Communitywide Smoking Prevention: Long-Term Outcomes of the Minnesota Heart Health Program and the Class of 1989 Study

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ABSTRACT

Objectives. The Class of 1989 Study is part of the Minnesota Heart Health Program (MHHP), a populationwide research and demonstration project designed to reduce cardiovascular disease in three educated communities from 1980 to 1993. This paper describes an intensive, school-based behavioral intervention on cigarette smoking, comparing long-term outcomes in one of the intervention communities with those in a matched reference community.

Methods. Beginning in sixth grade (1983), seven annual waves of cohort and cross-sectional behavioral measurements were taken from one MHHP intervention community and its matched pair. All students in each community were eligible to participate (baseline n = 2401). Self-reported data collected at each period described prevalence and intensity of cigarette smoking.

Results. There were no differences at baseline for either weekly smoking prevalence or intensity of smoking. Throughout the follow-up period, however, smoking rates as determined by these measures were significantly lower in the intervention community: 14.6% of students were weekly smokers at the end of high school compared with 24.1% in the reference community.

Conclusions. These results suggest that multiple intervention components such as behavioral education in schools, booster programs to sustain training, and complementary communitywide strategies may all be needed for lasting reductions in adolescent tobacco use. (*Am J Public Health.* 1992;82:1210–1216)

Introduction

Despite repeated disease warnings and some decline in the prevalence of cigarette smoking over the past 15 years, about 29.4% of the 1990 American high school graduates are current smokers.[1] They have acquired a pernicious habit that is difficult to give up and that has been described as the No. 1 cause of premature morbidity and mortality in the United States.[2] The peak time of smoking onset occurs in early adolescence, sixth to ninth grades,[3] when behavioral choices are complicated by biological, emotional, cognitive, identity, and social changes. The initiation of smoking, then, is embedded in these changes, which should be monitored and guided by the adult society.

Efforts to prevent the onset of cigarette smoking have been targeted primarily at the individual adolescent through school-based programs. These programs teach young adolescents the skills they need both to resist the social influences to smoke and to perform more general social competencies.[4,5] However, while the results of more than 20 research studies permit optimism that these approaches can delay onset of cigarette smoking, none has demonstrated positive outcomes after 3 years. Recently, several investigators have begun to add intervention components that explicitly target the social environment to aid adolescents in remaining nonsmokers.[6–9]

The Class of 1989 Study was designed to test the efficacy of a smoking prevention program that is part of a larger effort to reduce heart disease in whole communities. It is a substudy of the Minnesota Heart Health Program (MHHP), a populationwide, community-based cardiovascular disease prevention program funded by the National Heart, Lung, and Blood Institute over a 13-year period (1980 to 1993).[10] In the MHHP, the entire population in three participating cities in the north-central United States received a 5-year educational program encouraging healthy changes in eating, exercise, and smoking patterns to control high blood pressure. Three similar cities, also in the north-central portion of the United States, served as reference communities.[11] The Class of 1989 Study evaluated the youth education portion in two MHHP communities.

It was hypothesized that the effects of a school-based smoking prevention program (the Minnesota Smoking Prevention Program) with young adolescents would more likely be maintained if the program was part of 5 years of behavioral health programs in the schools and if these programs were implemented in communities where (1) adults were involved in risk factor screening and mass smoking cessation, (2) new smoking ordinances at school and in the community were being considered, and (3) multiple complementary school and community programs were established.

Methods

Research Design

The research design of the Class of 1989 Study was determined largely by the

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parent project, the MHHP. Two of the six MHHP communities were involved. The community made up of Fargo and West Fargo, North Dakota, and of Moorhead, Minnesota, was one of the three MHHP intervention communities, and it received an extensive communitywide intervention program designed to improve eating, exercise, and smoking patterns across the entire population. The youth smoking prevention program was one component of that communitywide effort. Sioux Falls, South Dakota, was the reference community matched to the Fargo-Moorhead intervention community for size, socioeconomic makeup, and distance from Minneapolis–St. Paul, Minnesota. There were no MHHP-sponsored education programs for either youth or adults in Sioux Falls.

The Class of 1989 Study was established on a quasi-experimental[12] basis to assess the net effect of combining a behavioral health education program in school with the communitywide MHHP on the youth living in the intervention community. All sixth graders enrolled in the public schools in both communities were invited to participate in a baseline survey in April 1983, and that grade cohort was surveyed annually each April until its graduation from high school in 1989. From 1983 to 1986, 13 grade schools participated in the survey; and from 1987 to 1989, participating students attended 7 high schools. All students in the grade cohort were eligible to participate in each annual survey regardless of their prior participation in either the Class of 1989 surveys or the MHHP education programs, or of how long they had resided in the community. Thus, each annual survey represented a cross-sectional sample of all students in each community for the appropriate grade. By recording identifying information at each survey, it was possible to analyze the data both as specific for a cohort and as representative of a series of cross-sectional surveys using all respondents. Cohort data, using only those respondents present at baseline and at subsequent surveys, provide the strongest basis with which to test the continuing effects of the interventions. While cross-sectional data may better reflect the secular trend, they also represent students new to the area who have not received the full treatment.

During this same period, the students in the Class of 1989 study intervention community participated in MHHP-sponsored behavioral health programs in school from 1983 to 1987. Smoking prevention programs, based on the social influences model, were implemented in 1983, 1984, and 1985. Details on all the interventions of the Class of 1989 Study and of the social influences model are described in detail elsewhere.[6,13]

The primary smoking intervention, the Minnesota Smoking Prevention Program, was implemented in 1984, the fall of seventh grade. This program addresses the prevention of tobacco use by influencing the social and psychological factors that encourage the onset of smoking. First, the students begin by identifying the short-term consequences of smoking, such as smelling like smoke or having bad breath. This generally is done through small group discussions so that the consequences are relevant to the age group. Second, the students discover that smoking is not a normative behavior for young adolescents; they do this by comparing their expectations of how many of their peers smoke with actual data and by discussing their overestimates of prevalence. Third, the reasons why adolescents smoke tobacco are explored—for example, a desire to have fun, a way of making friends, a signal of maturity, or a method of coping with personal problems[14]—and positive alternatives to achieve the same goals are provided. Fourth, the students learn how these associations are established in our culture through both advertising and peer and adult role models. The methods advertisers use to convince adolescents of tobacco's functional values are presented through discussions of selected advertisements. Mock social situations are analyzed to identify the type of influences that exist. Fifth and most important, the students learn and practice skills to resist these social influences to smoke. They create anti-tobacco advertisements and skits (role playing) around possible social encounters. Sixth, near the end of most programs, the students make a public commitment to abstain. This commitment acts as a psychological anchor and explicitly creates an intention not to experiment with substances. Finally, all these activities are experiential—designed to require active participation—and often are led by trained peer (same-age) leaders, who have proven to be effective communicators for many of the social and psychological messages intrinsic to the program.[15]

In addition to the school-based intervention, the intervention community participated in the MHHP populationwide intervention. Indirectly, the students received this intervention over a 5-year period through a deliberate attempt to restructure the adult social and physical environment with regard to heart-healthy behaviors and values.[10,11] The primary intervention components of the MHHP included seven strategies: (1) population-based risk factor screening for cardiovascular disease, in which more than 60% of adults participated in a 1-hour health assessment and direct education program for healthy eating, exercise, and smoking; (2) grocery and restaurant heart-health point-of-purchase food labeling education; (3) community organization and citizen task forces to develop annual risk factor education campaigns; (4) continuing education of health professionals to promote understanding of the nature of cardiovascular disease risk and prevention; (5) mass media education via television, radio, newsprint, etc.; (6) adult education in work sites, churches, workshops, and other organizations; and (7) youth education.

Outcome Evaluation

Outcome evaluation was conducted through an annual survey in all the school districts in the two communities from March to April of 1983 to 1989. The survey instrument was derived from a cognitive-behavioral model and the needs assessment surveys in each community.[13,16] Administered by survey staff from the MHHP who were trained for classroom administration, the survey took approximately 40 minutes and was completed by the students in their health, social science, or English classes. All students in the relevant grade level who were present on a particular day were tested.

The measures for tobacco use—the focus of this paper—each year included self-reported smoking history and, in 1986 only, the amount of thiocyanate in saliva samples. Psychosocial variables pertaining to smoking etiology were not included in this study because this question was the subject of a separate, ongoing research project and limited space was available on the survey instrument. The self-report items, standardized questions with acceptable reliability and validity, have been used in previous smoking research.[17] The prevalence of weekly smoking was used to assess the impact of the intervention. In addition, a smoking intensity score was created from the self-reported measures. Smoking intensity represents the number of cigarettes smoked per week by each student, calculated as an average of three self-report questions related to daily smoking, weekly smoking, and smoking history. The method of calculation of

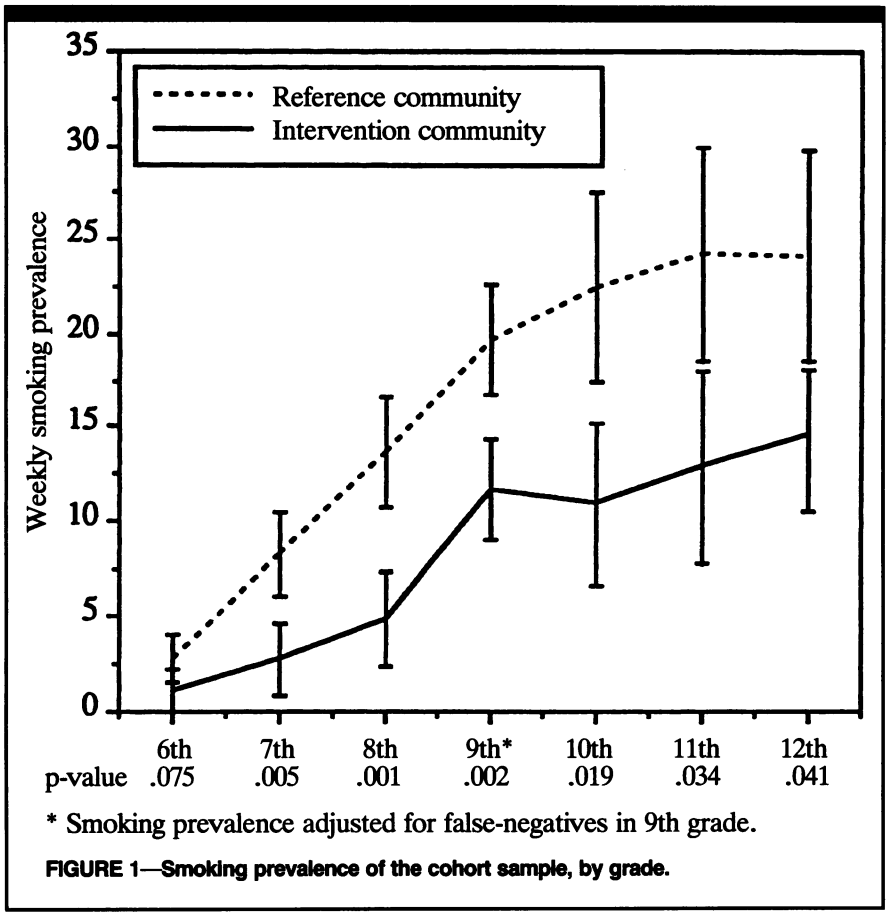

FIGURE 1—Smoking prevalence of the cohort sample, by grade.

smoking intensity has been described in detail elsewhere.[17] Test-retest correlation for smoking intensity from this age population was .99.[17]

Saliva samples were obtained for biologic validation of self-report in 1986 with a random sample of half the classrooms (n = 1076 students); this was done with dental cotton rolls, which were held in the mouth for 5 minutes. The amount of saliva thiocyanate (SCN), a byproduct of smoking tobacco, was collected and determined by methods described elsewhere.[17,18] The correlation of smoking intensity with SCN was 0.46 ($P < .0001$), a value not unexpected considering that student smoking habits at this age are sporadic. SCN is a useful measure in this situation primarily to identify false-negative self-reports (i.e., self-reported nonsmokers with an SCN value indicating smoking status) and is less likely to classify false-positive self-reports (self-reported smokers with a low SCN value) correctly. SCN values were used in these data to correct false-negative self-reports in 1986 using a cutoff point of 79 μg/mL derived from internal data as described by Cummings and Richard[19]; this accounts for low levels of SCN due to passive smoking.

Other relevant measures are age at the time of survey, sex, and parental occupation. Questions related to parental occupation were added in 1987 and are used to produce an index of household occupation in which 1 = both parents are white-collar workers, 2 = both parents are clerical workers, 3 = both parents are blue-collar workers, and 4 = parents are mixed as to the three categories. Single parents were coded for their occupation.

Analysis Methods

This study combines elements of what we have termed *nested cohort* and *nested cross-sectional* designs.[20] In these designs, intact social groups (e.g., whole cities) are assigned to conditions. In the nested cohort design, subjects within those groups are followed over time as a cohort to assess the effects of the interventions. In the nested cross-sectional design, independent samples of subjects within those social groups participate at each measurement occasion. In either design, subjects from a single community will tend to be more like one another than they are like subjects in other communities. This within-community correlation in the data, indexed by the community-level intraclass correlation coefficient (ICC), adds an additional component of variability to the intervention group means above and beyond that attributable to either the individual subjects or the interventions themselves.[21] Unless this component is accounted for in the analysis, the evaluation of the intervention effects will be positively biased in proportion to the magnitude of the ICC and the number of respondents in each community.[22]

Note that in the present study, students were observed in classrooms, which were nested within schools, which were nested within the towns assigned to the two treatment conditions. Fortunately, ICC, which reflects the within-unit correlation in the data at each level of nesting, also captures the within-unit correlation at all levels of nesting lower in the hierarchy. Thus, while we could not use the community as the unit of analysis, we could correct for most of the variance inflation expected in such a design by using instead the next level in the hierarchy: the school. This was accomplished for the data gathered after 1985 using PROC GLM in SAS,[23] in which a model that used the individual's smoking status as the outcome and included school as a nested random effect was fit for each round of data; the intervention effect was tested against the school variance. The school identifier was not available in the data collected for elementary schools prior to 1986, and so the school variance was estimated by standard methods using schools from subsequent years.[20,21] Separate analyses were performed for each follow-up round. For the cross-sectional analyses, all participants were included; for the cohort analyses, only those who also participated in the baseline survey were included. All analyses included covariance adjustments for age and sex, and in the years 1987 to 1989, adjustments were made for parental job class.

Results

Smoking Outcomes

The cross-sectional and cohort smoking outcome data were analyzed to examine differences between communities in both the percentage of weekly smokers and the smoking intensity for each year from 1983 to 1989. No significant differential program effects were observed between the sexes, so the results for the two sexes were pooled for presentation purposes. Figures 1 and 3 present the results from the cohort analyses for

weekly smoking prevalence and smoking intensity, respectively; Figures 2 and 4 present the results from the serial cross-sectional analyses. All figures present mean levels, 95% confidence intervals, and intervention/reference comparison *P* values, adjusted for the school effects as described in the Analysis section above. The unadjusted smoking prevalence and intensity differed by less than 1%, or by one cigarette per week, respectively, for either treatment condition, and these measures offer the same magnitude of intervention effects as the covariate adjusted results.

Although no significant differences were detected at baseline (1983) in the cohort sample, Figures 1 and 3 reveal significant differences for smoking prevalence and intensity between communities for this sample at all follow-up years (1984 to 1989). At the end of high school, 14.6% of the cohort sample from the intervention community were smoking compared with 24.1% from the reference community. Similarly, Figures 2 and 4 show significant differences between communities for the cross-sectional samples at all follow-up years. Cross-sectional students represent those remaining in the community throughout the study as well as those not present at baseline or new to the community. In Figures 2 and 4 we observe only a slight increase in smoking prevalence and intensity for the cross-sectional sample as compared with the cohort sample, indicating that these students have little impact on how these trends are interpreted.

Saliva samples were obtained from a random sample of approximately half of all classrooms in 1986, with SCN analyses completed on 667 and 409 students in the intervention and reference communities, respectively. Using school as the unit of analysis, significant differences between communities were found in the SCN level, with the intervention community significantly lower than the reference community in both the cohort sample (54 vs 39 μg/mL, $P = .0002$) and the cross-sectional sample (56 vs 41 μg/mL, $P = .0009$). Note that adjustment for false-negative self-reported smoking prevalence was done in 1986 as described in the Methods section above. The number of false-negative reports verified by SCN differed by community, with 9.8% (n = 40) in the reference community claiming falsely not to be smoking compared with 6.5% (n = 43) in the treatment community ($\chi^2 = 4.3$; $P = .038$; individual unit of analysis).[18] The effect of false-negative adjustment was to raise the prev-

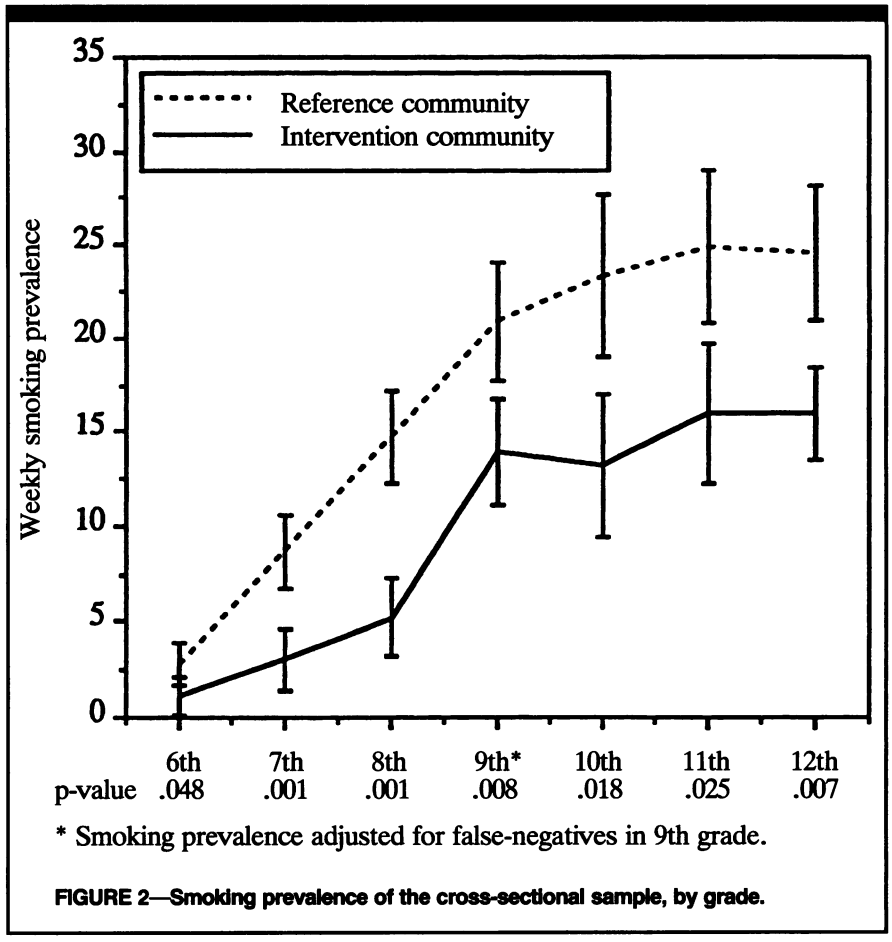

FIGURE 2—Smoking prevalence of the cross-sectional sample, by grade.

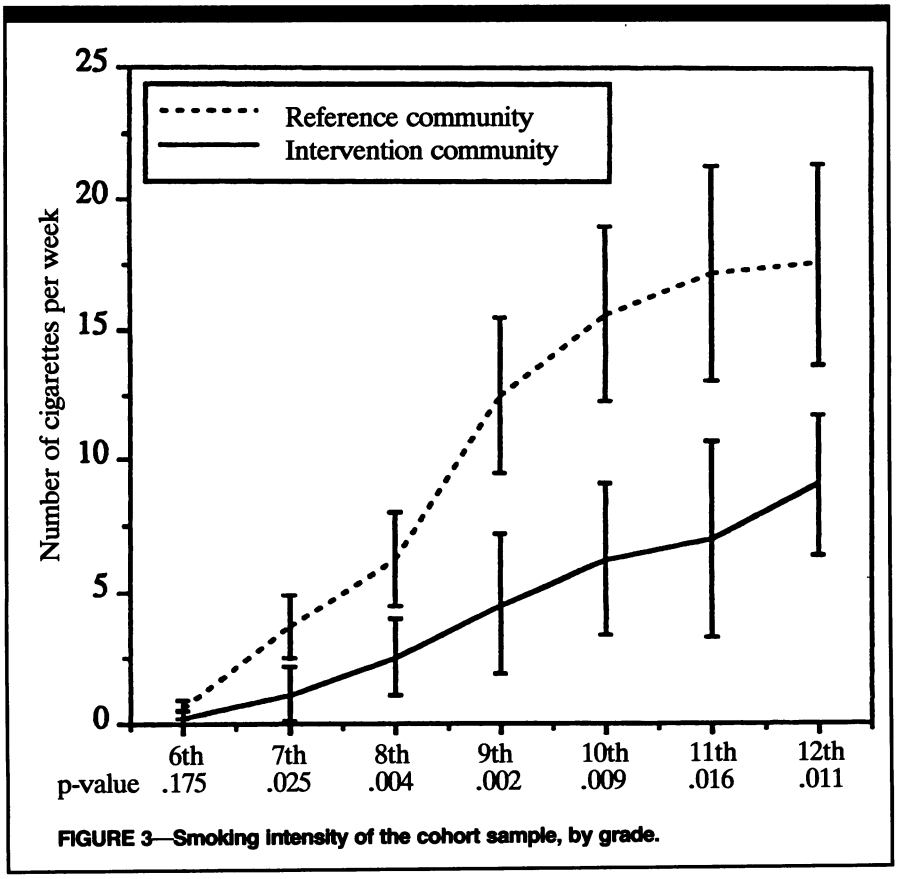

FIGURE 3—Smoking intensity of the cohort sample, by grade.

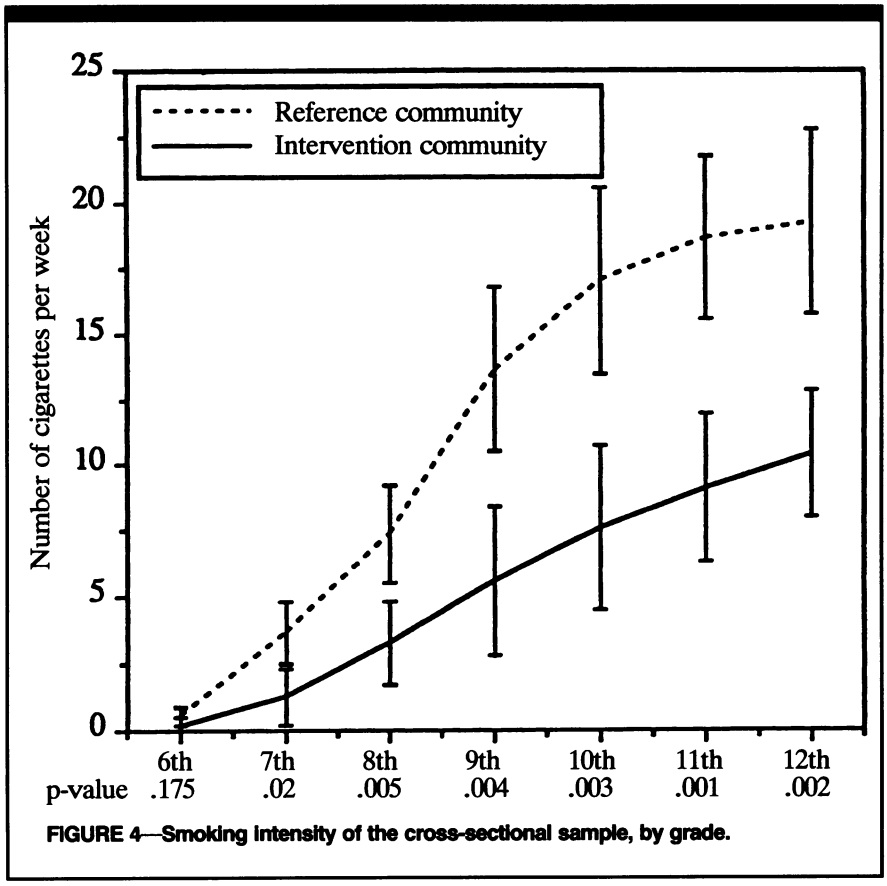

FIGURE 4—Smoking intensity of the cross-sectional sample, by grade.

TABLE 1—Sample Size and Follow-up by Year and Grade

	1983/ 6th	1984/ 7th	1985/ 8th	1986/ 9th	1987/ 10th	1988/ 11th	1989/ 12th
Cross-section, n	2401	2453	2416	2164	2124	1905	1439
Cohort, n	2401	2103	1943	1670	1578	1421	1080
Cohort, % follow-up	...	88	81	70	66	59	45
Cohort as % of cross-section	100	86	80	77	74	75	75

alence estimates for both communities. This is especially noticeable in Figures 1 and 2 for the intervention community, in which a sharp increase was observed between eighth and ninth grades, most of which can be attributed to the false-negative correction.

Attrition Analysis

Table 1 presents the study sample size and follow-up by year and grade for the cross-section and cohort samples. Financial constraints precluded any attempt to contact those students who moved out of the community, were absent, were involved in work-study, or dropped out and were not in class on the day of the survey. Response rates by intervention and reference communities were nearly equal except for the last year of data collection, in which 55% of intervention cohort students were resurveyed compared with only 32% in the reference schools. Because missing students were not recontacted, we cannot estimate the extent of differential attrition on smoking, but this can be approximated by identifying the previous year's values for those students not present. Table 2 presents the previous year's smoking prevalence for students missing in the cohort sample. For example, for students not present in 12th grade, 29% in the reference community were smoking at least weekly in 11th grade compared with 23% in the intervention community. Had those identified in any previous year remained smoking in the following year, the magnitude of the intervention difference would have been increased in four of the six follow-up evaluations by 0.5% to 2.3% and would have declined in the other two by 0.2% to 0.35%. In no year would the addition of these missing students have altered the intervention group differences observed or the given interpretation of these results.

Discussion

The Class of 1989 Study was designed to take advantage of the time of transition to adolescence by using peer-led, behavioral, school-based smoking prevention programs nested within a community-based intervention. This paper describes smoking outcomes for cross-sectional and cohort samples from the intervention and reference communities for 1983 to 1989.

Smoking rates throughout the follow-up period were substantially lower in the intervention community when measured by either weekly smoking prevalence or smoking intensity. These differences were confirmed by SCN analysis in 1986. The risk of being a smoker upon graduation in 1989 in the intervention community was about 40% lower than it was in the reference community.

The results of the study should be considered in comparison with other smoking prevention studies. For the most part, the effects of other programs have diminished over time, and few investigators have reported effects past the 10th grade.[9,24,25] This suggests that behavioral education in schools, booster programs to sustain training, and complementary communitywide change may all be needed to maintain effects with young people. Since virtually all cigarette smoking is initiated prior to high school graduation, the maintenance of significant differences through 12th grade should lead to the eventual reduction of adult smoking and smoking-related diseases.

The study has several limitations. The common threats to internal and external validity associated with nonrandom assignment are well known, and several such threats pertain to this design, including baseline pretreatment differences, regression to the mean, differential maturation and attrition, and history.[12] At baseline, both smoking prevalence and intensity measures were slightly higher in the reference community. These differences at the early stages of smoking onset were small, and separate analyses of covariance in the cohort sample adjusting for these differences required no changes in

TABLE 2—Previous Year's Smoking Prevalence of Students Missing in the Cohort Sample

	Identified Missing Students, n		Weekly Smoking, %	
	Intervention	Reference	Intervention	Reference
11th grade smoking prevalence of students missing in 12th grade	211	305	22.6	28.9
10th grade smoking prevalence of students missing in 11th grade	211	124	17.8	42.4
9th grade smoking prevalence of students missing in 10th grade	147	157	23.1	31.2
8th grade smoking prevalence of students missing in 9th grade	256	148	9.4	23.2
7th grade smoking prevalence of students missing in 8th grade	134	157	3.7	15.8
6th grade smoking prevalence of students missing in 7th grade	163	135	0.0	3.0

our interpretation of these data. Differential regression is unlikely, given the multiple observations and the fact that differences were observed after baseline observation and became larger over the 7 years. Attrition over time may underestimate smoking prevalence in both communities since absent students are more likely to smoke.[26,27] Attrition analysis indicates, for most years, a bias that reduced the magnitude of the intervention effect because of higher levels of smoking in the reference community as a result of those missing at the time of measurement.

Unfortunately, differential maturation and local history are completely confounded with the series of interventions, and thus they cannot be so easily dismissed. At issue is whether the lower onset rate in the intervention community was due to some cause other than the intervention, and whether the increase in smoking in the reference community was as high as it was due to some cause other than the usual high school secular trend. Annual reviews of related community programs as well as of the existing school health programs that were done by the investigators in either community did not reveal an alternative explanation for the effects observed. In addition, smoking rates at the completion of the study in Sioux Falls are comparable to those obtained in a 1990 representative survey of high school seniors for the North Central Region, in which 22.2% reported smoking at least one cigarette per day over the previous 30 days.[1] Finally, no policy level changes in taxes or availability of cigarettes were noted to have occurred during or immediately prior to the evaluation period.

The Class of 1989 Study does, then, permit optimism for the benefits to youth of long-term, school-based, communitywide programs, and specifically for the retardation of uptake of smoking behavior. The adoption of behavioral programs across multiple communities appears to be feasible; outcomes can be sustained in a supportive environment. The communities selected for this study represent typical middle-size midwestern communities, and the results should be generalizable to similar settings. Examination of these school-based, communitywide approaches appears to be warranted for youth with other high-risk social and health behaviors, and especially for youth in lower socioeconomic communities, where these problems are more acute and existing resources are scarcer. The need for research in these populations is clearly critical. □

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