

# Long-Term Effects of the Communities That Care Trial on Substance Use, Antisocial Behavior, and Violence Through Age 21 Years

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**Objectives.** To evaluate whether the effects of the Communities That Care (CTC) prevention system, implemented in early adolescence to promote positive youth development and reduce health-risking behavior, endured through age 21 years.

**Methods.** We analyzed 9 waves of prospective data collected between 2004 and 2014 from a panel of 4407 participants (grade 5 through age 21 years) in the community-randomized trial of the CTC system in Colorado, Illinois, Kansas, Maine, Oregon, Utah, and Washington State. We used multilevel models to evaluate intervention effects on sustained abstinence, lifetime incidence, and prevalence of past-year substance use, antisocial behavior, and violence.

**Results.** The CTC system increased the likelihood of sustained abstinence from gateway drug use by 49% and antisocial behavior by 18%, and reduced lifetime incidence of violence by 11% through age 21 years. In male participants, the CTC system also increased the likelihood of sustained abstinence from tobacco use by 30% and marijuana use by 24%, and reduced lifetime incidence of inhalant use by 18%. No intervention effects were found on past-year prevalence of these behaviors.

**Conclusions.** Implementation of the CTC prevention system in adolescence reduced lifetime incidence of health-risking behaviors into young adulthood. *Clinicaltrials.gov* identifier: NCT01088542. (*Am J Public Health.* 2018;108:659–665. doi:10.2105/AJPH.2018.304320)

 See also Greenberg, p. 592.

Young adulthood is a developmental period that often encourages exploration and experimentation and has been associated with increased substance use and risky behaviors.<sup>1</sup> To prevent health-risking behaviors, programs targeting young adults, typically college students, have been developed and shown to reduce substance use and abuse, depression, and violence.<sup>2</sup> An alternative strategy for improving young adult health and well-being is to intervene at earlier developmental stages, with the objective of sustained improvements in malleable risk and protective factors and preventable health-risking behaviors. This is the approach used in Communities That Care (CTC), a prevention planning and implementation system that trains and supports community coalitions to make science-based and data-driven decisions

about local prevention efforts so positive youth development occurs community-wide and is sustained. To assess the CTC system's preventive impacts on health-risking behavior, a longitudinal panel of 4407 participants has been followed since grade 5 as part of the Community Youth Development Study, a community-randomized trial involving 24 communities in 7 US states. This article reports the CTC system's long-term effects

through age 21 years on substance use, antisocial behavior, and violence—11 years after initial implementation.

Although evidence-based programs and policies have the potential to improve public health if implemented community-wide with high fidelity, widespread implementation typically does not occur. This is in part because communities often lack implementation support systems. The CTC system was developed to provide this support on the basis of theories of public health promotion, community competence, and prevention science.<sup>3,4</sup> The CTC logic model posits that enabling communities to select and implement evidence-based programs and policies targeted to specific local needs and priorities will decrease risk factors for health-risking behaviors (e.g., community norms favoring drug use, low school commitment) and enhance protective factors (e.g., strong family bonds, community opportunities for prosocial behavior). These changes will, in turn, lead to positive youth outcomes and decreased drug use, delinquency, violence, and other behavioral health problems.

To achieve this goal, the CTC system mobilizes and trains community stakeholders to develop a well-functioning coalition that understands how risk- and protection-focused prevention can help prevent common youth problems.<sup>5</sup> The coalition learns to collect and interpret survey data from local youths to prioritize elevated risk and suppressed

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protective factors and target them with appropriate evidence-based programs and policies. The coalition also learns to monitor implementation fidelity and youth outcomes and to make adjustments in the prevention plan when needed. Through this training and capacity building, the CTC system is expected to lead to the adoption of a science-based approach to prevention, a stronger commitment to implementing evidence-based programs and policies, greater collaboration among service providers and stakeholders, a common vision and greater support for community prevention, and stronger community norms against youth drug use and antisocial behavior.

Results from the Community Youth Development Study<sup>5-7</sup> and a quasi-experimental study of the CTC system in Pennsylvania<sup>8,9</sup> provide strong evidence for all elements of CTC's logic model, including improvements in coalition functioning and capacities,<sup>10</sup> sustained increases in the adoption of a science-based approach to prevention,<sup>11</sup> and implementation of more evidence-based programs in CTC communities compared with control communities.<sup>12</sup> The CTC system<sup>13,14</sup> and selected evidence-based programs were also implemented with high fidelity and maintained over time.<sup>7,13</sup>

The CTC system also improved primary outcomes (i.e., substance use, delinquency, and violence) among the Community Youth Development Study panel. By eighth grade, the CTC system led to reduced levels of targeted risk factors<sup>15</sup>; increased levels of protective factors<sup>16</sup>; later initiation of alcohol use, tobacco use, and delinquency; and lower prevalence of past-year delinquency, past-2-week binge drinking, and past-month alcohol and smokeless tobacco use.<sup>15</sup> Although almost all CTC coalitions were still active when the panel was in high school,<sup>13</sup> very few communities implemented preventive evidence-based programs in these grades. Despite the panel's minimal exposure to CTC-selected programs during the high-school years, sustained effects in grades 10 and 12 were observed on targeted risk factors, past-month use of cigarettes, past-year delinquency and violence, and lifetime delinquency, alcohol use, and cigarette use.<sup>17,18</sup> Although none of the implemented prevention programs targeted boys or girls specifically, some effects were found to

be stronger among male than female participants.<sup>19,20</sup>

Greater lifetime abstinence from antisocial behavior in CTC communities compared with control communities continued at age 19 years, 1 year beyond high school. Effects on lifetime initiation of other drug use and violence were sustained among male but not female participants.<sup>21</sup> Although the CTC system prevented incidence of these health-risking behaviors, it did not have a sustained effect on recent substance use or antisocial behavior at age 19 years. It also did not improve secondary outcomes, including substance use disorders, major depression, suicidality, educational attainment, and sexual risk behaviors.

To determine whether high-quality community-based prevention implemented in early adolescence could have a lasting impact into young adulthood, we examined the CTC system's long-term effects on primary outcomes at age 21 years, 11 years after initial implementation of the CTC system in the trial. Study participants exhibited greater independence and more had attained adult roles at age 21 years than at age 19 years, the most recent previous survey. For example, 22% fewer were pursuing postsecondary education, 15% more were working, 15% more were cohabiting or married, 10% more had children, 13% more were no longer living with their parents, and 28% more had moved away from the community in which they resided at the end of high school.

Some of these changes are associated with increased risks. Alcohol and, in some states, marijuana use become legal at age 21 years, and the prevalence of drinking, drug use, and sexual risk behaviors (e.g., condomless sex) peak during the early young adult years and increase the risk for substance use disorders and sexually transmitted infections.<sup>22</sup> Mental health problems such as major depression and generalized anxiety also become more prevalent.<sup>23</sup> Other developmental transitions, such as marriage and parenthood, if timed normatively, can reduce antisocial behaviors.<sup>24</sup> Understanding whether the CTC system had an enduring effect at age 21 years on primary trial outcomes, when risks increase for some and decrease for others, is an important public health question, particularly because health improvements at this age can

help set the stage for better health later in adulthood.<sup>25</sup>

## METHODS

Data are from the Community Youth Development Study, a community-randomized trial of the CTC system.<sup>5</sup> The mayor or city manager, school superintendent, and lead law enforcement officer in 24 communities in Colorado, Illinois, Kansas, Maine, Oregon, Utah, and Washington State agreed that they and their communities would participate. Communities were matched in pairs within state on multiple sociodemographic factors. One community from each pair was then assigned randomly by coin toss to the intervention or control condition before the start of the trial. All communities are rural incorporated towns with distinct geographic boundaries and governmental, educational, and law enforcement structures, and range from 1500 to 50 000 residents. Figure A (available as a supplement to the online version of this article at <http://www.ajph.org>) shows the flow of communities and individuals through the trial.

Intervention communities were trained in the CTC system over 6 to 12 months.<sup>14</sup> In years 2 through 5 of the study, they implemented between 1 and 5 evidence-based programs and policies addressing risk factors prioritized from their unique risk profile. Programs targeted youths in grades 6 through 9.<sup>7,12</sup> Eighteen different universal school-, family-, and community-based programs were implemented, with many implemented multiple times over multiple years within a community.<sup>26</sup> Throughout the initial 5-year efficacy trial (2003–2008), intervention communities received technical assistance to ensure high-quality implementation of the CTC prevention system and selected evidence-based programs. Communities also received financial support to pay for a community coordinator.

## Sample

Nine waves of data were collected from a longitudinal panel of students between grade 5 baseline and age 21 years. All students in fifth grade in 2003 to 2004 were eligible to participate. Recruitment continued into grade 6 to increase study participation. Parents of 4420 students consented to their children's

participation (76% of those eligible; 76% in CTC communities, 77% in control communities). Students who completed a wave 1 or wave 2 survey and remained in their communities for at least 1 semester ( $n = 4407$ ) comprised the longitudinal panel.<sup>6</sup> By age 21 years, 28 deaths and 2 exclusions because of significant disability reduced the active sample to 4377. The sample was 50% male, and 20% Hispanic, 64% White, 3% African American, and 12% other race/ethnicity. Less than half of participants' parents (44%) had earned a college degree at baseline. At age 21 years, 91% ( $n = 4002$ ) of the active sample completed data collection. Retention was slightly but significantly higher among participants from experimental compared with control communities (92% CTC, 90% control;  $P = .04$ ) and among female compared with male participants (95% female participants, 88% male participants;  $P < .001$ ), but did not differ by race, Hispanic ethnicity, or parental education.

## Measures

Data were from the Youth Development Survey.<sup>27</sup> In grades 5 through 12, panel youths completed the Youth Development Survey as a paper-and-pencil questionnaire during a class period. After high school, it was offered online or as a mailed questionnaire. At age 21 years, 88% completed the survey online. Participants received completion incentives of \$5 to \$10 through grade 12, \$25 at age 19 years, and \$35 at age 21 years.

**Substance use.** At each wave, participants reported their lifetime use of 11 different substances (alcohol, tobacco, marijuana, smokeless tobacco, inhalants, nonmedical prescription drugs, ecstasy (MDMA), cocaine, LSD, stimulants, and other illicit drugs; e.g., "Have you ever smoked cigarettes?"; "On how many occasions [if any] have you used marijuana in your lifetime?"). Beginning in grade 12, participants were also asked about their past-year substance use (e.g., "On how many occasions [if any] have you had beer, wine, or hard liquor in the past 12 months?"). On the basis of these prospective reports across 9 waves, we examined sustained abstinence from alcohol, tobacco, and marijuana use through age 21 years (coded 1 if no lifetime use was reported at any wave, coded 0 if lifetime use was reported in at least 1 wave). We created the same measure for any

substance use, gateway drugs (alcohol, tobacco, or marijuana use), and binge drinking (having 5 or more drinks in 1 occasion). We examined lifetime use (coded opposite of lifetime abstinence) for substances in which abstinence was the norm (i.e., sample lifetime incidence was less than 50%), which was the case for smokeless tobacco, inhalants, nonmedical use of prescription drugs, MDMA, cocaine, LSD, stimulants, and other illicit drugs.<sup>17</sup> This allowed meaningful examination of adjusted risk ratios (ARRs), which are most informative when an outcome is not prevalent.<sup>28</sup> We also examined the prevalence of past-year use for each substance on the basis of participant reports at age 21 years.

**Antisocial behavior and violence.** At each wave, adolescents reported past-year participation in 7 behaviors (stealing, damaging property, shoplifting, attacking someone with intent to harm, carrying a handgun [other than while hunting or as part of their job], being arrested, and beating up someone so badly that they probably needed medical attention). We used 3 of these items (attacking someone with intent to harm, carrying a handgun, and beating up someone) to measure violent behavior. We used prospective data from all 9 waves to compute sustained abstinence from antisocial behavior (no participation in any of the 7 behaviors at any wave) and lifetime incidence of violence (participation in any of the 3 violent behaviors in at least 1 wave) through age 21 years. The prevalence of these outcomes in the past year was based on participant reports at age 21 years.

## Analysis Strategy

Analyses tested the hypothesis that the CTC system increased sustained abstinence and reduced lifetime incidence of health-risking behaviors through age 21 years and reduced prevalence of past-year behaviors at age 21 years. We estimated the effect of the CTC system as the difference in incidence or prevalence of each outcome (e.g., alcohol use, marijuana use, antisocial behavior) in intervention and control communities by using a 2-tailed 0.05 type I error rate to determine statistical significance.

Using Hierarchical Linear and Nonlinear Modeling, version 7 (Scientific Software International, Lincolnwood, IL), we estimated generalized linear mixed models with

random intercepts to account for clustering of participants in 24 communities and 12 community pairs. We used Poisson regression with a log link, binomial error distribution, and overdispersion to estimate ARRs and their 95% confidence intervals (CIs). We also estimated model-predicted standardized mean difference effect sizes (Cohen  $d$ ) for each outcome. To account for small amounts of missing data that could result in biased estimates, we conducted intent-to-treat analyses with 40 imputed data sets and averaged the results according to Rubin's rules.<sup>29</sup>

To improve estimate precision,<sup>30</sup> all analyses adjusted for age, gender, race, Hispanic ethnicity, parental educational attainment, attendance at religious services at grade 5 baseline, and baseline rebelliousness (mean of 3 items; Cronbach  $\alpha = 0.69$ ) at level 1 and community characteristics at level 2 (total population of students in the community and the percentage of students eligible for free or reduced-price school lunch in the year before baseline). We assessed the effect of the CTC system on sustained abstinence and lifetime incidence through age 21 years among those who had not used the substance or engaged in the behavior by baseline. We evaluated the effect of the CTC system on the prevalence of past-year behavior among all participants and included baseline measures of the dependent variable in addition to the other covariates.

In addition to analyses of individual outcomes, we used a global test<sup>31</sup> to evaluate the overall effect of the CTC system across all outcomes, consistent with the goal of CTC to shift youth development in a favorable direction. This test adjusts for the increased risk of type I error in the presence of multiple dependent variables and statistical tests. We calculated separate global test statistics for lifetime abstinence or incidence outcomes and for the prevalence of past-year behaviors.

In separate analyses, we assessed whether the CTC system effects differed in male and female participants by including a gender-by-intervention condition interaction term in the generalized linear mixed models. Because the intervention was implemented at the community level, the interaction was cross level (CTC vs control condition at the community level  $\times$  gender at the individual level). Power to detect a statistically significant cross-level interaction with only 12 community pairs was limited. Therefore, we also conducted

subgroup analyses for each gender to further explore the possibility of effects within each gender. We also calculated global test statistics summarizing the effect of the CTC system on male and female participants.

## RESULTS

The ARR and 95% CIs reported in Table 1 indicate that the likelihood of abstaining from gateway drug use through age 21 years was significantly higher, by 49%, in CTC communities compared with control communities ( $d = 0.26$ ), and the likelihood of abstaining from antisocial behavior was also significantly higher, by 18% ( $d = 0.14$ ). The CTC system also significantly reduced the risk of lifetime engagement in violence by 11% ( $d = -0.12$ ). These results were found among those who had not

yet engaged in these behaviors at baseline. The CTC and control communities did not significantly differ in sustained abstinence or lifetime incidence for the other substances examined. The global test showing the CTC system's overall long-term impact across all primary outcomes through age 21 years did not achieve statistical significance (global  $t = -1.79$ ;  $P = .10$ ).

The prevalence of past-year substance use, antisocial behavior, and violence did not significantly differ between CTC and control communities. The global test was also not significant (global  $t = -0.32$ ;  $P = .75$ ). Results of these analyses are included in Table A (available as a supplement to the online version of this article at <http://www.ajph.org>).

Gender interaction tests reported in Table 1 did not indicate that main effects of the CTC system were significantly different for male versus female participants. However,

subgroup analyses conducted because of limited power to detect interaction effects and reported in Table 2 indicated some additional CTC system effects in male but not female participants. Among male participants, the CTC system was associated with a statistically significant increase in the likelihood of sustained abstinence through age 21 years from tobacco use by 30% ( $d = 0.23$ ) and marijuana use by 24% ( $d = 0.19$ ). It was also associated in male participants with reduced likelihood of lifetime inhalant use by 18% ( $d = -0.17$ ). The CTC system had a nonsignificant negative effect on lifetime incidence of other drug use for male participants and a nonsignificant positive effect for female participants. Because of the opposite direction of these effects, the gender interaction was statistically significant, but this result is substantively meaningless as neither subgroup effect was statistically

**TABLE 1—Communities That Care Prevention System Effects on Health-Risking Behaviors Through Age 21 Years, Community Youth Development Study: United States, 2004–2014**

Health-Risking Behavior	Main Effects Model (No Gender Interaction Term)				Models Including CTC × Gender Interaction, t (95% CI)
	CTC Adjusted Prevalence, % <sup>a</sup>	Control Adjusted Prevalence, % <sup>a</sup>	t	ARR (95% CI)	
Sustained abstinence <sup>b</sup>					
Any substance use	8.1	6.1	1.55	1.33 (0.89, 2.01)	1.03 (0.72, 2.30)
Gateway substance use	10.1	6.7	2.44	1.49 (1.03, 2.16)	0.54 (0.65, 1.96)
Alcohol use	11.7	8.2	2.05	1.43 (0.96, 2.13)	0.57 (0.69, 1.84)
Binge drinking	18.8	16.8	0.80	1.12 (0.81, 1.56)	1.16 (0.85, 1.62)
Tobacco use	34.5	29.4	1.99	1.17 (0.98, 1.41)	1.92 (0.95, 1.62)
Marijuana use	36.4	32.4	2.23	1.12 (1.00, 1.26)	1.92 (0.95, 1.58)
Antisocial behavior	33.9	28.8	2.50	1.18 (1.02, 1.37)	1.67 (0.91, 1.70)
Lifetime incidence <sup>c</sup>					
Smokeless tobacco use	42.8	44.4	−0.45	0.97 (0.81, 1.15)	−1.50 (0.68, 1.09)
Nonmedical prescription drug use	34.6	35.8	−0.66	0.97 (0.87, 1.08)	−1.77 (0.65, 1.06)
Inhalant use	27.8	31.9	−2.18	0.87 (0.76, 1.01)	−1.05 (0.64, 1.19)
LSD use	16.3	16.8	0.37	0.97 (0.81, 1.16)	−1.61 (0.55, 1.12)
MDMA use	17.7	16.0	−0.37	1.11 (0.89, 1.38)	−1.75 (0.52, 1.10)
Cocaine use	14.5	13.9	1.06	1.04 (0.83, 1.30)	−1.28 (0.55, 1.19)
Stimulant use	7.9	8.1	−0.21	0.98 (0.76, 1.25)	−0.23 (0.56, 1.62)
Other drug use	28.8	28.8	−0.28	0.98 (0.86, 1.13)	−2.44 (0.58, 0.99)
Violence	36.7	41.4	−2.27	0.89 (0.79, 0.99)	−0.74 (0.72, 1.19)

Note. ARR = adjusted risk ratio; CI = confidence interval; CTC = Communities That Care; LSD = lysergic acid diethylamide; MDMA = ecstasy.

<sup>a</sup>Population average results from generalized linear mixed Poisson regression analyses of those who had not initiated the outcome at baseline. Baseline noninitiators ranged from  $n = 3157$  for any drug use to  $n = 4383$  for marijuana. Regression models adjusted for individual (gender, race/ethnicity, parental education, baseline rebelliousness, baseline attendance at religious services) and community characteristics (baseline school district enrollment, percentage of students eligible for free or reduced-price school lunch).

<sup>b</sup>Percentages reflect the proportion of the sample who never reported the behavior in any data collection wave between grade 5 baseline and age 21 years.

<sup>c</sup>Percentages reflect the proportion of the sample who reported using the substance or engaging in the behavior in at least 1 wave between grade 5 baseline and age 21 years.

**TABLE 2—Communities That Care Prevention System Effects on Health-Risking Behaviors Among Male and Female Participants Through Age 21 Years, Community Youth Development Study: United States, 2004–2014**

Health-Risking Behavior	Male Participants				Female Participants			
	CTC Adjusted Prevalence, % <sup>a</sup>	Control Adjusted Prevalence, % <sup>a</sup>	t	ARR (95% CI)	CTC Adjusted Prevalence, % <sup>a</sup>	Control Adjusted Prevalence, % <sup>a</sup>	t	ARR (95% CI)
<b>Sustained abstinence<sup>b</sup></b>								
Any substance use	8.2	5.3	2.18	1.57 (0.98, 2.50)	7.3	6.3	0.50	1.17 (0.58, 2.34)
Gateway substance use	10.2	6.1	2.52	1.66 (1.05, 2.62)	10.2	7.6	1.67	1.35 (0.90, 2.03)
Alcohol use	12.9	7.9	1.95	1.64 (0.92, 2.90)	11.2	8.7	1.69	1.30 (0.92, 1.83)
Binge drinking	18.6	14.7	1.32	1.27 (0.84, 1.92)	20.0	19.1	0.34	1.05 (0.77, 1.42)
Tobacco use	34.7	26.7	3.07	1.30 (1.07, 1.58)	34.7	31.9	0.89	1.09 (0.88, 1.34)
Marijuana use	35.9	29.1	2.59	1.24 (1.03, 1.49)	36.6	35.6	0.43	1.03 (0.88, 1.21)
Antisocial behavior	28.9	21.7	2.53	1.33 (1.03, 1.72)	39.2	35.5	1.50	1.10 (0.95, 1.28)
<b>Lifetime incidence<sup>c</sup></b>								
Smokeless tobacco use	52.7	57.5	−1.06	0.92 (0.76, 1.10)	34.0	33.4	0.20	1.02 (0.89, 1.25)
Nonmedical prescription drug use	31.8	36.3	−1.90	0.88 (0.75, 1.03)	37.8	35.4	0.91	1.07 (0.91, 1.26)
Inhalant use	26.3	32.0	−2.54	0.82 (0.69, 0.98)	29.3	32.2	−0.97	0.91 (0.73, 1.13)
LSD use	16.7	19.5	−0.53	0.86 (0.68, 1.08)	15.8	14.2	0.89	1.11 (0.86, 1.42)
MDMA use	16.4	17.0	−1.53	0.96 (0.76, 1.22)	18.9	14.9	0.92	1.27 (0.95, 1.70)
Cocaine use	14.0	14.9	−0.38	0.94 (0.72, 1.23)	14.5	13.0	1.86	1.12 (0.84, 1.47)
Stimulant use	7.8	7.9	−0.07	0.99 (0.71, 1.39)	8.0	8.1	−0.09	0.99 (0.69, 1.40)
Other drug use	27.5	31.5	−1.85	0.87 (0.74, 1.03)	30.2	26.8	1.20	1.13 (0.90, 1.42)
Violence	47.8	55.9	−2.81	0.86 (0.75, 0.97)	28.3	30.5	−0.86	0.93 (0.76, 1.13)

Note. ARR = adjusted risk ratio; CI = confidence interval; CTC = Communities That Care; LSD = lysergic acid diethylamide; MDMA = ecstasy.

<sup>a</sup>Population average results from generalized linear mixed Poisson regression analyses of those who had not initiated the outcome at baseline. Regression analyses were conducted on separate samples of male and female participants. For male participants, baseline noninitiators ranged from  $n = 1536$  for any drug use to  $n = 2173$  for marijuana. For female participants, baseline noninitiators ranged from  $n = 1621$  for any drug use to  $n = 2210$  for marijuana. Regression models adjusted for individual (gender, race/ethnicity, parental education, baseline rebelliousness, baseline attendance at religious services) and community characteristics (baseline school district enrollment, percentage eligible for free or reduced-price school lunch at baseline).

<sup>b</sup>Percentages reflect the proportion of the sample who never reported the behavior in any data collection wave between grade 5 baseline and age 21 years.

<sup>c</sup>Percentages reflect the proportion of the sample who reported using the substance or engaging in the behavior in at least 1 wave between grade 5 baseline and age 21 years.

significant. Gender-specific global tests indicated that the CTC system had a statistically significant effect across all primary outcomes in the hypothesized direction for male (global  $t = -3.14$ ;  $P = .01$ ) but not for female participants (global  $t = 0.01$ ;  $P = .99$ ).

There were no gender differences in CTC system effects on the prevalence of past-year outcomes on the basis of interaction or global tests (male global  $t = -1.41$ ;  $P = .18$ ; female global  $t = 0.73$ ;  $P = .48$ ; Table B, available as a supplement to the online version of this article at <http://www.ajph.org>). As in some previous subgroup analyses,<sup>21</sup> we found a significantly greater prevalence of past-year MDMA use among female CTC system participants compared with female control participants (adjusted prevalence 7.0% CTC, 4.0% control; ARR = 1.75; 95% CI = 1.086, 2.821;  $P = .03$ ).

## DISCUSSION

Community prevention planning and implementation support systems may help communities achieve desired improvements in public health by implementing appropriate evidence-based programs and policies community-wide with high fidelity. Sustaining better outcomes is an important goal. This study provides evidence that the CTC system, which emphasizes high-quality implementation of evidence-based programs and policies matched to community prevention priorities, is an effective approach to improving public health in the long term by preventing the incidence of health-risking behaviors many years after the most direct exposure to evidence-based programs and policies. Specifically, the CTC system had an enduring effect on abstinence from gateway drug use and antisocial behavior and reduced

lifetime incidence of violence in the sample through age 21 years. The CTC system's sustained effects on healthier behavior into young adulthood are important because this is a particularly risky period, characterized by many life changes, fewer social controls than in adolescence, and new freedoms that encourage exploration and experimentation, sometimes with risky behaviors.

The CTC system continued to prevent the initiation of gateway drug use through age 21 years, when alcohol, tobacco, and, in some states, marijuana use are legal and fairly normative. In 2014, when age 21 data were collected, 87% of those aged 21 to 22 years used alcohol, 29% smoked cigarettes, and 35% used marijuana in the past year.<sup>32</sup> In this context, incidence of use of these drugs in CTC communities between ages 19 and 21 years could have increased more quickly than



in control communities to catch up to normative levels. However, we found that the proportion of new initiators continued to be lower among young adults from CTC communities than controls at age 21 years. For example, 31% of control and 22% of CTC panel members initiated gateway drug use between the ages of 19 and 21 years, evidence of CTC's sustained impact on new initiation.

Although interaction tests did not indicate gender differences in intervention effects, analyses conducted separately by gender provided some evidence that effects were stronger overall for male participants, continuing a pattern first observed at age 19 years.<sup>21</sup> Evidence-based programs were not targeted to adolescents of a particular gender, but some other studies have also reported intervention effectiveness favoring male participants. Whether findings relate to higher prevalence of substance use, antisocial behavior, and violence among males, differential responsiveness to the CTC system and evidence-based programs and policies, or other factors remains to be explored. The study continued to find a significant effect for female participants on past-year MDMA use that favored control communities, also observed at age 19 years.<sup>21</sup> Given no other unexpected findings, we do not believe this is an iatrogenic CTC system effect.

Results are conservative as we conducted intent-to-treat analyses that did not take into account differential exposure to the CTC system and evidence-based programs among participants who moved away from study communities and those who stayed throughout the study period. An analysis of differential effectiveness showed that CTC system effects on eighth-grade outcomes were stronger for the 85% who remained in study communities through grade 8.<sup>33</sup> Long-term effects at age 21 years would likely be stronger if differential exposure were taken into account.

## Limitations

This study had limitations. Findings may not generalize to urban communities and other regions (e.g., the South) not represented in the trial. However, it is important to understand how a prevention system like CTC affects the life course of rural youths as they are a sizable population who are more likely to be

poor and to have decreased access to mental health and addiction prevention and treatment services compared with metropolitan youths. Furthermore, small communities face the unique challenge that young adults with the most resources and academic potential tend to leave, leaving behind those with less educational promise and fewer socioeconomic resources who often are at higher risk for problems in young adulthood. The fact that the CTC system had enduring positive effects at age 21 years is important, as the CTC system could be a viable tool for small towns in preparing young adults who remain to become productive and contributing citizens.

An additional limitation is that the CTC system reduced lifetime incidence but not current substance use, antisocial behavior, and violence at age 21 years. Findings are consistent with the idea that the CTC system strengthened norms against substance use and antisocial behavior, which resulted in fewer youths and young adults initiating these behaviors. However, once the behaviors were initiated, the CTC system did not affect prevalence of the behavior. More proximal interventions may be needed to achieve reductions in current health-risking behaviors.

## Public Health Implications

Implementation of the CTC system in early adolescence led to fewer individuals initiating substance use, antisocial behavior, and violence into young adulthood. Findings indicate that CTC, a community-based prevention system, can be implemented to support important public health objectives in a sustained manner, including reductions in the incidence of prevalent health-risking behaviors in young adulthood. **AJPB**

## CONTRIBUTORS

All authors contributed to the interpretation of study findings and to the writing, editing, and final review of the article. S. Oesterle and J. D. Hawkins originated the study design. S. Oesterle and M. R. Kuklinski drafted the article, on which all authors reviewed and commented. M. R. Kuklinski and M. L. Skinner conducted all statistical analyses. S. Oesterle and J. D. Hawkins supervised the study.

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## HUMAN PARTICIPANT PROTECTION

This study was reviewed and approved by the University of Washington Human Subjects Review Committee.

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