smoking by Indiana Adolescents, 1991-2000

Kele Ding, PhD; Mohammad R. Torabi, PhD, MPH, FAAHB
William J. Bailey, MS, MPH

Objectives: To examine the feasibility of using a composite index of smoking behaviors to analyze adolescent smoking. Methods: A secondary analysis of data from 10 annual surveys (1991-2000), from 566,467 Indiana students in grades 6 through 12. A composite index was calculated, and differences between index scores were analyzed using 1-way ANOVA, Tukey's post hoc tests, and 2-way moving averages. Results: Index scores increased before 1997 and decreased after 1976, with greater change among 7th through 10th graders. Conclusions: The 2-way moving average comparison of a composite index, used with prevalence-based trend analyses, provides a more complete picture of changes in adolescent cigarette smoking.

Key words: adolescent smoking, trend analysis

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Tobacco use is the single most preventable cause of disability and death in the United States and the cause of more deaths than AIDS, alcohol, cocaine, heroin, homicide, suicide, motor vehicle crashes and fires combined. Most tobacco users started using tobacco during adolescence. Estimations of the prevalence of tobacco use by teenagers often are made through various surveys at national, state, and local levels. National surveys include the Monitoring the Future Survey, the Youth Risk Behavior Survey (YRBS), the National Youth Tobacco Survey (NYTS), and the National Household Survey on Drug Abuse. Although these surveys often collect data on both quantity and frequency of use, most of the reports from these surveys describe simple prevalence of use rates that are based solely upon the proportion of survey participants who are the users, without considering quantity and intensity of use. This practice may understate or overstate the extent to which important changes in cigarette smoking behaviors occur over time.

Since 1991, the Indiana Prevention Resource Center (IPRC) at Indiana University has coordinated annual surveys to measure the extent of alcohol, tobacco, and other drug (ATOD) use by a representative sample of Indiana children and adolescents. The results of this survey provide data on drug-use prevalence and drug-use trends to state and local governments, school districts, and individual schools as a source of information for decision making in planning and evaluating drug use prevention and education programming.

Nationally, adolescent tobacco use had a peak in the 1970s and then lowered...
Trend Analysis of Cigarette Smoking

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Slightly before climbing again in the mid-1990s. National smoking rates among public school students were reported as increasing from the early 1990s to the mid-1990s. However, surveys in recent years (since 1996 or 1997) have found the beginnings of a reduction in smoking rates each year among certain grades and with certain smoking patterns. For example, current cigarette smoking and daily smoking by adolescents declined in 1999 according to the Monitoring the Future Study, but mostly among 8th to 10th graders. These declines were minimal among 12th graders. The smoking rate for Indiana children and adolescents has repeatedly been found higher than the national average, whereas its trends parallel those found in national surveys: increases throughout the early 1990s and a drop in smoking rates in recent years.

One difficulty in interpreting adolescent smoking trends is that most reports focus on smoking frequency rates, without adjustment for quantity. This means that one cigarette per month is treated the same as 2 packs (40 cigarettes) per day when calculating the prevalence of monthly smoking. This study analyzed cigarette smoking data from IPRC’s surveys from 1991 to 2000 using a composite smoking index that accounted for both quantity and frequency of use to determine the trends in cigarette smoking.

**METHOD**

**Subjects and Sampling**

A secondary analysis of existing data was conducted to calculate a trend analysis of changes in adolescent smoking in Indiana over the past decade. The data were derived from 10 annual surveys with a total of 608,795 students in grades 6 through 12 from 230 school districts in Indiana. Each annual survey used a 3-stage, purposive, quota cluster sampling procedure to yield a representative sample of Indiana students, stratified by grade and purposively selected, taking into account geographic balance, ethnic diversity, and community size. Details on instrument development, reliability, and validity were previously published. Each year, data were collected in a comparable sampling time frame beginning in the last week of March and ending in late April. Schools and communities were selected to assure proportional representation throughout the state, using planning regions established by the Governor’s Commission for a Drug-Free Indiana, and to assure adequate sampling of minority populations and students from rural areas. Schools were assigned a quota to yield appropriate numbers of subjects in each grade. Intact classes were used as sampling clusters, and in most schools, the entire population of students in the participating grades was surveyed. The sample reasonably represented the sociodemographic makeup of the state, based on the 1990 decennial Census of Population and Housing. The response rate of eligible students agreeing to participate and submitting usable surveys varied slightly from year to year over the 10-year period, ranging from 92.3% to 94.8%.

**Variables in Analysis**

The surveys used a 4-page, self-contained questionnaire developed in 1991 by the Indiana Prevention Resource Center. Items were based on questionnaires...
Table 2
Mean Cigarette Smoking Index by Year and Grade

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developed for the National Institute on Drug Abuse's Monitoring the Future national high school survey.\(^3\) Items were selected for their value in providing statewide planning data and for comparability with national data. All items were closed-ended questions, including demographic information.

Three smoking-related questions were chosen from the questionnaire for this analysis, including lifetime smoking, annual smoking, and monthly smoking (Appendix A). The responses to these 3 questions were examined for internal consistency, resulting in a 0.93 Cronbach Alpha coefficient. These questions had an ordinal scale as response categories, varying from never to used most frequently. In order to study smoking behavior as a whole, this study developed a composite smoking index\(^2\) by adding the scores of the 3 variables together. The possible smoking index scores range from 0 to 16. The higher the index score, the heavier one's smoking.

**Data Analysis and Procedures**

Smoking trends in this study were analyzed by examining the significant difference between the mean smoking index scores of 2 adjacent years by using the one-way ANOVA statistical test, and by fitting a best line into the mean indices by using the 2-way moving-average technique described by Yamane.\(^1\) According to Yamane,\(^1\) trend analysis is fitting a straight line or straight lines into the data to show general long-term movement of the data series. There are various methods to do this, such as the free-hand method, the method of semivariance, the method of moving averages, and the method of least squares.\(^3\)\(^-\)\(^5\) This study used the 2-year moving-average method to illustrate the smoking trend line in order to reduce the trend fluctuations of a 10-point data series. It is worth noting that these methods of trend analyses versus others were chosen because they were most appropriate only to the nature of the survey data and their limitations. For the statistical significance, the alpha level was set at 0.05 or below. The analysis was conducted using the SPSS computer program.

Data from each survey were merged by using key variables of year and grade. Cases that refused to participate, with inconsistent responses to drug use questions, with missing responses to the 3 cigarette-smoking questions, or reportedly answered the questionnaire untruthfully were excluded, yielding a total of 566,467 usable surveys for this study. Data were weighted by the number of students actually enrolled in Indiana public schools in each year and grade of the survey prior to analysis.

**RESULTS**

A total of 566,467 usable cases were retained for analysis. Table 1 presents the number of usable cases by year and grade. Data were not weighted in Table 1, but were weighted by actual enrollment in Tables 2 and 3.

Overall, males accounted for 50.1% of the retained cases; females, 49.6%; and 0.3% did not respond to the gender question. The ethnicity of the respondents was white/Caucasian (87%), Black/African American (4.6%), Mexican American (1.4%), Oriental or Asian American (1.1%), and Puerto Rican/Latin American (0.5%).
**Table 3**

Statistical Differences of Smoking Index Mean Scores Between 2 Adjacent Years by Grade, 1991-2000

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**Note.**

\[+\] The mean index score had no statistically significant change from last year
- The mean index score had a statistically significant decrease from last year
+ The mean index score had a statistically significant increase from last year

and 5.4% did not respond to the ethnicity question. A composite smoking index was computed by adding the scores of the 3 cigarette-smoking questions together, with a potential range of 0 to 16. Table 2 displays the mean index scores obtained by grade and year.

The mean scores between any 2 adjacent years at each grade were tested for statistically significant differences by using one-way ANOVA and Tukey's post hoc tests. The ANOVA tests were conducted at each grade level separately. Tests for all 7 grades received a significant F value with P>.01. However, the follow-up post hoc tests yielded mixed findings, showing the mean index scores in some of the years were not significantly higher or lower than year immediately preceding them. Table 3 briefly indicates the post hoc test results for each grade.

As Table 3 indicates, significant increases in the mean scores mostly occurred before 1997 and among 7th through 10th graders. After 1996, decreases of the scores were predominant wherever statistical tests were significant. Again, the decreases most often were found among 7th through 10th graders. Less change was detected for subjects in grades 6, 11, and 12 when using this analytical method. Although descriptive statistical analysis of percentage use of cigarettes for each individual question found a decrease of smoking in 2000 in comparison to 1999 for 7th to 10th graders, Table 3 shows only 10th and 11th graders achieved a significant decrease in 2000 from the previous year.

In order to visually observe the trend of cigarette smoking among Indiana school children, mean scores for every 2 adjacent years were averaged, and a line chart was used to fit into the averaged mean scores to compose a 2-way moving-average line chart for each grade, shown in Figure 1.

The trend in cigarette smoking by visual observation of the figure shows a linear decrease for 6th graders since 1991. The trend for 7th and 8th graders presents a cubic movement that is decreasing, increasing, and then decreasing again. A biphasic trend was seen for grades 9 through 12, which is increasing and then decreasing. Although the contour of the lines generated by plotting the mean smoking index scores on Figure 1 is similar to those generated by plotting data from separate prevalence measures from annual surveys such as the Monitoring the Future survey, the IPRC survey, and to a lesser extent from the biennial YRBS surveys, there are subtle differences. The data plotted on Figure 1 show that the smoking-index score differences for a given year are twice as great when comparing the 3 grades between 6th and 9th to
DISCUSSIONS AND CONCLUSIONS

Cigarette smoking by Indiana adolescents has decreased in recent years compared to what was found in the early and mid-1990s. The Indiana Prevention Resource Center first reported an early decrease in youth tobacco, alcohol, and other drug use in 1998 after a leveling off of the use rates in 1997 and reported a slow but steady decrease of rates in 1999 and 2000. This decline in drug and tobacco use was viewed as a success due to the new statewide prevention initiatives including the addition of 500 more after-school prevention programs, a statewide prevention coordination effort, the federal mass media campaign, new programs for enforcement of youth access to tobacco products, and changes in public attitudes and policies. However, when looking into the data precisely, the conclusion regarding a decreasing trend of tobacco use was mainly based on a decrease in tobacco use prevalence in terms of lifetime, annual, monthly, or daily use.

It is a common practice that local and national reports use annual or biannual survey studies to count the percentage of respondents who reportedly used a drug, at least once, in a designated period of time such as a lifetime or during the past month. The changes of the percentages obtained from year to year were used in this study to depict the trend of drug use. An apparent advantage of such a practice is that it could provide the simplest, most straightforward, and most easily understood quantitative information about the percent of drug users. However, this method could lead to either under- or overestimation of the true score of drug use in 2 ways: (a) without seriously con-
Trend Analysis of Cigarette Smoking

sidering how severe the drug use has been and (b) lacking a clear description when the percentages change in different directions among various drug use patterns, such as an increase in lifetime use while decrease in annual use. Studies have found that from one third to one half of the reported use rates were accounted for by youth who smoked only 1 to 5 times in the month, year, or their lifetimes.\textsuperscript{7, p. 65-79},\textsuperscript{16} For example, smoking one cigarette per month was often weighted the same as smoking 2 packs (40 cigarettes) per day when calculating the percentage of users smoking monthly. Apparently, the use of certain drug use patterns to represent the use trend has limitations.

The focus of this study was to combine multiple information of drug use patterns, including both the frequency of use and the severity of use into a united score and then use the score as a representative of the drug use behavior as a whole to determine a trend. When the average index scores for smoking were used in trend analysis as in this study, the findings generally matched the drug use patterns reported by national and local surveys, but somewhat less steeply. This is probably due to the use of 2-year moving-average method in smoothing the fluctuation of the original data across time. The use of the index could eliminate the response contradiction to different cigarette-smoking questions by combining information.

This study used the 2-way moving-average method and the ANOVA test in analyzing the index scores to determine a trend. Both techniques were able to smooth the raw trend lines constructed by the cigarette-smoking index scores and provide a clearer picture of the trend. However, there were some unresolved issues related to the construction of a valid and reliable behavioral index and the use of 2-way versus other ways of moving-average calculation. Nevertheless, to use moving average techniques and the smoking index in this study was experimental and exploratory. The method would be mostly appropriate only to the data that were from such surveillance surveys.

As policy makers develop new tobacco control strategies, in light of the multistate tobacco settlement,\textsuperscript{17} it is essential to have accurate and complete information about changes in cigarette consumption. Interpreting the results of various surveys may be difficult, because different reports might appear to present conflicting information. For example, in a recent publication, CDC reported the trends of frequent smoking and lifetime smoking as worse and unchanged since 1991.\textsuperscript{18} Several months later, another CDC publication reported decreases in frequent smoking and lifetime smoking between 1997 and 1999.\textsuperscript{5} Differences in the reference years for comparison could account for this confusion. Many such reports limit their discussion only to specific patterns of cigarette smoking trends, such as lifetime annual or monthly use. Other drug use patterns, such as current use, and heavier consumption patterns should be incorporated in future trend analyses regarding tobacco and other drug use.

When conducting trend analyses of adolescent smoking, there are significant advantages to working with surveys conducted annually and in as many grades as possible. Data from annual surveys, such as the Monitoring the Future\textsuperscript{3} survey and the IPRC survey,\textsuperscript{7} allow policy makers to observe year-to-year changes in smoking trends. Biennial surveys, such as the YRBS\textsuperscript{18} and the NYTS,\textsuperscript{5} must wait for 2 years to note the trend changes, and such surveys have only half the number of data points. Surveys such as the IPRC all-grades survey\textsuperscript{7} allow observers to note how the trends vary by grade, such as the differences in the trends for 6th graders (linear decrease), 7th and 8th graders (cubic movement), and 9th through 12th graders (biphasic movement). This may suggest different strategies for tobacco prevention and control programs at different grade levels.

The 2-way moving-average comparison of a composite smoking index has the potential for providing critical additional information about changes in cigarette consumption for policy makers. When used in conjunction with traditional trend analyses based upon simple prevalence rates, a more complete picture of changes in adolescent cigarette smoking is provided.

Acknowledgment

The data used in this study were obtained from archival data for the 10 annual surveys at the Indiana Prevention
Resource Center. The original surveys that collected these data were funded by annual contracts with the Indiana Family and Social Services Administration, Division of Mental Health. The study protocol was reviewed and approved by Indiana University's IRB, the Committee for the Protection of Human Subjects. Participant informed consent (or assent), and parental informed consent in the case of minors, was obtained prior to survey.

REFERENCES
### Appendix A
Smoking Questions Included in the Study

1. **Have you ever smoked cigarettes?**
   - 0 Never
   - 1 Once or twice
   - 2 Occasionally but not regularly
   - 3 Regularly in the past
   - 4 Regularly now

2. **How often in the past year have you smoked cigarettes?**
   - 0 None
   - 1 A few times
   - 2 1 to 5 cigarettes per day
   - 3 About one half a pack per day
   - 4 About one pack per day
   - 5 About 1 and a half packs per day
   - 6 Two or more packs per day

3. **How often in the past month (30 days) have you smoked cigarettes?**
   - 0 None
   - 1 A few times
   - 2 1 to 5 cigarettes per day
   - 3 About one half a pack per day
   - 4 About one pack per day
   - 5 About 1 and a half packs per day
   - 6 Two or more packs per day