How did Project Northland reduce alcohol use among young adolescents? Analysis of mediating variables

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Abstract

Project Northland is a randomized trial designed to create, implement and evaluate multilevel, community-wide strategies to prevent alcohol use among adolescents. This paper will focus on the mediating outcomes of the early adolescent phase of Project Northland when the students in the study cohort were in Grades 6–8. The project was conducted in 24 school districts and adjacent communities in northeastern Minnesota. The intervention consisted of social-behavioral curricula in schools, peer leadership activities, parental involvement and education, and community-wide activities. At the end of 3 years of intervention, significantly fewer students in the intervention school districts reported alcohol use than students in the reference districts. Mediation analyses were conducted to investigate if the intervention's effects on mediating variables could explain the reduction in alcohol use. Important mediators of Project Northland's effect on alcohol use were: (1) peer influence to use, including normative estimates, (2) functional meanings of alcohol use, (3) attitudes and behaviors associated with alcohol and drug problems like stimulus seeking, rule violations and bad judgement, and (4) parent–child alcohol-related communication around al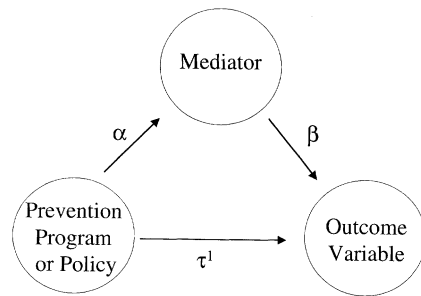cohol use. In addition, among those who did not use alcohol at baseline, self-efficacy to refuse offers of alcohol was a significant mediator.

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Introduction

Prevention science advances with each critical analysis of prevention programs. If a program or policy is found to be effective in changing the targeted health behavior, the next step is to analyze how the program worked. That is, did the prevention program affect the mediating variables that were targeted by the intervention? Theories guide the development of prevention programs and analyzing how prevention programs worked helps to fine tune these theories, leading to the refinement of prevention strategies. With the advancement of statistical techniques, prevention scientists are now able to analyze how their prevention programs affected the targeted health behavior.

Prevention and intervention programs are designed to change critical mediating variables thought to be causally related to health outcomes (MacKinnon and Dwyer, 1993). Mediators are those risk and/or protective factors that are amenable to change and are the focus of prevention strategies. Prevention programs or policies are designed to reduce risk factors and increase protective factors with the goal of increased positive health outcomes. A mediator is an intervening variable (risk and/or protective factor) that explains (or accounts for) the relationship between the program or policy and the desired outcome (Baron and Kenny, 1986). Mediation analysis assesses the extent to which the prevention program or policy changed the mediator which in turn changed the outcome variable (MacKinnon *et al.*, 1995).

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Indirect Effect $= \alpha \times \beta$ Total Effect $= \alpha\,\beta + \tau^1 = \tau$
Direct Effect $= \tau^1$

Fig. 1. A mediation model [adapted from (MacKinnon *et al.*, 1995)].

Mediation analysis in prevention studies is important because the processes that lead to behavior change can be delineated (MacKinnon, 1994). The path from the program to the mediator to the outcome is the process of mediation and is depicted in Figure 1 [from (MacKinnon *et al.*, 1995)]. The indirect or mediated effect is equal to $\alpha\beta$. Other effects in the model include the direct effect, τ', and the total effect, $\tau = \tau' + \alpha\beta$. A few drug prevention studies have conducted mediation analysis on the outcomes of prevention studies and these are reviewed below. However, more research is needed to understand the specifics of how prevention programs work and to tease out the most important prevention components.

The Life Skills Training (LST) curricula series resulted in reduced drug use rates among students exposed to the curricula compared to controls (Botvin *et al.*, 1995). Schools were recruited and randomly assigned to intervention ($n = 34$) or control ($n = 22$) conditions. The intervention schools received the LST curricula series. The LST curricula targets general life skills and skills for resisting social influences to use drugs. The curricula include 15 sessions during Grade 7, 10 during Grade 8 and five during Grade 9. The curricula resulted in significant long-term reductions in monthly and weekly cigarette use, and having been drunk among the cohort when in Grade 12, 6 years after the program started ($n = 3597$; 60% of initial Grade 7 sample). Among the high fidelity group ($n = 2752$), defined as those who received 60% or more of sessions, significant reductions were found among the Grade 12 students exposed to the program compared to controls in monthly, weekly and pack-a-day smoking; monthly, weekly and heavy use of alcohol, and having been drunk; and monthly and weekly marijuana use. In another study of the curricula (Botvin *et al.*, 1992), the authors examined the effects of the 15 session curriculum on smoking and mediating variables among a population of urban minority youth. Schools were randomly assigned to receive the LST curriculum ($n = 25$) or serve as controls ($n = 22$). The results of this study are based on a post-test survey that was administered 4 months after the pre-test survey. Smoking prevalence and onset were lower among the students who received the curriculum compared to the control students. In addition, the following mediator variables were significantly different between the intervention and control groups: smoking prevalence knowledge, immediate consequences knowledge and social acceptability knowledge were significantly higher among the intervention group, and normative expectations for peers and normative expectations for adults were significantly lower among the intervention group. These mediators were then assessed using a structural modeling approach and the results indicated that the best-fitting model was one that included a mediated path between the intervention and smoking outcome, but did not include a direct path between the intervention and smoking outcome. This result indicates that the impact of the intervention on cigarette smoking was mediated by these variables. However, the curriculum was also designed to have an impact on more distal mediators of smoking initiation (e.g. self-efficacy, self-esteem, decision making, assertiveness and psychological well-being). There were no significant effects found on these hypothesized mediators. The authors concluded that having an impact on the more distal mediating variables was not necessary for producing short-term prevention effects with this population.

A community-based program for the prevention

of drug use, the Midwestern Prevention Project, resulted in lower rates of drug use at 1-year follow-up (Pentz *et al.*, 1989). Of 42 schools, eight were randomly assigned to program or control condition, 20 could reschedule existing programs and were assigned to the program condition, and 14 did not have flexibility to reschedule existing programs and were assigned to the control condition. There were no baseline differences in drug use or demographics between conditions. The intervention included a 10-session school-based curriculum on skills training for resistance of drugs, with 10 homework sessions involving active interviews and role-plays with parents and family members, and mass media coverage. Analysis of potential mediators found that friends' reactions to drug use explained 66% of the program effect on alcohol use and 45% of the program effect on cigarette use (MacKinnon *et al.*, 1991). Intentions not to use alcohol were a marginally significant mediator of the program effect on alcohol use, accounting for 31% of the program effect (MacKinnon *et al.*, 1991). There were no strong program effects on perceived resistance skills, perceived peer norms and negative consequences of drug use (MacKinnon *et al.*, 1991).

Project DARE (Drug Abuse Resistance Education) uses specially trained law enforcement officers to teach a drug prevention curriculum. The DARE core curriculum is 17 sessions for Grade 5 or 6 students, and focuses on the skills needed to recognize and resist social pressures to use drugs (DARE America, 1996). A meta-analysis of eight methodologically rigorous Project DARE outcome evaluations found that the short-term effectiveness for reducing or preventing drug use behavior is small and is less than for interactive prevention programs (Ennet *et al.*, 1994). Hansen and McNeal (Hansen and McNeal, 1997) examined 12 postulated mediators of substance use prevention programs to determine if DARE had an effect on mediators and if those mediators accounted for behavioral outcomes. The sample for the study included three cohorts of Grade 8 students in one school district ($n = 1033$, 1669 and 1556) during the period when the DARE curriculum was being introduced to the district. Analyses are based on self-reported exposure to the DARE program. Results indicated that the primary effect of DARE was a change in commitment to not use substances. This change significantly mediated the behavioral effects; however, DARE's effect on the mediator was small. Also, DARE only had significant behavioral effects on tobacco use, it did not have significant effects on alcohol use, illegal drug use, steroid use, inhalant use, and drug selling and dealing. The authors then examined the 12 mediators' potential for affecting behavioral outcomes by examining the relationship between the mediators and drug use. The results indicated that four of the 12 mediators had strong and consistent relationships with substance use: (1) manifested a commitment to not use substances, (2) normative beliefs, (3) lifestyle/value incongruence with substance use and (4) social skills, but associated in a negative direction.

Results of mediation analyses from these three studies indicate that norms (smoking prevalence knowledge, social acceptability knowledge, normative expectations and friends reactions to drug use), commitment to not use substances and intentions are important mediators for prevention programs. Hypothesized mediators that were not found to be significant included resistance skills, social skills, self-efficacy, self-esteem and psychological well-being. Knowledge of negative consequences was a significant mediator in the LST study, but not in the Midwestern Prevention Project. Thus, prevention programs should continue to include analysis of targeted mediators to help delineate how prevention programs are working and to guide future efforts.

The purpose of this paper is to analyze several potential mediating variables of Project Northland to determine how the intervention worked to reduce the onset of alcohol use. Project Northland is a randomized community trial designed to create, implement and evaluate alcohol use prevention strategies for adolescents (Perry *et al.*, 1993). Project Northland was funded in two primary phases. Phase I targeted a cohort of adolescents during their middle schools years from Grade 6 to
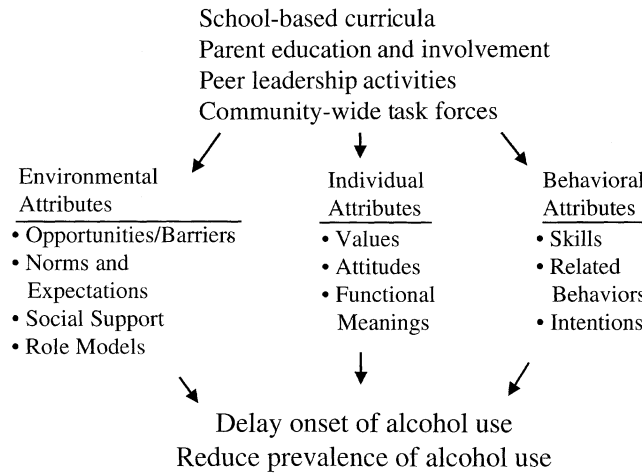
Fig. 2. The conceptual model for the prevention of adolescent alcohol use by Project Northland.

8 (Perry *et al.*, 1993, 1996). Phase II targeted this same cohort of adolescents into their high school years, from Grade 10 to 12 (Perry *et al.*, 2000). Outcome analysis from Phase I indicates that the Project Northland intervention significantly reduced alcohol use among young adolescents. The outcomes analyses from Phase II are in progress. This paper will focus on mediation analysis of Phase I of Project Northland. It was hypothesized that the effects of the Project Northland intervention on alcohol use were mediated through the environmental, personal and behavioral factors outlined in Figure 2 [adapted from (Perry *et al.*, 1989)].

Method

Design

Project Northland is a randomized community trial. In 1991, 24 school districts were recruited systematically from northeastern Minnesota. Four smaller districts were combined with nearby districts to ensure adequate sample size in each unit, and these 20 combined districts and their surrounding communities were blocked by size and randomly assigned to the intervention ($n = 10$) or delayed program ($n = 10$) condition (Perry *et al.*, 1996). These communities are rural and small with populations ranging from 250 to 18 000.

Participants

The primary study cohort were in Grade 6 in 1991 when the study began and present for the survey at the end of Grade 8 in 1994 ($n = 1901$; 81% of the baseline survey) (Perry *et al.*, 1996). The study cohort was 95.6% white, 3.7% American Indian, 49% girls and 70% lived in a two-parent household. There were no significant differences in baseline alcohol use between those lost to follow-up in the intervention or control schools, or for those lost to follow-up and those who remained (Perry *et al.*, 1996).

Intervention

Project Northland Phase I intervention included school curricula (Williams *et al.*, 1992; Perry *et al.*, 1993), peer leadership (Komro *et al.*, 1994, 1996), family education and involvement (Williams *et al.*, 1992; Perry *et al.*, 1993), and community-wide activities (Veblen-Mortenson *et al.*, 1999). The intervention components were designed to target the constructs in the theoretical model presented in Figure 2, with the goal of preventing alcohol use or reducing use among those adolescents who had already started to consume alcohol.

Measures

Evaluation methods for Project Northland consisted of: (1) a student survey for the study cohort, (2) a

parent survey, (3) an observation study of potential underage buying of alcohol and (4) a survey of alcohol merchants (Perry *et al.*, 1993). This mediation study will only use the student survey. A self-report questionnaire was administered in the beginning of the cohort's Grade 6 and at the end of each grade thereafter. This study utilizes the baseline and end of Grade 8 surveys. The survey consists of measures of demographic variables, alcohol and other drug use, and variables associated with alcohol use among adolescents.

Scales were created to measure the constructs targeted by the intervention. Scales measuring tendency to use alcohol (intentions and alcohol use behaviors), self-efficacy (confidence in being able to refuse offers of alcohol), functional meanings (reasons for not using alcohol), peer influence to use alcohol and other drugs (estimates of use by peers and offers to use), and perceived access to alcohol were found to have satisfactory psychometric properties in previous samples (Williams *et al.*, 1995) and with our current study sample. In addition, two dichotomous normative items and four parent–child alcohol-related communication items were used.

Four scales from the Minnesota Multiphasic Personality Inventory for Adolescents were analyzed as potential mediators, and include the Alcohol/Drug Problem Proneness Scale (Weed *et al.*, 1994), Adolescent-School Problems Scale, Adolescent-Low Aspirations Scale and Adolescent-Family Problems Scale (Williams *et al.*, 1992). Although these scales were developed and are used to measure personality attributes and behaviors of individuals, we hypothesized that Project Northland might affect these scales, since we were changing the social context of adolescents in these communities and thus might create an effect at the population level. The Proneness Scale measures behaviors that have been identified as risk factors for early adolescent alcohol and other drug use, including negative peer group influences, less involvement with parents, rule breaking, stimulus seeking and less achievement orientation. Items about actual use of alcohol were excluded from this scale. The School Problems Scale measures

numerous problems in school, e.g. poor grades, truancy, negative attitudes towards teachers and strong dislike of school. An elevated score on this scale is associated with academic and behavioral problems in school. The Low Aspirations Scale measures disinterest in being successful and low expectations of success. An elevated score on this scale is associated with poor achievement and limited participation in school activities. The Family Problems Scale measures detachment and emotional distance from one's family and family conflict. Individuals with an elevated score on this scale do not view their family as a source of support and do not have strong emotional ties to their family. Table I provides a summary of the hypothesized mediating variables within the framework of the conceptual model.

Data analysis

The mediating effects of the program on one specific behavioral outcome, tendency to use alcohol, were estimated using the rationale provided in MacKinnon (MacKinnon, 1994), and the statistical procedures described in MacKinnon and Dwyer (MacKinnon and Dwyer, 1993) and Krull and MacKinnon (Krull and MacKinnon, 1999). These statistical analyses were performed in order to determine the extent to which the program effects on this behavioral outcome could be due to the program effects on several hypothesized mediators.

Three regression models provided the parameter estimates and the standard errors needed to establish the presence or absence of mediation between one mediating variable and the outcome variable (Judd and Kenny, 1981a,b). The first regression model tested and estimated the effect of the program on the outcome variable (τ). The second regression model tested and estimated the effect of the program on the hypothesized mediating variable (α). If the program did not have at least a marginally significant effect ($P < 0.10$) on the hypothesized mediator then no further analyses were conducted with that variable. The third regression model tested and estimated the effect of the mediating variable on the outcome

Table I. *Measurement of the outcome variable and potential mediators*

		Items	α	Score range
Outcome variable				
alcohol use	Tendency to Use Alcohol Scale	8	0.93	8–48
Environmental attributes				
opportunities/barriers	Perceived Access Scale	6	0.73	6–30
norms/expectations	Peer Non-Use Norm Item	1	–	0–1
	Not many people my age drink alcohol			
	Peer Use Norm Item	1	–	0–1
	Most people my age will drink alcohol by the time they are seniors in high school			
	Parent–Child Communication Item 1	1	–	0–1
	My parents talk with me about problems drinking alcohol can cause young people			
	Parent–Child Communication Item 2	1	–	0–1
	My family has rules against young people drinking alcohol			
	Parent–Child Communication Item 3	1	–	0–1
	I think my parents will allow me to drink by the time I am a high school senior			
	Parent–Child Communication Item 4	1	–	0–1
	My parents have told me what would happen if I were caught drinking alcohol			
Environmental attributes				
social support	MMPI-A Family Problems Scale	32	0.90	0–32
role models	Peer Influence Scale	15	0.93	15–71
Individual attributes				
values/attitudes	MMPI-A Low Aspirations Scale	16	0.70	0–16
functional meanings	Functional Meaning Scale	10	0.92	10–50
Behavioral attributes				
skills	Self-Efficacy Scale	5	0.93	5–25
related behaviors	MMPI-A School Problems Scale	20	0.83	0–20
Environmental/Individual/Behavioral attributes				
	MMPI-A Alcohol/Drug Problem Proneness Scale	36	0.82	0–36

variable after adjusting for the effect of the program (β). The magnitude of the mediated effect was calculated by multiplying the latter two regression coefficients together ($\alpha\beta$). The standard error of the mediated effect was derived using the multivariate delta method (square root of $[(\alpha)^2 (\sigma\beta)^2 + (\beta)^2 (\sigma\alpha)^2])$ (Sobel, 1982, 1986; Goodman, 1960). The statistical test for the significance of the mediated effect was calculated using a *t*-statistic. In addition, a measure of the extent of mediation, the percent of the total effect that is mediated $[\alpha\beta/(\alpha\beta + t')]$ (MacKinnon, 1994), was calculated for each mediator.

Separate models were run for each potential mediator. Mixed model analyses of covariance were performed using SAS PROC MIXED (SAS Institute, 1989). SAS PROC MIXED was used rather than structural equation modeling to account for the group-level variance. School district, the unit of assignment to condition, was specified as a nested random effect in order to account for the group-level variance found when intact social groups are assigned to condition (Murray, 1998; Krull and MacKinnon, 1999). Baseline measures of the tendency to use alcohol; the mediators, if available (some parent communication items and

the functional meanings items were not available at baseline); gender; and race were used as co-variates in the analyses. Only those students present at baseline and follow-up ($n = 1901$) were used in this investigation. The analyses described below were conducted twice: (1) on the entire cohort ($n = 1901$) and then (2) on those students who reported no use of alcohol in their lifetime at baseline (baseline non-users; $n = 1176$). Mediation analyses were not conducted on the subsample of students who reported having used alcohol at least once in their lifetime at baseline ($n = 712$) because there was no significant difference in alcohol use among the intervention and control groups at follow-up.

Results

Program effects

Elsewhere we reported significant effects of the program on a number of behavioral and psycho-social outcomes (Perry *et al.*, 1996; Williams *et al.*, 1999). Among all students and students who were non-users at baseline, significant program effects on the behavioral outcome of interest in this study, tendency to use alcohol, were found. The school districts receiving the prevention program had significantly lower scores on the Tendency to Use Alcohol Scale (indicative of less likelihood of drinking) at the end of Grade 8 than did students in the comparison school districts among all students in the cohort ($n = 1901$) and among those students who reported no use of alcohol at baseline ($n = 1176$). There were no differences found between students who reported alcohol use at baseline ($n = 712$). Therefore, mediation analyses were conducted for all students and baseline non-users, but not for baseline users, since there were no program effects among this group.

There were statistically significant ($P < 0.05$) to marginally statistically significant ($P < 0.10$) program effects on all of the hypothesized media-tors presented in Table I except for the following variables: (1) perceived access to alcohol among all students and baseline non-users, (2) peer non-use norm among baseline non-users, (3) peer use norm among all students and baseline non-users, (4) parent–child alcohol-related communication item 3 among all students and baseline non-users, (5) MMPI-A Family Problems among all students and baseline non-users, (6) MMPI-A Low Aspirations Scale among all students, (7) Self-Efficacy Scale among all students, and (8) MMPI-A School Problems among all students. Mediation analyses were not conducted on these variables because there were no program effects found on them. All other variables presented in Table I were considered potential mediators of the program effects on alcohol use. Marginally statistically significant effects were included because of the practical importance of identifying the most critical components of prevention programs and the reduced statistical power inherent in detecting mediating effects (Baron and Kenny, 1986).

Mediating effects

The mediating effects of the program on alcohol use are presented in Tables II (all students) and III (baseline non-users). Project Northland had a number of significant mediated effects on the tendency for young persons to use alcohol.

Among all students, statistically significant ($P < 0.05$) mediators included parent–child alcohol-related communication items 1 and 4, the Peer Influence Scale, the Functional Meaning Scale and the MMPI-A Proneness Scale. The peer non-use norm item and parent–child alcohol-related communication item 2 were marginally significant mediators for the entire group of Grade 8 students.

Among those students who did not use alcohol at baseline, significant mediators included the parent–child alcohol-related communication items 1 and 4, the Peer Influence Scale, the Functional Meaning Scale, the Self-Efficacy Scale, the MMPI-A School Problems Scale and the MMPI-A Proneness Scale. The parent–child communication item 2 and the MMPI-A Low Aspirations Scale were marginally significant mediators for this group of Grade 8 students who did not use alcohol at baseline.

Table II. *Multilevel estimates, standard errors and percent mediated of Project Northland-mediated effects among all students*

	Mediated effect ($\alpha\beta$)	t value	Percent mediated ($\alpha\beta/\alpha\beta + \tau$')
Environmental attributes			
Perceived Access Scale	no significant program effect; mediation analysis not conducted		
Peer Non-Use Norm Item	0.2277 (0.1124)	2.0264[c]	14.0
Peer Use Norm Item	no significant program effect; mediation analysis not conducted		
Parent–Child Communication Item 1	0.2742 (0.1144)	2.3973[b]	17.7
Parent–Child Communication Item 2	0.1890 (0.0933)	2.0248[c]	13.0
Parent–Child Communication Item 3	no significant program effect; mediation analysis not conducted		
Parent–Child Communication Item 4	0.1971 (0.0827)	2.3834[b]	12.6
MMPI-A Family Problems Scale	no significant program effect; mediation analysis not conducted		
Peer Influence Scale	1.6457 (0.5876)	2.8005[b]	97.3
Individual attributes			
MMPI-A Low Aspirations Scale	no significant program effect; mediation analysis not conducted		
Functional Meaning Scale	1.2973 (0.3055)	4.2466[a]	88.0
Behavioral attributes			
Self-Efficacy Scale	no significant program effect; mediation analysis not conducted		
MMPI-A School Problems Scale	no significant program effect; mediation analysis not conducted		
Environmental/Individual/Behavioral attributes			
MMPI-A Drug/Alcohol Problems Proneness	0.8454 (0.3755)	2.2515[b]	61.5

All models are adjusted for gender, race, baseline alcohol use and baseline measures of the mediator where available. [a]$P < 0.01$, [b]$P < 0.05$, [c]$P < 0.10$ (two-tailed t-test at 18 d.f.).

Discussion

The results of the mediation analyses for all students and baseline non-users of alcohol suggest that Project Northland achieved its result of lowering the rate of alcohol use among students in Grade 8 by decreasing peer influence to use alcohol, increasing functional meanings supportive of non-use, decreasing the likelihood of developing alcohol or drug problems (i.e. reduction in risk factors associated with alcohol or drug problems as measured with the MMPI-A Alcohol/Drug Proneness Scale) and increasing parent–child alcohol-related communication around use. These mediating variables were the focus of specific components of Project Northland's multicomponent intervention. Process evaluation indicated that the peer-led, classroom curricula (Williams *et al.*, 1992; Perry *et al.*, 1996); parent education and involvement (Williams *et al.*, 1992; Toomey *et al.*, 1996); peer-planned social activities (Komro

et al., 1994; Perry *et al.*, 1996); and community education and involvement (Peery *et al.*, 1996; Veblen-Mortenson *et al.*, 1999) were successfully implemented in the intervention communities. The results of the mediation analyses suggest which mediating variables, and therefore which intervention components, had an effect on the rate of alcohol use.

Understanding and learning techniques for young adolescents to manage social influences and pressures to use alcohol and creating a non-use norm were main themes of all 3 years of the intervention. This is reflected in the significance of peer influence to use alcohol as a mediator—this scale measures estimates of peers' use and offers to use. Project Northland programs and activities were also designed to suggest and offer positive alternatives to drinking alcohol, especially the Garde 7 programs, 'Amazing Alternatives!' (Perry *et al.*, 1993; Komro *et al.*, 1994; Toomey *et al.*, 1996). These types of activities supported reasons for not using alcohol, reflected in the

Table III. *Multilevel estimates, standard errors and percent mediated of Project Northland-mediated effects among baseline non-users*

	Mediated effect ($\alpha\beta$)	*t* value	Percent mediated ($\alpha\beta/\alpha\beta + \tau$')
Environmental attributes			
Perceived Access Scale	no significant program effect; mediation analysis not conducted		
Peer Non-Use Norm Item	no significant program effect; mediation analysis not conducted		
Peer Use Norm Item	no significant program effect; mediation analysis not conducted		
Parent–Child Communication Item 1	0.4350 (0.1418)	3.0671[a]	28.1
Parent–Child Communication Item 2	0.2642 (0.1353)	1.9530[c]	17.5
Parent–Child Communication Item 3	no significant program effect; mediation analysis not conducted		
Parent–Child Communication Item 4	0.2202 (0.0888)	2.4795[b]	13.8
MMPI-A Family Problems Scale	no significant program effect; mediation analysis not conducted		
Peer Influence Scale	1.5750 (0.5354)	2.9419[a]	88.8
Individual attributes			
MMPI-A Low Aspirations Scale	0.4195 (0.2008)	2.0890[c]	32.2
Functional Meaning Scale	1.0967 (0.2442)	4.4900[a]	76.1
Behavioral attributes			
Self-Efficacy Scale	1.0076 (0.2663)	3.7830[a]	67.8
MMPI-A School Problems Scale	0.6375 (0.3039)	2.0977[b]	51.2
Environmental-Individual-Behavioral Attributes			
MMPI-A Drug/Alcohol Problems Proneness	0.8031 (0.3218)	2.4961[b]	71.6

All models are adjusted for gender, race, baseline alcohol use and baseline measures of the mediator where available. [a]$P < 0.01$, [b]$P < 0.05$, [c]$P < 0.10$ (two-tailed *t*-test at 18 d.f.).

finding that functional meanings was a significant mediator. The Alcohol/Drug Problem Proneness Scale, measuring high-risk environmental, individual and behavioral factors, was also a significant mediator. This scale measures such concepts as negative peer group influence, stimulus seeking, rule violation, negative attitudes towards achievement and school, and friction with parents. Project Northland's activities encouraged peer leadership and active involvement of students within their classrooms, schools, families and communities. These types of activities may have influenced these attitudes and behaviors which in turn affected alcohol use rates. In addition, all 4 years of the intervention included parent education and involvement, and parent–child alcohol-related communication was a statistically significant mediator.

Among the subsample of baseline non-users, additional significant mediators of the program's effect on alcohol use (which were not significant mediators among the entire sample) included decreasing school problems and increasing self-efficacy to refuse offers of alcohol. Project Northland's interventions supported a non-use message and norm. Among those students who had not begun to use alcohol, these messages and activities provided support for their decisions and may have increased their confidence in their decisions and ability to resist offers to use alcohol. These results suggest that resistance skills training may be more efficacious before the onset of a particular behavior since it was only a significant mediator among baseline non-users. In addition, these findings may indicate that self-efficacy training may need to be more intensive.

An important point to keep in mind regarding the generalizability of the findings from Project Northland is that it was implemented and carried out in a rural area of Minnesota with a mostly white population. This area of the state was selected because of high levels of alcohol-related problems

(Perry *et al.*, 1993). It will be important to replicate and evaluate Project Northland with a more ethnically diverse population to investigate the generalizability of these findings. However, in support of generalizability, the results of the analysis of Project Northland's mediating variables are similar to those found in other prevention programs, particularly the peer influence mediator (MacKinnon *et al.*, 1991; Botvin *et al.*, 1992). Similar results across these intervention trials highlight the significance and importance of concentrating on reinforcing and building healthy norms and peer influence. Self-efficacy or resistance skills were not found to be significant mediators in the LST curriculum (Botvin *et al.*, 1992) or the Midwestern Prevention Project (MacKinnon *et al.*, 1991). In this study of Project Northland we found that self-efficacy to resist offers of alcohol was a significant mediator of the program effect, but only for those students who had not started to drink at baseline. This finding suggests that resistance skills training may be especially efficacious before the onset of behavior, as a primary prevention tool.

It is also important to consider the hypothesized mediators that were not statistically significant. The results of the mediation analyses suggest that Project Northland's results were less attributed to: (1) reducing access to alcohol and (2) decreasing family problems. The Project Northland interventions specifically targeted parent–child alcohol-related communication and monitoring. The MMPI-A Family Problems Scale measures serious problems in families, which were not directly targeted by the Project Northland home-based programs. Therefore, it is not surprising that family problems were not found to be a significant mediator. However, we did observe a reduction in family problems (measured with the MMPI-A Family Problems Scale) after the first year of intervention which included Project Northland's most successful parent–child intervention, the Slick Tracy Home Team Program (Williams *et al.*, 1999). Community efforts during Phase I of Project Northland concentrated more on creating alcohol-free alternatives for youth and community education, rather than on reducing access to alcohol. Therefore, the finding that perceived access was not a significant mediator of program efforts was not surprising. Making changes in adolescents' social environment, including reducing access to alcohol, and increasing family communication, family support and parental monitoring, is difficult and requires comprehensive and long-term efforts. Yet making changes in the larger social environment is important to sustain behavior change long-term (Bronfenbrenner, 1979).

Project Northland achieved positive changes at the individual, peer and family levels, and in the three domains specified by the conceptual model used to design the intervention (the environmental, individual and behavioral domains). The larger social environment was less affected. Despite the significant reductions in alcohol use and significant individual-, peer- and family-level mediators, the differences between the intervention and reference groups began to dissipate by the end of Grade 9 (Williams and Perry, 1998). Both Phase I and II of Project Northland were designed with the idea that positive changes in the most proximal social units need to be supported by changes in the larger social environment. It seems that Phase I was successful in making short-term changes in the individual, peer and family units, but less effective in making changes in the larger social environment of the community. The larger social environment became the primary focus of Phase II (Perry *et al.*, 2000).

Prevention programs should include analysis of targeted mediators to help delineate how prevention programs are working. Both proximal and more distal hypothesized mediators should be examined and relationships between the mediators and outcomes should be analyzed over an extended period of time. Mediation analyses play an important role in helping us to understand how prevention programs are working. This detailed information will hopefully lead to the development of more effective prevention strategies.

Acknowledgements

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