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Variation in the Sustained Effects of the Communities That Care Prevention System on Adolescent Smoking, Delinquency, and Violence

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Abstract Communities That Care (CTC) is a universal, science-based community prevention system designed to reduce risk, enhance protection, and prevent adolescent health and behavior problems community wide. CTC has been found to have sustained effects on cigarette use and delinquent and violent behaviors in grade 10 in a panel of 4,407 students followed from fifth grade in a community randomized trial. It is important to test variation in the effects of this prevention system designed to be universal to understand for whom it is most effective and whether it fails to produce change or leads to iatrogenic effects for certain categories of individuals. The present study examined variation in the sustained effects of CTC on tenth-grade cigarette use and delinquent and violent behaviors. Interaction analyses suggest that the effect of CTC did not differ between those who had high levels of community-targeted risk factors at baseline or had already engaged in substance use, delinquency, or violence at baseline versus those who had not. Although CTC reduced the prevalence of both girls' and boys' problem behaviors, the effect on delinquency was marginally (p=0.08) larger for boys than for girls.

Keywords Universal community intervention · Risk moderation · Gender · Adolescents · Substance use · Delinquency

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Communities That Care (CTC) is a universal, science-based community prevention system designed to reduce risk, enhance protection, and prevent adolescent health and behavior problems community wide. CTC mobilizes and trains community stakeholders to collaborate on the development and implementation of a science-based community prevention system, and it guides communities to choose, install, and monitor tested and effective preventive interventions to address elevated risks and suppressed protective factors affecting youth (Hawkins et al. 2002). Results from the first randomized trial of CTC in 24 communities across seven US states (Brown et al. 2009; Hawkins et al. 2008) found that initiation and prevalence rates of adolescent delinquent behavior and drug use were significantly lower in CTC than control communities 4 years after the initial implementation of CTC in intervention communities (Hawkins et al. 2009). These reductions were found by the end of eighth grade in a panel of students followed from fifth grade. Sustained effects of CTC 1 year after study-provided resources ended and 6 years after initial implementation of CTC have also been found, that is, when the panel of students was in grade 10 (Hawkins et al. 2012). Initiation rates of delinquent behavior, alcohol use, and cigarette use in tenth grade were significantly lower in CTC than in control communities. In addition, the prevalence of past-month cigarette use and past-year delinquent and violent behavior also was significantly lower in CTC than in control communities in grade 10.

Because CTC is a universal prevention system that is not intended to focus on specific populations, CTC is not expected to differentially affect particular individuals or groups of individuals. However, preventive interventions have at times been found to be effective only for certain subgroups of the population, such as youth who are at risk of developing health and behavior problems (Kellam et al. 1998, 2008; Van Horn et al. 2008). Testing variation in the effects of a prevention system that was designed to be universal is important because it provides information about how the system operates, for

whom and under what conditions it is most effective, whether it fails to produce change or leads to iatrogenic effects for certain individuals, and how it may need to be modified. Establishing the generalizability of intervention effects is one of the standards of evidence for effective prevention programs and policies of the Society for Prevention Research (Flay et al. 2005) and is important for widespread dissemination of preventive programs.

Variation in the effects of CTC on adolescent substance use and delinquency was first examined when the panel of youth followed in the randomized trial was in grade 8, 4 years after the initial implementation of CTC in intervention communities (Oesterle et al. 2010). Results showed that CTC reduced substance use and delinquency in all examined subgroups, including boys and girls; youths who had already started drinking, smoking, or engaging in delinquent behavior at baseline in fifth grade and those who had not; and adolescents with higher and lower levels of community-targeted risk factors at baseline. Overall, there was little evidence for significant variation in the effects of CTC on grade 8 substance use and delinquency. The effects of CTC did not differ significantly between early initiators of substance use and those who had not yet started using alcohol or cigarettes at baseline, neither did the effect of CTC differ between those who had high levels of risk and those who did not. However, tests of the interaction between gender and intervention condition suggested that CTC may have had a greater impact on reducing alcohol and smokeless tobacco use (but not the use of other drugs or delinquency) among boys than girls in grade 8. Results also suggested that CTC may have reduced the number of delinquent behaviors in which eighth graders engaged during the past year more so for students who had not committed any delinquent acts at baseline in fifth grade compared to those who had. The effect of CTC on substance use outcomes did not differ for students who had already engaged in delinquent behavior at baseline and those who had not.

To establish the generalizability of intervention findings, the present study examined variation in the effects of CTC on the prevalence of youth problem behaviors observed 6 years after initial implementation of CTC and when the panel was in the tenth grade. Sustained effects in the full sample were found on the prevalence of past-month cigarette use and past-year delinquent and violent behaviors (Hawkins et al. 2012). We examined variation in CTC's effects on these outcomes by gender and using the same risk-related subgroups as in the prior study (Oesterle et al. 2010).

Methods

Data came from the Community Youth Development Study (CYDS; Hawkins et al. 2008), the first community-randomized trial of CTC. The 24 communities participating in the CYDS were selected from 41 communities in the states of Colorado, Illinois, Kansas, Maine, Oregon, Utah, and Washington that participated in an earlier descriptive study of the diffusion of science-based prevention strategies (Arthur et al. 2005). The drug abuse prevention agencies in these states identified 20 of the 41 communities that the agencies thought were trying to implement risk- and protection-focused prevention services. These 20 communities were then matched, within state, on population size, racial and ethnic diversity, economic indicators, and crime rates to comparison communities that were not thought to be using a risk- and protection-focused approach. In spite of states' initial assessments of these communities, neither community in 13 of the 20 pairs of communities was advanced in the use of science-based prevention to the point of selecting and using tested, effective preventive interventions to address prioritized community risks (Arthur et al. 2005). These 13 pairs of communities were deemed eligible for inclusion in the CYDS study. Recruitment of communities required securing letters from the superintendent of schools, the mayor or city manager, and the lead law enforcement officer, agreeing to all data collection activities required of the project. Twelve of the 13 pairs of matched communities met all recruitment criteria and were successfully recruited for the CYDS. One community from within each matched pair was assigned randomly by a coin toss to either the intervention (CTC) or control condition. CYDS communities are small- to moderate-sized incorporated towns with their own governmental, educational, and law enforcement structures with populations ranging from 1,500 to 50,000 residents.

The randomized study began in 2003 when the 12 intervention communities received a series of six structured training workshops and technical assistance to aid their understanding and implementation of the CTC operating system (Quinby et al. 2008). For the randomized trial, CTC communities were asked to focus their prevention plans on programs for youths aged 10 to 14 years (grades 5–9) and their families and schools so that possible effects on drug use and delinquency could be observed within the initial 5-year grant period. Each CTC community in CYDS prioritized a different set of elevated risk factors to be targeted by preventive programs based on the community's unique profile of risk identified by the CTC Youth Survey (Arthur et al. 2002), administered community wide in public middle and high schools. Each CTC community selected between two and five risk factors, for a total of 11 different risk factors across all 12 intervention communities (see Table 1).

Starting in the 2004–2005 school year and annually thereafter, community coalitions implemented between one and five preventive programs to address prioritized risk factors. On average, three programs were implemented per community each year. CTC communities chose programs

Table 1 Risk factors prioritized and targeted by CTC communities

Risk factors	CTC community											
	1	2	3	4	5	6	7	8	9	10	11	12
1. Laws and norms favorable to drug use									x			
2. Low commitment to school		x	x	x		x	x	x	x		x	x
3. Academic failure				x	x			x		x	x	
4. Family conflict	x	x					x					
5. Poor family management			x	x						x		x
6. Parental attitudes favorable to problem behavior						x						
7. Antisocial friends	x	x			x				x	x	x	x
8. Peer rewards for antisocial behavior	x						x					
9. Attitudes favorable to antisocial behavior	x					x				x		
10. Rebelliousness	x							x	x			
11. Low perceived risk of drug use								x				x
Number of risk factors	5	3	2	3	2	3	3	4	4	4	3	4

from the CTC Prevention Strategies Guide (http://www.communitiesthatcare.net/Prevention Strategies Guide/introduction.pdf), which provides a menu of programs that have been found to be effective in well-controlled trials in preventing tobacco, alcohol, or other drug use or delinquent behavior. Chosen programs included school-based programs (*All-Stars*, *Life Skills Training*, *Lion's Quest Skills for Adolescence*, *Project Alert*, *Olweus Bullying Prevention Program*, *Project Towards No Drug Abuse*, and *Program Development Evaluation Training*) as well as community-based youth-focused programs (*Participate and Learn Skills*, *Big Brothers/Big Sisters*, *Stay Smart*, *Valued Youth*, and academic tutoring) and family-focused programs (*Strengthening Families 10–14*, *Guiding Good Choices*, *Parents Who Care*, *Family Matters*, and *Parenting Wisely*) (Fagan et al. 2008, 2009; Quinby et al. 2008). Most programs were universal, designed to be implemented with all students in targeted grades, for example, or for parents of all middle school children in the community, regardless of family problems or youth involvement in problem behaviors. Some selected programs, like mentoring and tutoring after-school programs, were designed for children at greater risk by virtue of family factors or academic difficulties.

CYDS implementation staff provided technical assistance throughout the 5-year efficacy phase of the trial (2003–2008) via weekly phone calls, emails, and site visits to CTC communities at least once per year. Intervention communities were also provided with funding for a full-time, local coordinator to oversee CTC activities and $75,000 annually to support the implementation of selected prevention programs. Control communities received data from the CTC Youth Surveys (Arthur et al. 2002) administered in their schools, but no other training, technical assistance, or financial support from the study. The present study tested variation in the effect of CTC on adolescent smoking, delinquency, and violence 1 year after study-provided resources ended, that is, 6 years after initial implementation of CTC and 4.67 years after CTC communities began implementing prevention programs selected through the CTC process.

Sample and Data Collection

Data on adolescent smoking, delinquent behavior, and violence were obtained from annual surveys of the panel of public school students in the 24 CYDS communities who were followed annually from grade 5 through grade 10 (N= 4,407; 50 % male; 67 % White, 4 % Black, 29 % other races). Twenty percent of all students in the sample identified themselves as Hispanic/Latino. All students in fifth-grade classrooms during the 2003–2004 school year in these schools were eligible for participation in the CYDS. A total of 4,420 students (76.4 % of the eligible population) received consent from their parents to participate in the study. The first wave of data, collected when the panel was in grade 5 in the spring of 2004, was a pre-intervention baseline assessment. Recruitment continued in wave 2 (grade 6) to increase the overall participation rate. This strategy resulted in an active longitudinal panel of 4,407 students who completed a survey in grade 5 or 6. Students in the longitudinal panel who remained in the intervention or control communities for at least one semester were tracked and surveyed annually, even if they left the community. Ninety-four percent of students (n= 4,135) in the longitudinal panel completed the survey in tenth grade, the sixth annual wave of data collected in the spring of 2009. Retention rates did not differ by condition.

In spring of each year, students completed the Youth Development Survey (Social Development Research Group 2009, a self-administered paper-and-pencil

questionnaire based on the CTC Youth Survey (Arthur et al. 2007; Arthur et al. 2002; Glaser et al. 2005) and designed to be completed in a class period. Identification numbers but no names or other identifying information were included on the surveys. The University of Washington Human Subjects Review Committee approved this protocol.

Measures

Baseline Risk Baseline risk for subsequent smoking, delinquency, and violence was defined in four ways: lifetime cigarette use ("Have you ever smoked a cigarette, even just a puff?"), past-year delinquent behavior (stealing, damaging property, shoplifting, or attacking someone with the intent to harm them), past-year violent behavior (attacking someone with the intent to harm them), and high levels of risk factors targeted by intervention communities. For students in CTC communities, risk factor scores were calculated by taking the average of the community-specific set of standardized risk factors targeted by the community (see Table 1). For example, for students in community 1, the targeted risk factor score was calculated by taking the average of the standardized scale scores for family conflict, antisocial friends, peer rewards for antisocial behavior, attitudes favorable to antisocial behavior, and rebelliousness, whereas for students in community 2, the targeted risk factor score was calculated by taking the average of the standardized scale scores for low commitment to school, family conflict, and antisocial friends. Since control communities did not prioritize and target risk factors using the CTC process, risk factor scores for students in control communities were calculated based on the set of targeted risk factors in the matched CTC community. Students whose targeted risk factor score was at least 1 standard deviation above the sample mean at baseline were considered as having high levels of targeted risk (1 = high risk, 0 = not high risk). All baseline risk measures were coded as binary indicators.

Outcomes Outcome measures were based on self-reports when students were in tenth grade and included past-month cigarette smoking (1 = yes, 0 = no), past-year delinquency (1 = student engaged in any of the following: stealing, damaging property, shoplifting, attacking someone with intent to harm, carrying a gun, beating up someone, stealing a vehicle, selling drugs, or being arrested; 0 = otherwise), and past-year violence (1 = student engaged in any of the following: attacking someone with intent to harm, carrying a gun, or beating up somebody; 0 = otherwise).

Student and Community Characteristics Characteristics of students and communities were used as covariates in all analyses. Student-level covariates included gender, age, White vs. non-White, Hispanic ethnicity, parental education (1 = grade school or less to 6 = graduate or professional degree), attendance at religious services during grade 5 (1 = never to 4 = about once a week or more), and rebelliousness in grade 5 (mean of three items; α=0.69). Community-level covariates included total population of students in the community (mean=2,628; SD=1,917) and the percentage of students eligible for free or reduced-price school lunch (mean=38.2 %; SD=13.8 %). Intervention condition was coded 1 for CTC communities and 0 for control communities.

Analysis Sample and Missing Data Procedures

As reported in more detail in Hawkins et al. (2012), after exclusion of 66 students based on several validity criteria, the analysis sample consisted of 4,069 tenth-grade students (92.3 % of the 4,407 students in the longitudinal panel). Missing data were imputed using multiple imputations to obtain unbiased estimates of model parameters and their standard errors assuming that data are missing at random (Schafer and Graham 2002). Using NORM version 2.03 (Schafer, 2000), 40 separate datasets including data from all six waves were imputed separately by intervention condition (Graham et al. 2006).

Analysis

The effects of CTC on grade 10 prevalence rates of smoking, delinquency, and violence were assessed using the generalized linear mixed model (GLMM; Breslow and Clayton 1993; Liang and Zeger 1986; Murray 1998) and analyzed using HLM version 6.08 (Raudenbush et al. 2004) using a logit link transformation. In addition to student and community characteristics, all analyses included the respective baseline measure of each outcome and the interaction of intervention status with each subgroup, one at a time. For example, models examining gender variation in the impact of CTC on smoking included gender (1 = male, 0 = female), intervention status (1 = CTC, 0 = control), the gender×intervention status interaction, baseline smoking, and student and community characteristics as predictors of the tenth-grade prevalence rate. Models examining variation in the impact of CTC on tenth-grade smoking by baseline targeted risk included baseline targeted risk (1 = high, 0 = not high), intervention status (1 = CTC, 0 = control), the baseline targeted risk×intervention status interaction, baseline smoking, gender, and student and community characteristics. Models examining variation in the impact of CTC on tenth-grade smoking by baseline smoking included baseline smoking (1 = yes, 0 = no), intervention status (1 = CTC, 0 = control), the baseline smoking×intervention status interaction, gender, and student and community characteristics. Random-intercept models were estimated with degrees of freedom for intervention effects being equal to the number

of community-matched pairs (12) minus the number of community-level covariates (2), minus 1.

Results

Eight percent of students reported ever having used cigarettes at baseline, about 15 % of students had high targeted risk factor scores at baseline, and 21 % had engaged in any delinquent behavior at baseline. About 9 % of students had engaged in violent behavior at baseline. CTC and control communities had equivalent baseline levels of targeted risk factors, delinquency, violence, and smoking (Hawkins et al. 2008, 2009, 2012).

Figure 1 shows the effect of CTC for each outcome in the full sample and for all subgroups by plotting the adjusted odds ratios and their 95 % confidence intervals calculated based on the GLMM that included the interaction term (intervention condition × subgroup). Figure 1 also lists the p values for the t tests evaluating whether the interaction terms are significantly different from zero. None of the interaction effects were statistically significant ($p \leq 0.05$, two-tailed), indicating that the effect of CTC did not differ significantly in any of the examined subgroups.

Although none of the interaction tests met standard levels of statistical significance, one of the interaction tests by gender was marginally significant ($p \leq 0.10$, two-tailed), adjusted odds ratios were quite different, and their confidence intervals were reasonably narrow. Comparison of the adjusted odds ratios suggests that CTC may have reduced the odds of tenth-grade delinquency more among boys than girls. As Fig. 2 shows, the unadjusted prevalence of delinquent behavior was almost 10 percentage points lower among boys in CTC communities than among boys in control communities, yielding a 28 % reduction in the adjusted odds. The difference between CTC and control communities in unadjusted delinquency rates was only 3 % among girls (a 5 % reduction in the adjusted odds).

None of the statistics examined in this study suggested a differential CTC effect for youth with and without high targeted risk at baseline. Although high risk at baseline clearly had a deleterious effect on smoking, delinquency, and violence (Fig. 2), corresponding to higher odds of all three behaviors in tenth grade, the differences between control and CTC communities in observed rates of these behaviors were similar for youth with and without high targeted risk at baseline. This is consistent with previous analyses that did not find evidence for differential effects of CTC by baseline levels of risk in the eighth grade (Oesterle et al. 2010).

The evidence is less clear with respect to a possible differential effect of CTC for baseline smokers versus nonsmokers, baseline delinquent and nondelinquent students, and baseline violent and nonviolent youth. While none of the interaction tests were significant, the adjusted odds ratios suggest that

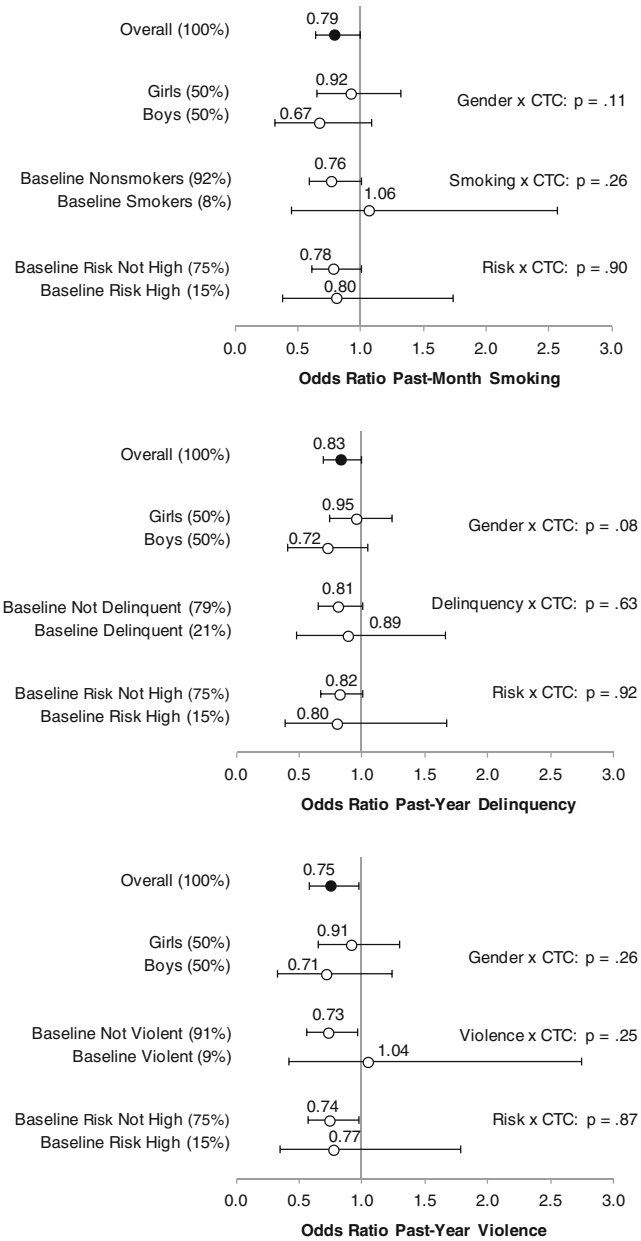

Fig. 1 Predicted[a] effect of CTC on grade 10 smoking, delinquency, and violence: odds ratio (CTC vs. control) and 95 % confidence intervals. [a]Based on generalized linear mixed model, adjusted for baseline prevalence of outcome, student age, gender, race/ethnicity, parental education, religious attendance, rebelliousness, student population in the community, and percentage of students in the community receiving free/reduced-price lunch

CTC may have had a greater beneficial effect among baseline nonsmokers and nondelinquent and nonviolent youths than among those youths who had already started smoking, delinquent behavior, or violence in fifth grade. The precision of the adjusted odds ratio estimates was quite low, however, especially in the smaller high-risk groups. The wide confidence intervals inhibit confident conclusions about the presence of differential intervention effects in these subgroups. More

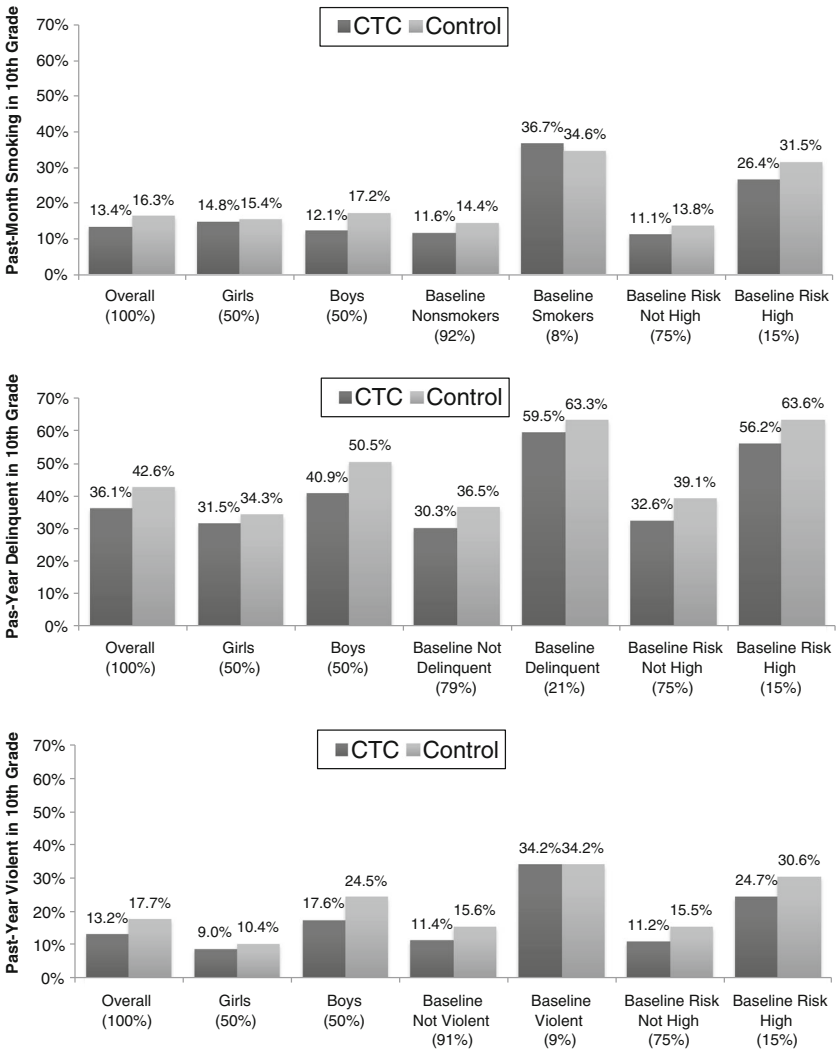

Fig. 2 Unadjusted prevalence of smoking, delinquency, and violence in tenth grade by subgroups

definite results may require a sample with a greater number of communities (Brown et al. 2008).

Discussion

Prior analyses (Hawkins et al. 2012) found that the prevalence rates of current cigarette use and past-year delinquent and violent behavior were significantly lower in CTC than in control communities when the panel of students followed in the randomized trial was in grade 10. These effects were found 1 year after study-provided resources to intervention communities ended and 6 years after initial implementation of CTC. The present study examined variation in these sustained effects of CTC to establish the generalizability of these intervention findings.

As in the prior study that examined variation in the effect of CTC when the panel of students was in eighth grade (Oesterle et al. 2010), the sustained effects of CTC on tenth-grade adolescent smoking, delinquency, and violence did not significantly vary by gender or by the examined risk-related subgroups. Although it is possible that this study did not have sufficient power to detect some differential effects of CTC, the use of formal interaction tests instead of separate subgroup analyses makes this less likely. Nevertheless, power to detect true interactions may have been somewhat limited because the present study had only 12 community pairs. Power to detect significant interactions also is dependent on the size of the interaction relative to the overall intervention effect. The differential effect has to be about four times the size of the overall effect to have the same power to detect it (Brookes et al. 2001; Brown et al. 2008). In the present study, the interaction effects were generally less than four times the size of the overall intervention effect.

While CTC is a universal prevention system, intended to be similarly effective for both genders, and communities in the study equally targeted boys and girls for prevention services, the possibility that the intervention had stronger effects on males' delinquency is consistent with etiological studies of drug use and delinquency. Based on an administration of the CTC Youth Survey with tenth-grade students in 40 communities participating in a prior diffusion study, Fagan et al. (2007)

found that boys reported higher levels than girls on the majority of family, school, peer, and individual risk factors assessed, including all but one of the set of risk factors prioritized and targeted for change by intervention communities in the randomized trial of CTC. Also, about half of these risk factors were more strongly associated with serious delinquency for boys than girls. Other research also has found that boys are more likely to be exposed to risk factors and that such experiences are often more strongly related to problem behaviors for boys than girls (Moffitt et al. 2001; Rowe et al. 1995). Such findings suggest that boys may experience greater benefits from participating in risk-focused prevention services such as those offered by the CTC communities participating in the CYDS.

The subgroups examined in the present analysis were of clear substantive interest because they identify important demographic subpopulations and indicate the presence and absence of the baseline risks and behaviors that CTC aims to change. Examining subgroups one at a time also allows comparison of findings with those from others studies, including our prior study (Oesterle et al., 2010). However, it ignores that individuals are often exposed to multiple risks and may engage in multiple behaviors simultaneously. An analysis that uses multiple characteristics and risks to define subgroups of youths (e.g., gender–risk group combinations that allow the comparison of high-risk and low-risk boys and girls) may be a promising alternative approach for examining differential responsiveness to an intervention that may also provide increased power to detect interaction effects (Hayward et al. 2006). One such approach to examining differential treatment effects in subgroups defined by multiple characteristics is the identification of latent subgroups using latent class analysis (Lanza and Rhoades 2011). This method has been successfully applied also in a multilevel framework by analyzing cross-sectional data collected from students in the 24 communities in the present study (Van Horn et al. 2008). At baseline in 2004, there were no differences by condition in the proportion of eighth graders in latent subgroups identified as abstainers, drug experimenters, alcohol users, drug users, and problem students (those who engaged in relatively high rates of substance use and delinquency).

Conclusions

CTC is a universal community prevention system designed to reduce risk, enhance protection, and prevent adolescent health and behavior problems community wide. It is not expected to differentially affect particular individuals or subpopulations. The present analyses of tenth-grade data from a panel of public school students followed since fifth grade in communities participating in a randomized trial of CTC are consistent with prior findings examining variation in the effect of CTC on eighth-grade outcomes (Oesterle et al. 2010). There was no evidence for differential effectiveness of CTC on adolescent smoking, delinquency, and violence based on high-risk exposure at baseline; CTC reduced the prevalence of both girls' and boys' problem behaviors but with a larger effect on delinquency for boys than for girls, though not significantly so. The present data do not clearly indicate that CTC had a differential effect on those who had already engaged in substance use, delinquency, or violence at baseline versus those who had not. We would not expect differential effectiveness of CTC for these subgroups. The choice of programs in CTC is based on a community-wide risk assessment of the general youth population using the CTC Youth Survey. These assessments are not likely to lead to selection of indicated programs targeted at the most deviant youths or those exposed to greatest risk (i.e., those already engaged in substance use, delinquency, or violent behaviors in grade 5).

A limitation of this study is that findings may not generalize to larger communities. Communities chosen for the randomized trial of CTC were towns of 50,000 or fewer residents. The study does not include urban or suburban populations. Nonetheless, results from the present trial indicate that CTC generally had universal effects on reducing adolescent substance use, delinquency, and violence, with few differential effects.

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Conflict of Interest Richard F. Catalano is a board member of Channing Bete Company, distributor of Supporting School Success® and Guiding Good Choices®. These programs were used in some communities in the study that produced the dataset used in this paper.

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