

# Multilevel Prevention Trial of Alcohol Use Among American Indian and White High School Students in the Cherokee Nation

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**Objectives.** To evaluate the effectiveness of a multilevel intervention designed to prevent underage alcohol use among youths living in the Cherokee Nation.

**Methods.** We randomly assigned 6 communities to a control, Communities Mobilizing for Change on Alcohol (CMCA; a community-organizing intervention targeting alcohol access) only, CONNECT (a school-based universal screening and brief intervention) only, or a combined condition. We collected quarterly surveys 2012–2015 from students starting in 9th and 10th grades and ending in 11th and 12th grades. Response rates ranged from 83% to 90%; 46% of students were American Indian (of which 80% were Cherokee) and 46% were White only.

**Results.** Students exposed to CMCA, CONNECT, and both showed a significant reduction in the probability over time of 30-day alcohol use (25%, 22%, and 12% reduction, respectively) and heavy episodic drinking (24%, 19%, and 13% reduction) compared with students in the control condition, with variation in magnitude of effects over the 2.5-year intervention period.

**Conclusions.** CMCA and CONNECT are effective interventions for reducing alcohol use among American Indian and other youths living in rural communities. Challenges remain for sustaining intervention effects. (*Am J Public Health*. Published online ahead of print January 19, 2017; e1–e7. doi:10.2105/AJPH.2016.303603)

American Indians (AIs) suffer from significant health disparities related to alcohol.<sup>1,2</sup> Early prevention is critical, because early onset is a risk factor for problematic use into adulthood,<sup>3</sup> and AIs have a higher rate of early onset than do other groups.<sup>4</sup> In addition, rural youths and rural youths who are a racial minority in their community are at increased risk for alcohol use and getting drunk.<sup>5</sup> Despite increased risk, rural communities and AI populations have been underrepresented in clinical and community trial research.<sup>6</sup>

To address this gap, we designed a trial with the Cherokee Nation that involved rural and racially diverse communities in north-eastern Oklahoma in the 14-county jurisdictional service area of the Cherokee Nation, the second largest AI tribe in the United States. The location is not a reservation; rather it is the area of Indian Territory to which the

Cherokees were forcibly relocated in 1838–1839.<sup>7</sup> Following the Dawes Act of 1887, the commonly held tribal land was divided, and a family allotment was provided to individual AIs registered on the Dawes Rolls. Presently, 40% of the 333 094 members of the Cherokee Nation live in this jurisdictional service area, and Cherokee citizens constitute a significant proportion of the population.

The trial was initiated through a partnership between university-based prevention scientists and Cherokee Nation Behavioral

Health psychologists. Together, we implemented a rigorous trial to evaluate the effectiveness of 2 distinct strategies to reduce underage drinking and associated consequences among youths living in rural, racially diverse communities within the Cherokee Nation. We selected 2 evidence-based strategies that are adaptable to local culture. Communities Mobilizing for Change on Alcohol (CMCA) is a community-organizing intervention designed to reduce alcohol access, use, and consequences among underage youths.<sup>8–10</sup> Community organizing has been used effectively in multiple other health intervention trials<sup>11–13</sup> and appeared to be an optimal strategy to engage diverse citizens in these multicultural communities. The second strategy, called CONNECT, was an individually delivered screening and brief intervention (SBI) in schools; it was supported by findings of a recent systematic review.<sup>14</sup> We implemented SBI universally among all students along with motivational interviewing because it is responsive to individual student needs and readiness to change.

## METHODS

We conducted a factorial experiment with intensive longitudinal data collection to examine the effectiveness of the 2 preventive interventions implemented alone or in

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combination.<sup>15</sup> We purposively selected and randomly assigned communities to (1) CMCA, (2) CONNECT, (3) both interventions combined, or (4) delayed intervention control.

Of the communities with a high school within the 14-county region, 12 met study selection criteria: (1) served by a high school with 400 to 700 students; (2) had at least a 30-mile separation from other communities; and (3) had local businesses, including ones that sell alcohol. We constructed a risk score for each community on the basis of school characteristics and selected 4 of the 6 highest-risk communities. These 4 communities were randomly assigned 1 of the 4 conditions using computer-generated random numbers.

Following pilot youth surveys in the 4 schools, we updated power calculations to include more precise parameters from study sites. We determined that additional students were necessary to power the study for planned effect sizes and recruited 2 additional schools from the original eligible list: we added 1 that was physically proximal to the original control community to the control condition, and we added 1 that was physically proximal to the combined community to the combined condition. Thus, the final sample included 6 communities (each with 1 high school), 2 each in the combined and control conditions and 1 each in the CMCA-only and CONNECT-only conditions.

Leaders at all 6 schools agreed to participate. The communities ranged in population from 1423 to 9300, with 9% to 37% of the population being AI households. Median household income ranged from \$26 222 to \$38 000, below median income for Oklahoma (\$44 287) and the United States (\$52 762).<sup>15</sup>

## Data Collection Procedures

We administered a brief (10–15 minutes) survey in study schools in October, December, February, and May of each year. We sent parents consent letters (with 2 reminders) and asked them to call a toll-free number or to return a postage-paid postcard if they did not want their child to participate. We gave students an assent form, and they could refuse participation at each survey administration. Detailed data collection procedures and measures were described previously.<sup>15,16</sup>

The graduating classes of 2015 and 2016 formed the study cohort and were followed for 3 years from their 9th or 10th to 11th or 12th grade. We implemented 2 baseline surveys before the intervention began (fall 2012) and 10 surveys following the initiation of the intervention (January 2013) through spring 2015.

## Intervention

CMCA uses community-organizing strategies to galvanize adults to take actions to reduce youths' access to alcohol through social and commercial sources.<sup>15</sup> We hired organizers from within the communities in which they served. CMCA followed a structured implementation process and included strategic planning and management. Through many one-on-one conversations, community organizers developed relationships with local citizens and formed local action teams. Action teams initiated evidenced-based activities from a menu of options (the CMCA manual is available at [tinyurl.com/CMCA-CONNECT](http://tinyurl.com/CMCA-CONNECT)). Organizers additionally provided technical assistance to the action teams and helped community members use resources and educate their communities about new strategies, policies, and procedures.

We designed our SBI as a universal prevention strategy to implement in high schools.<sup>15</sup> We partnered with the Oklahoma Department of Human Services to provide a full-time social worker in each CONNECT high school. The school-based social workers devoted half their effort serving as the school's CONNECT coach and the other half serving as a typical school human service provider to link students and their families with relevant community services.

In a private office at school, coaches conducted a brief one-on-one health consultation with each student each semester. Our implementation of SBI was grounded on the National Institute on Alcohol Abuse and Alcoholism's guide.<sup>17</sup> In the brief session, we used motivational interviewing to encourage healthy behavior change related to alcohol consumption, including feedback on normative behavior and discussion of personal goals. Students who reported risky drinking attended a follow-up session approximately 2 weeks later, and we referred students for ongoing follow-up support or specialty

treatment when appropriate. We mailed postcards with behavioral tips<sup>11</sup> 3 times per year to high school students' primary residence. We placed posters throughout the community in commonly frequented venues, such as restaurants and places of worship.

## Measures

A computerized data management system enabled field staff to record daily work tasks, facilitate evaluation of implementation, and support continuous quality improvement. Using this system, CMCA organizers documented each one-on-one conversation, action team meeting, action, and outcome using predesigned forms with drop-down menus. CONNECT coaches documented each encounter with a student. Additionally, 3 times during the intervention period we videotaped all coaches conducting a simulated encounter with a student actor; we systematically coded and rated these for motivational interviewing skills.<sup>18</sup>

We also measured the implementation of other unaffiliated alcohol prevention efforts in all study communities via an annual survey of high school principals and community representatives.

The main outcome of interest was alcohol use, measured with 2 standard items from the Youth Risk Behavior Surveillance System,<sup>19</sup> including any use in the past 30 days (current use) and heavy episodic drinking in the past 30 days (i.e., 5 or more drinks in a row on at least 1 occasion). We measured alcohol-related consequences (5 items; e.g., academic, social, physical; Cronbach  $\alpha = 0.98$ ) using a previously validated scale.<sup>16</sup>

## Statistical Analysis

We estimated linear probability models<sup>20</sup> to assess the combined and independent effects of CMCA and CONNECT on the change in probability of the outcomes over time. We tested additivity between the interventions by estimating fully saturated models including CMCA  $\times$  CONNECT  $\times$  time interactions. We estimated the modeled probabilities of each outcome by condition and survey wave to examine patterns of treatment effects over time. We estimated average treatment effects by the average mean difference in outcome probability between each intervention condition and the control condition across survey waves.

To account for repeated measures over time, we fit all models using weighted generalized estimating equations in PROC GENMOD in SAS version 9.3 (SAS Institute, Cary, NC) using an autoregressive covariance structure. Because of the small number of communities per condition (1–2), we were unable to explicitly control for within-community clustering. However, the generalized estimating equation approach has the benefit of being relatively unaffected by minor errors in the specified correlation structure.

We used similar generalized estimating equations to estimate the combined and independent effects of CMCA and CONNECT on alcohol-related consequences. To aid in the interpretability of the scale, while avoiding the problems of z-standardization for longitudinal data, we transformed the scale using the proportion of maximum scaling method.<sup>21</sup> The proportion of maximum scaling method transformation results in a regression estimate that is interpreted as the change in the proportion of the maximum possible scale value.

We used multiple imputation to account for nonresponse over time and potential differential attrition. We converted data to a wide structure and generated 10 imputation data sets using multiple imputations by chained equations in SAS callable IVEWARE version 2.0. We estimated combined treatment effects using PROC MIANALYZE. We combined  $\chi^2$  statistics across imputations<sup>22</sup> and implemented them in the MICEADDS package in R version 3.2 (R Foundation for Statistical Computing, Vienna, Austria).

To account for possible prestudy differences that may confound treatment effects, we used inverse probability of treatment weights<sup>23</sup> to balance a set of alcohol risk factors (found in our previous etiological work in these communities)<sup>16</sup> across all 4 intervention groups. We used multinomial logistic regression models containing variables from the 2 baseline survey waves to produce the stabilized weights for each intervention condition.

The trial was not designed to have the power for race-specific analyses. However, because of the importance of the nearly 50% AI sample, we conducted secondary analyses to test for differential effects between those who self-reported as AI and all other students (90% White).

## RESULTS

Wave-specific response rates for the 12 repeated surveys over 3 years were 83% to 90%. Reasons for nonresponse included absenteeism (5%–13%), undeliverable parent consent letters (<1%–3%), parent refusals (1%), and student refusals (<1%–6%). Of the 1623 students present at baseline, 615 completed all 12 surveys, 635 were middle-censored, and 373 were right-censored (Figure A and Table A, available as supplements to the online version of this article at <http://www.ajph.org>). Item nonresponse never exceeded 5%.

Students from the CONNECT-only ( $\chi^2 = 31.74$ ;  $P < .001$ ) and combined ( $\chi^2 = 56.25$ ;  $P < .001$ ) conditions were significantly more likely to complete all 12 surveys than were students in the control condition. Students were less likely to complete all survey waves if they were older at baseline ( $\chi^2 = 32.46$ ;  $P < .001$ ), were not White ( $\chi^2 = 6.10$ ;  $P = .014$ ), and reported current use ( $\chi^2 = 20.87$ ;  $P < .001$ ) and heavy episodic drinking ( $\chi^2 = 18.64$ ;  $P < .001$ ) at baseline. Students reporting current use (odds ratio [OR] = 2.0; 95% confidence interval [CI] = 1.5, 2.6) and heavy episodic drinking (OR = 2.3; 95% CI = 1.6, 3.4) were twice as likely to miss a survey administration. Importantly, we found no differential loss to follow-up by study condition for baseline current use, heavy episodic drinking, race/ethnicity, age, or gender.

We found no significant differences between study conditions at baseline in lifetime alcohol use, current use, and heavy episodic drinking. We found significant differences between study conditions at baseline for demographic variables (age, race/ethnicity, and eligibility for free or reduced price lunch), although some of the differences were small (e.g., age; Table 1).

## Implementation Results

For CMCA, each organizer made a substantial number of contacts with community members in the initial months ( $n = 137, 176,$  and  $310$ , respectively). The one-on-one conversations allowed each organizer to develop an action team and identify supporters in the community. The citizen action teams conducted between 38 and 85 actions per community (e.g., gaining support from a key

stakeholder, increasing police patrols, increasing police compliance checks of alcohol outlets). Actions resulted in 23 to 43 sustained outcomes per community, such as media campaigns, new police procedures institutionalized, parental interventions to reduce social access to alcohol, and new local ordinances regarding compliance checks. Action teams were most active during the second year of the intervention and least active in the last 6 months of the intervention phase. There were no notable implementation differences between the 3 CMCA communities (Figure B, available as a supplement to the online version of this article at <http://www.ajph.org>).

Almost all students participated in a brief meeting with the school's CONNECT coach each semester (73%, 81%, 100%, 97%, and 100%, respectively, were reached each of the 5 semesters). The average meeting length was 16 minutes. Coaches exhibited beginning proficiency level for motivational interviewing and improved over time, with 3 motivational interviewing booster trainings, monthly in-person meetings with motivational interviewing-trained clinical supervisors, and weekly telephone consultations with supervisors. There were no notable implementation differences between the 3 CONNECT schools (Figure C, available as a supplement to the online version of this article at <http://www.ajph.org>).

Results from the prevention activity surveys revealed other activities in the control schools, particularly during years 2 and 3, including other types of SBI as well as other community-wide activities (Figure D, available as a supplement to the online version of this article at <http://www.ajph.org>).

## Outcome Results

CMCA and CONNECT were associated with reductions in current use, heavy episodic drinking, and alcohol-related consequences over time. Three-way CMCA  $\times$  CONNECT  $\times$  time interactions were statistically significant for current use ( $\chi^2 = 24.79$ ;  $P = .006$ ), heavy episodic drinking ( $\chi^2 = 18.58$ ;  $P = .046$ ), and alcohol consequences ( $\chi^2 = 18.98$ ;  $P = .041$ ). Patterns of effects by study condition are presented in Figures 1–3. For all treatment conditions, the magnitude of effects varied across

**TABLE 1—Student Baseline Characteristics by Study Condition: Northeastern Oklahoma, 2012–2015**

Characteristic	Control (n = 588), Mean (SE) or % (SE)	CMCA Only (n = 208), Mean (SE) or % (SE)	CONNECT Only (n = 224), Mean (SE) or % (SE)	Combined (n = 603), Mean (SE) or % (SE)	P
Age, y	15.0 (0.03)	15.2 (0.06)	14.9 (0.05)	15.0 (0.03)	<.001
Female	51 (2.1)	50 (3.5)	48 (3.3)	49 (2.0)	.79
Race/ethnicity					<.001
AI only	19 (1.6)	38 (3.4)	17 (2.5)	24 (1.8)	
AI and White	21 (1.7)	25 (3.0)	23 (2.8)	19 (1.6)	
AI and other	2 (0.6)	3 (1.1)	1 (0.8)	1 (0.4)	
White only	46 (2.1)	27 (3.1)	49 (3.3)	52 (2.0)	
Other	12 (1.3)	7 (1.8)	10 (2.0)	4 (0.8)	
Receives free or reduced price lunch	48 (2.2)	65 (3.7)	57 (3.6)	55 (2.2)	<.001
Lifetime alcohol use	47 (2.1)	42 (3.4)	47 (3.4)	42 (2.0)	.27
Past month alcohol use	18 (1.5)	19 (2.7)	20 (2.7)	16 (1.6)	.55
Past month heavy alcohol use	10 (1.2)	13 (2.3)	13 (2.3)	9 (1.2)	.30

Note. AI = American Indian; CMCA = Communities Mobilizing for Change on Alcohol.

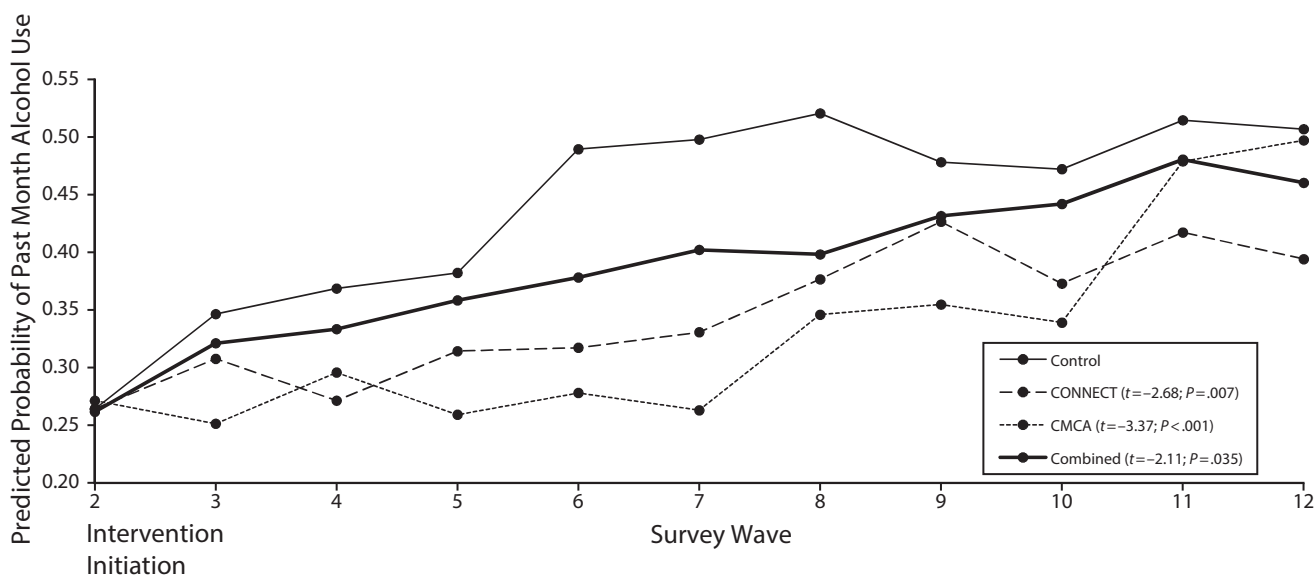
intervention years, peaking in year 2 and lessening in year 3 (Table B, available as a supplement to the online version of this article at <http://www.ajph.org>).

On average, CMCA-only students (n = 208) had a 13 percentage point reduction in current use (95% CI = -20%, -5%;  $t = -3.37$ ;  $P < .001$ ), a 12 percentage point

reduction in heavy episodic drinking (95% CI = -19%, -5%;  $t = -3.38$ ;  $P < .001$ ), and an 8 percentage point decrease in alcohol-related consequences (95% CI = -13%, -2%;  $t = -2.81$ ;  $P = .005$ ) compared with control students over the full intervention period. These results amounted to 22% to 25% reductions in outcomes relative to the control condition.

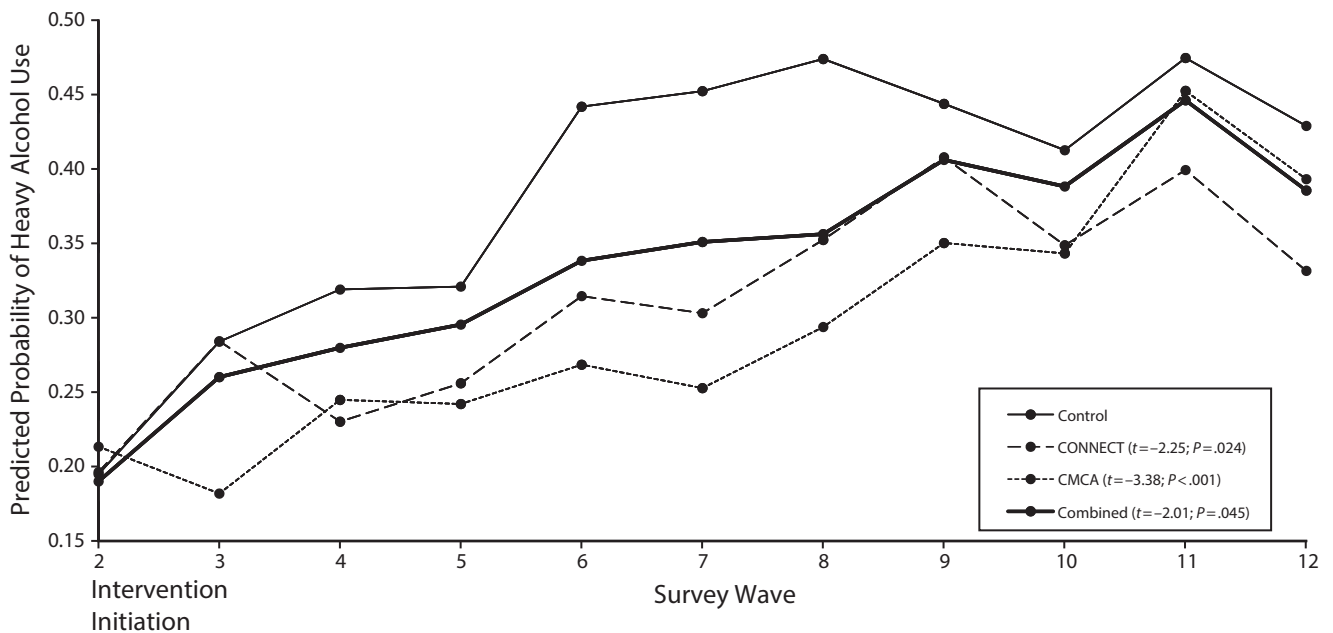
On average, CONNECT-only students (n = 224) had an 11 percentage point reduction in current use (95% CI = -18%, -3%;  $t = -2.68$ ;  $P = .007$ ), 8 percentage point reduction in heavy episodic drinking (95% CI = -16%, -1%;  $t = -2.25$ ;  $P = .024$ ), and 7 percentage point decrease in alcohol-related consequences (95% CI = -12%, -2%;  $t = -2.74$ ;  $P = .006$ ) compared with control students over the full intervention period. These results amounted to 19% to 23% reductions in outcomes relative to the control condition.

On average, combined condition students (n = 603) had a 5 percentage point reduction in current use (95% CI = -11%, 0%;  $t = -2.11$ ;  $P = .035$ ), a 5 percentage point reduction in heavy episodic drinking (95% CI = -10%, 0%;  $t = -2.01$ ;  $P = .045$ ), and a 4 percentage point decrease in alcohol-related consequences (95% CI = -8%, -1%;  $t = -2.52$ ;  $P = .012$ ) compared with control students over the full intervention period. These results amounted to 12% to 15% reductions in outcomes relative to the control condition.



Note. CMCA = Communities Mobilizing for Change on Alcohol.

**FIGURE 1—Past Month Alcohol Use by Study Condition: Northeastern Oklahoma, 2012–2015**



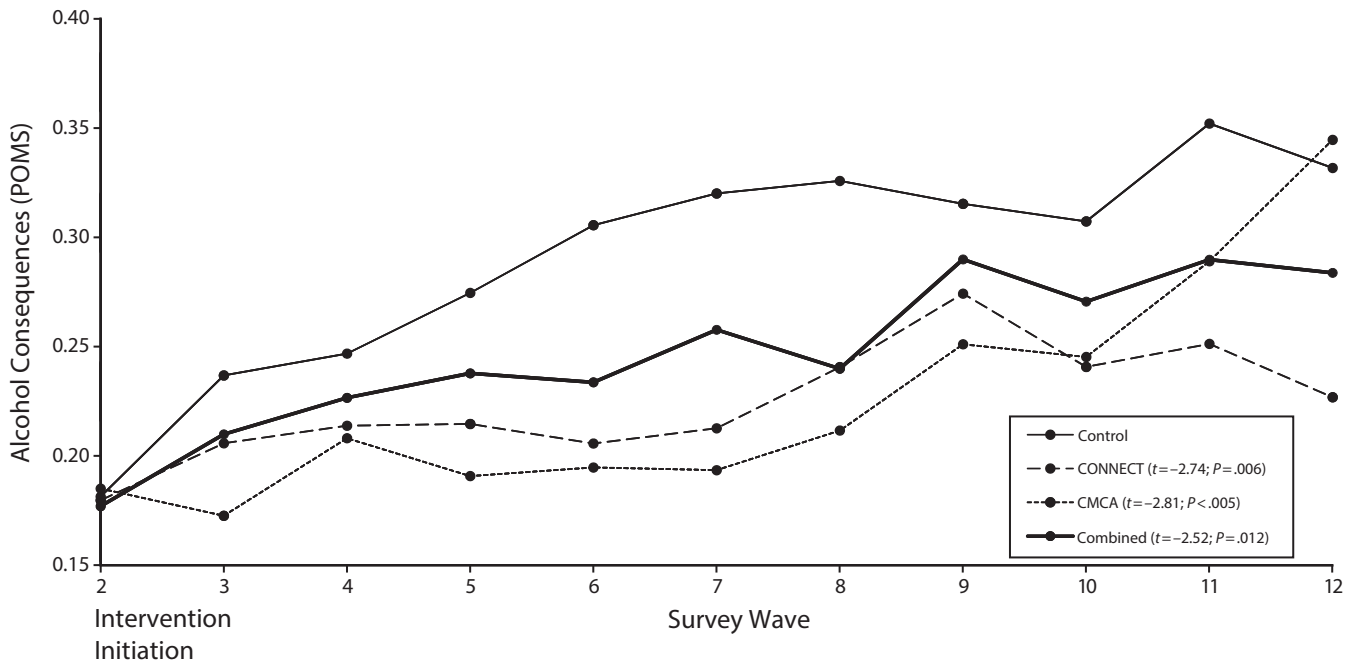
Note. CMCA=Communities Mobilizing for Change on Alcohol.

FIGURE 2—Past Month Heavy Episodic Alcohol Use by Study Condition: Northeastern Oklahoma, 2012–2015

The results of secondary analyses that tested differential effects by race/ethnicity, AI versus other (90% White), were not

statistically significant, indicating no differential treatment effects by race/ethnicity. Considering that the original study design did

not include enough power for precise race-specific effect estimates, it is nevertheless noteworthy that patterns of effects among AI



Note. CMCA=Communities Mobilizing for Change on Alcohol; POMS=proportion of maximum scaling method.

FIGURE 3—Consequences of Alcohol Use by Study Condition: Northeastern Oklahoma, 2012–2015

youths were similar to the pattern of effects among the full sample (Figure E, available as a supplement to the online version of this article at <http://www.ajph.org>).

## DISCUSSION

Among a sample of AI and White high school students in the boundaries of the Cherokee Nation, 2 preventive interventions, CMCA and CONNECT, significantly reduced the well-established typical adolescent developmental trajectory<sup>19,24</sup> of upwardly trending alcohol use and heavy episodic use during the adolescent years. The student sample was nearly 50% AI, providing rigorous evidence of the effectiveness of 2 distinct alcohol prevention strategies for this high-risk population. Although the trial was not powered to test race-specific effects, secondary analyses revealed similar patterns of effects among AI youths as the full sample.

The 2 distinct interventions alone and in combination resulted in similar patterns of effect across time, with the beneficial effect growing over the first 2 years of the intervention phase, followed by a shrinking of the effect during the last 6 months, especially in the CMCA-only community. Contrary to hypothesis, we found no evidence that the 2 interventions combined had greater effects than either alone. In fact, the observed effect in the combined condition was smaller than was that observed for either intervention alone (but was still significantly improved over the controls).

On the basis of implementation data, there were no notable differences in implementation by community that could help explain these results. Perhaps students in the combined condition had less room to improve—students in CMCA-only and CONNECT-only conditions were at greater risk at baseline on the basis of school and community archival data and baseline alcohol use (although differences were not statistically significant). It may also be that there is a limit to achievable population-wide prevention effects within a short, 2.5-year time frame. Perhaps the effects of 1 effective strategy do not act additively or synergistically unless concomitant changes occur in larger cultural, market, and regulatory structures.<sup>25</sup> Thus, effects over a decade-long intervention period might well differ.

The shrinking of differences between the intervention and control groups during the final year appears to have resulted from a slowing of the upward trajectory of alcohol use in the control group, rather than an escalation of use in the intervention conditions. The typical developmental trajectory among high school students is increased rates of alcohol use by grade (e.g., 23% among 9th graders to 42% among 12th graders nationally).<sup>24</sup> The change in the trajectory of alcohol use in the control group, from a typical increasing trajectory to a leveling off, may have occurred because of compensatory equalization, compensatory rivalry, or treatment diffusion.<sup>26</sup>

According to our annual surveys of school and community representatives, control schools reported numerous school-based prevention activities, including SBIs. Furthermore, community-wide prevention activities were reported in the CONNECT and control conditions. These prevention activities, along with the reduction of alcohol use during the final year among the control group, highlight complexities and limitations of experimental control in community-based research. In short, the pattern of data suggests that the most plausible explanations for shrinking differences between study conditions during the final year are prevention activities and treatment diffusion leading to reduction in alcohol use in the control group, rather than a diminished treatment effect in the intervention sites.

CMCA reduced alcohol use among high school students by 25% and alcohol-related consequences by 22%. These results add to the growing evidence favoring the use of community environmental change strategies, specifically CMCA, in general populations<sup>27,28</sup> and AI communities.<sup>29</sup> Results of this trial replicate a randomized community trial of the CMCA approach conducted in the 1990s in rural Minnesota and Wisconsin communities,<sup>9,10</sup> but we found larger benefits for participants than did the previous study and we have provided new evidence of CMCA's effectiveness among young AIs. Furthermore, CMCA has the benefit of using no classroom time and focuses on the strengths of adult citizens to make change.

CONNECT was also found to reduce alcohol use among high school students by 22% and alcohol-related consequences by 23%. Our findings are consistent with a recent systematic review concluding that brief

school-based interventions using motivational interviewing are effective in reducing alcohol consumption among adolescents.<sup>14</sup> The reviewed studies all had a maximum of 6-month follow-ups; therefore, the duration of effects in previous studies is unknown.

Our trial differs from most others in important ways. The research design combined elements from time-series designs (many repeated measures) with random assignment to study condition, permitting a close examination of the evolution of intervention effects over time not possible in pre-post designs. The interventions also differ from convention. CMCA follows a citizen-driven community-organizing model. It is not the same as widely implemented community coalition models, which rely on representatives of community organizations and institutions. Many times, it is exactly these community institutions that need to change, and activated citizens outside the organizations are necessary to achieve it. CONNECT is also distinctive in that, compared with typical SBIs, it is relatively brief and is universally implemented rather than targeted to high-risk students and repeated multiple times.

Because of the limited prevention research to date among AI populations, especially among AI youths,<sup>6,30</sup> and the challenges of developing programmatic approaches for a multitude of culturally specific tribal communities,<sup>30</sup> the results offer guidance and encouragement for future prevention efforts. Both CMCA and CONNECT were effective in this rural, multiracial context because they are not narrow, fixed programs but are adaptable community and individual change strategies. For example, CONNECT used motivational interviewing skills that are well suited for adolescents, particularly AI adolescents, because of its nonconfrontational style, collaborative nature, and emphasis on respect and empowerment.<sup>31</sup> Results of our trial support the effectiveness of both a community-organizing approach and universally implemented school-based SBIs in racially and culturally diverse communities and schools.

## Limitations

Our study has some important limitations. Because of funding restrictions and the importance of testing a community-wide approach to prevention, it was possible to

include only a small number of communities (1–2) per study condition. Despite this limitation, results showed significant reductions in the normative trajectory of alcohol use among high school students in the CMCA and CONNECT communities. Because of the intensive longitudinal nature of our design, wave and item nonresponse required attention.

We used rigorous epidemiological methods to control for both item and wave nonresponse and are confident that these methods reduced threats of bias. Finally, we could not blind school leadership to study condition, and outcomes were on the basis of student self-report. However, we followed strict protocols to limit the potential of reporting bias, including complete separation of intervention and survey logos, identity, and staff.

## Conclusions

Alcohol use among high school students remains a serious public health problem, and rural and AI youths are particularly vulnerable populations. CMCA and CONNECT are effective approaches that can be beneficially implemented in diverse communities. These interventions develop community engagement and leadership, organize local citizens to take action, use existing community resources, and disseminate specific strategies and actions known from research to be effective. **AJPH**

## CONTRIBUTORS

K. A. Komro wrote the first draft of the article. K. A. Komro and A. C. Wagenaar reviewed and provided input to the statistical analyses and data interpretation. K. A. Komro, A. C. Wagenaar, and T. K. Kominsky conceptualized the overall study design, measurement plan, and data collection procedures. K. A. Komro, A. C. Wagenaar, D. W. Pettigrew, and B. A. Garrett conceptualized the intervention design and implementation strategies. M. D. Livingston led the statistical analyses and data interpretation and wrote the first draft of the analysis and results sections. A. C. Wagenaar, T. K. Kominsky, D. W. Pettigrew, and B. A. Garrett edited and contributed to the writing of the article. All authors approved the final version of the article.

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The Cherokee Nation Prevention Trial Team members in alphabetical order include Billy J. Boyd, Misty L. Boyd, Bethany J. Livingston, Sarah D. Lynne, Mildred Maldonado Molina, Lisa J. Merlo, and Amy L. Tobler.

**Note.** The content is solely the responsibility of the authors and does not necessarily represent the views of the NIH or the Cherokee Nation.

## HUMAN PARTICIPANT PROTECTION

The Cherokee Nation and the University of Florida institutional review boards approved the study protocol. The Emory University and the University of North Texas Health Sciences Center institutional review boards approved the analysis phase. The Cherokee Nation institutional review board approved the article for publication.

## REFERENCES

- Espey DK, Jim MA, Cobb N, et al. Leading causes of death and all-cause mortality in American Indians and Alaska Natives. *Am J Public Health*. 2014;104(suppl 3):S303–S311.
- Agency for Healthcare Research and Quality. 2013 National healthcare quality report. 2014. Available at: <http://www.ahrq.gov/sites/default/files/publications/files/2013nhqr.pdf>. Accessed April 20, 2016.
- Ohannessian CM, Finan LJ, Schulz J, Hesselbrock V. A long-term longitudinal examination of the effect of early onset of alcohol and drug use on later alcohol abuse. *Subst Abuse*. 2015;36(4):440–444.
- Chartier K, Caetano R. Ethnicity and health disparities in alcohol research. *Alcohol Res Health*. 2010;33(1–2):152–160.
- Swaim RC, Stanley LR. Rurality, region, ethnic community make-up and alcohol use among rural youth. *J Rural Health*. 2011;27(1):91–102.
- Etz KE, Arroyo JA, Crump AD, Rosa CL, Scott MS. Advancing American Indian and Alaska Native substance abuse research: current science and future directions. *Am J Drug Alcohol Abuse*. 2012;38(5):372–375.
- Cherokee Nation. About the nation: history. Available at: <http://www.cherokee.org/AboutTheNation/History.aspx>. Accessed September 26, 2016.
- Wagenaar AC, Gehan JP, Jones-Webb R, et al. Communities mobilizing for change on alcohol: lessons and results from a 15-community randomized trial. *J Community Psychol*. 1999;27(3):315–326.
- Wagenaar AC, Murray DM, Gehan JP, et al. Communities mobilizing for change on alcohol: outcomes from a randomized community trial. *J Stud Alcohol*. 2000;61(1):85–94.
- Wagenaar AC, Murray DM, Toomey TL. Communities Mobilizing for Change on Alcohol (CMCA): effects of a randomized trial on arrests and traffic crashes. *Addiction*. 2000;95(2):209–217.
- Komro KA, Perry CL, Veblen-Mortenson S, et al. Outcomes from a randomized controlled trial of a multi-component alcohol use preventive intervention for urban youth: Project Northland Chicago. *Addiction*. 2008;103(4):606–618.
- Komro KA, Perry CL, Veblen-Mortenson S, et al. Violence-related outcomes of the D.A.R.E. plus project. *Health Educ Behav*. 2004;31(3):335–354.
- Forster JL, Murray DM, Wolfson M, Blaine TM, Wagenaar AC, Hennrikus DJ. The effects of community policies to reduce youth access to tobacco. *Am J Public Health*. 1998;88(8):1193–1198.
- Hennessy EA, Tanner-Smith EE. Effectiveness of brief school-based interventions for adolescents: a

meta-analysis of alcohol use prevention programs. *Prev Sci*. 2015;16(3):463–474.

- Komro KA, Wagenaar AC, Boyd M, et al. Prevention trial in the Cherokee Nation: design of a randomized community trial. *Prev Sci*. 2015;16(2):291–300.
- Komro KA, Livingston MD, Kominsky TK, et al. Fifteen-minute comprehensive alcohol risk survey: reliability and validity across American Indian and White adolescents. *J Stud Alcohol Drugs*. 2015;76(1):133–142.
- National Institute on Alcohol Abuse and Alcoholism. Alcohol screening and brief intervention for youth: a practitioner's guide. 2015. Available at: <http://pubs.niaaa.nih.gov/publications/Practitioner/YouthGuide/YouthGuide.pdf>. Accessed June 1, 2015.
- Moyers TB, Martin T, Manuel JK, Miller WR, Ernst D. Revised global scales: motivational interviewing treatment integrity 3.1.1 (MITI 3.1.1). Albuquerque, NM: University of New Mexico; 2010. Available at: <http://c.yumcdn.com/sites/www.marrrch.org/resource/resmgr/imported/02-09-MITI-3-1-1.pdf>. Accessed December 21, 2016.
- Centers for Disease Control and Prevention. Youth risk behavior surveillance—United States, 2009. *MMWR Surveill Summ*. 2010;59(5):1–142.
- Ganzach Y, Saporta I, Weber Y. Interaction in linear versus logistic models: a substantive illustration using the relationship between motivation, ability, and performance. *Organ Res Methods*. 2000;3(3):237–253.
- Moeller J. A word on standardization in longitudinal studies: don't. *Front Psychol*. 2015;6:1389.
- Enders CK. *Applied Missing Data Analysis*. New York, NY: Guilford Press; 2011.
- Lunceford JK, Davidian M. Stratification and weighting via the propensity score in estimation of causal treatment effects: a comparative study. *Stat Med*. 2004;23(19):2937–2960.
- Centers for Disease Control and Prevention. High school YRBS. Available at: <https://nccd.cdc.gov/Youthonline/App/Default.aspx>. Accessed September 26, 2016.
- Wagenaar AC, Perry CL. Community strategies for the reduction of youth drinking: theory and application. *J Res Adolesc*. 1994;4(2):319–345.
- Shadish WR, Cook TD, Campbell DT. *Experimental and Quasi-Experimental Designs for Generalized Causal Inference*. Belmont, CA: Wadsworth Cengage Learning; 2002.
- Flewelling RL, Grube JW, Paschall MJ, et al. Reducing youth access to alcohol: findings from a community-based randomized trial. *Am J Community Psychol*. 2013;51(1–2):264–277.
- Johnson MB. A successful high-visibility enforcement intervention targeting underage drinking drivers. *Addiction*. 2016;111(7):1196–1202.
- Moore RS, Roberts J, McGaffigan R, et al. Implementing a reward and reminder underage drinking prevention program in convenience stores near Southern California American Indian reservations. *Am J Drug Alcohol Abuse*. 2012;38(5):456–460.
- Whitbeck LB, Walls ML, Welch ML. Substance abuse prevention in American Indian and Alaska Native communities. *Am J Drug Alcohol Abuse*. 2012;38(5):428–435.
- Gilder DA, Luna JA, Calac D, Moore RS, Monti PM, Ehlers CL. Acceptability of the use of motivational interviewing to reduce underage drinking in a Native American community. *Subst Use Misuse*. 2011;46(6):836–842.

Table A. Percentage of Students Missing Data by Condition and Number of Waves Missed.

<b># of Missing Waves</b>	<b>Control (n=588)</b>	<b>CMCA (n=208)</b>	<b>Connect (n=224)</b>	<b>Combined (n=603)</b>
<b>0</b>	26.4	32.2	47.3	47.6
<b>1</b>	18.4	19.2	19.2	15.9
<b>2</b>	8.8	10.1	7.6	7.3
<b>3</b>	8.2	8.2	1.8	3.2
<b>4</b>	7.3	6.3	5.4	4.5
<b>5</b>	5.4	5.8	1.3	2.5
<b>6</b>	4.3	1.9	2.2	2.2
<b>7</b>	3.2	3.9	1.8	1.2
<b>8</b>	6.1	3.9	6.7	6.3
<b>9</b>	4.1	1.9	2.2	3.0
<b>10</b>	4.9	1.9	2.7	3.5
<b>11</b>	2.9	4.8	1.8	3.0



Table B. Treatment effects by study condition and year.

	<u>Past 30 Day Alcohol Use</u> Change in Probability (95% CI)	<u>Past 30 Day Heavy</u> <u>Alcohol Use</u> Change in Probability (95% CI)	<u>Alcohol Consequences</u> Change in POMS (95% CI)
<i>CMCA</i>			
<b>Overall</b>	<b>-0.13 (-0.20, -0.05)</b>	<b>-0.12 (-0.19, -0.05)</b>	<b>-0.08 (-0.13, -0.02)</b>
Year 1	-0.09 (-0.17, -0.01)	-0.11 (-0.19, -0.02)	-0.06 (-0.11, 0.00)
Year 2	-0.19 (-0.28, -0.11)	-0.18 (-0.26, -0.09)	-0.11 (-0.17, -0.06)
Year 3	-0.08 (-0.17, 0.01)	-0.07 (-0.16, 0.01)	-0.05 (-0.11, 0.01)
<i>CONNECT</i>			
<b>Overall</b>	<b>-0.11 (-0.18, -0.03)</b>	<b>-0.08 (-0.16, -0.01)</b>	<b>-0.07 (-0.12, -0.02)</b>
Year 1	-0.07 (-0.15, 0.02)	-0.05 (-0.12, 0.03)	-0.03 (-0.09, 0.03)
Year 2	-0.14 (-0.22, -0.05)	-0.12 (-0.20, -0.03)	-0.09 (-0.14, -0.03)
Year 3	-0.09 (-0.18, 0.00)	-0.07 (-0.15, 0.01)	-0.08 (-0.13, -0.02)
<i>Combined</i>			
<b>Overall</b>	<b>-0.05 (-0.11, 0.00)</b>	<b>-0.05 (-0.10, 0.00)</b>	<b>-0.04 (-0.08, -0.01)</b>
Year 1	-0.03 (-0.08, 0.03)	-0.03 (-0.08, 0.02)	-0.02 (-0.06, 0.02)
Year 2	-0.09 (-0.14, -0.03)	-0.08 (-0.14, -0.03)	-0.06 (-0.10, -0.02)
Year 3	-0.04 (-0.10, 0.02)	-0.03 (-0.09, 0.03)	-0.04 (-0.08, 0.00)

Note. We transformed the scale using the proportion of maximum scaling method (POMS).<sup>22</sup>  
The POMS transformation results in a regression estimate that is interpreted as the change in the proportion of the maximum possible scale value.

Figure A. CONSORT Diagram for Prevention Trial in the Cherokee Nation.

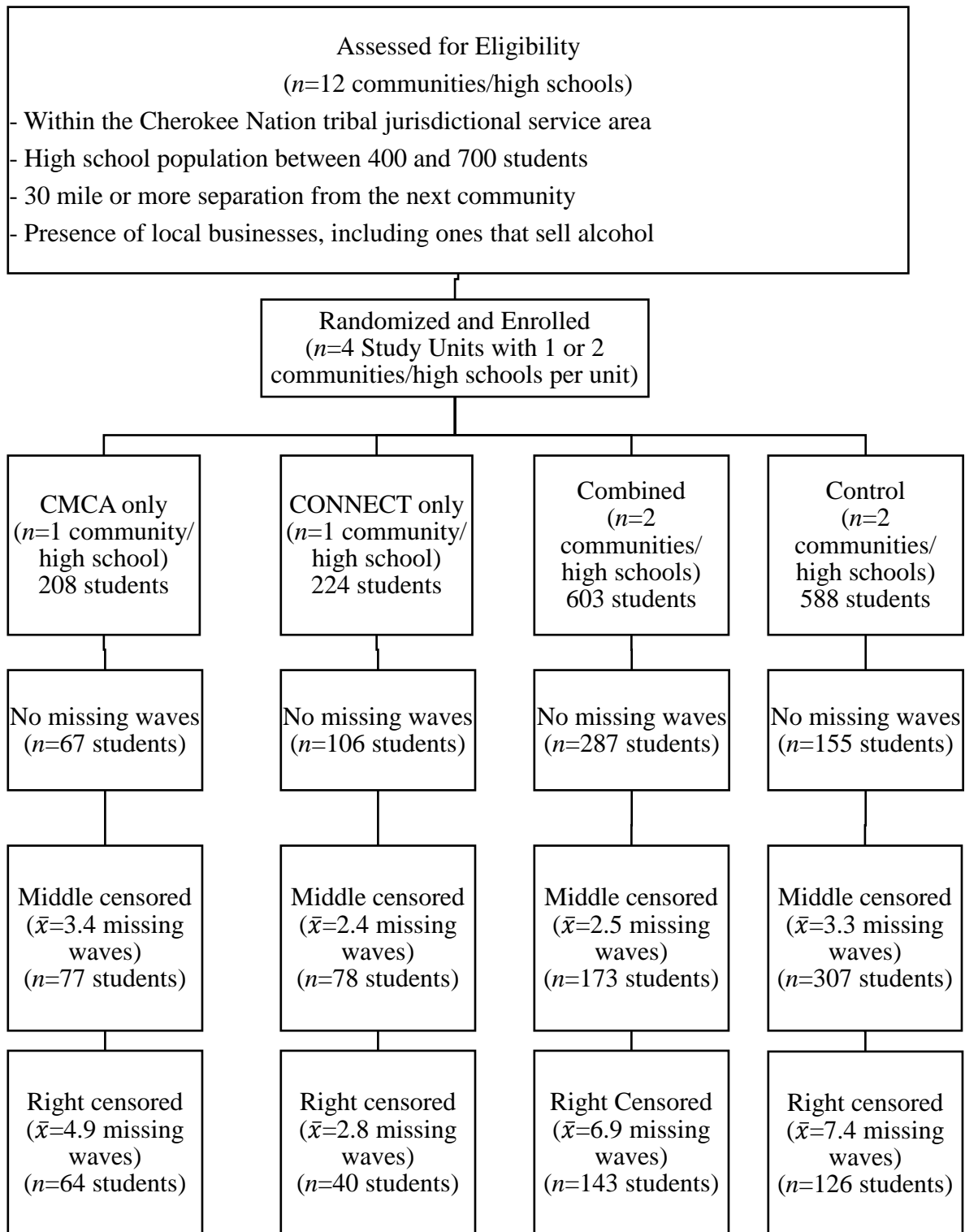
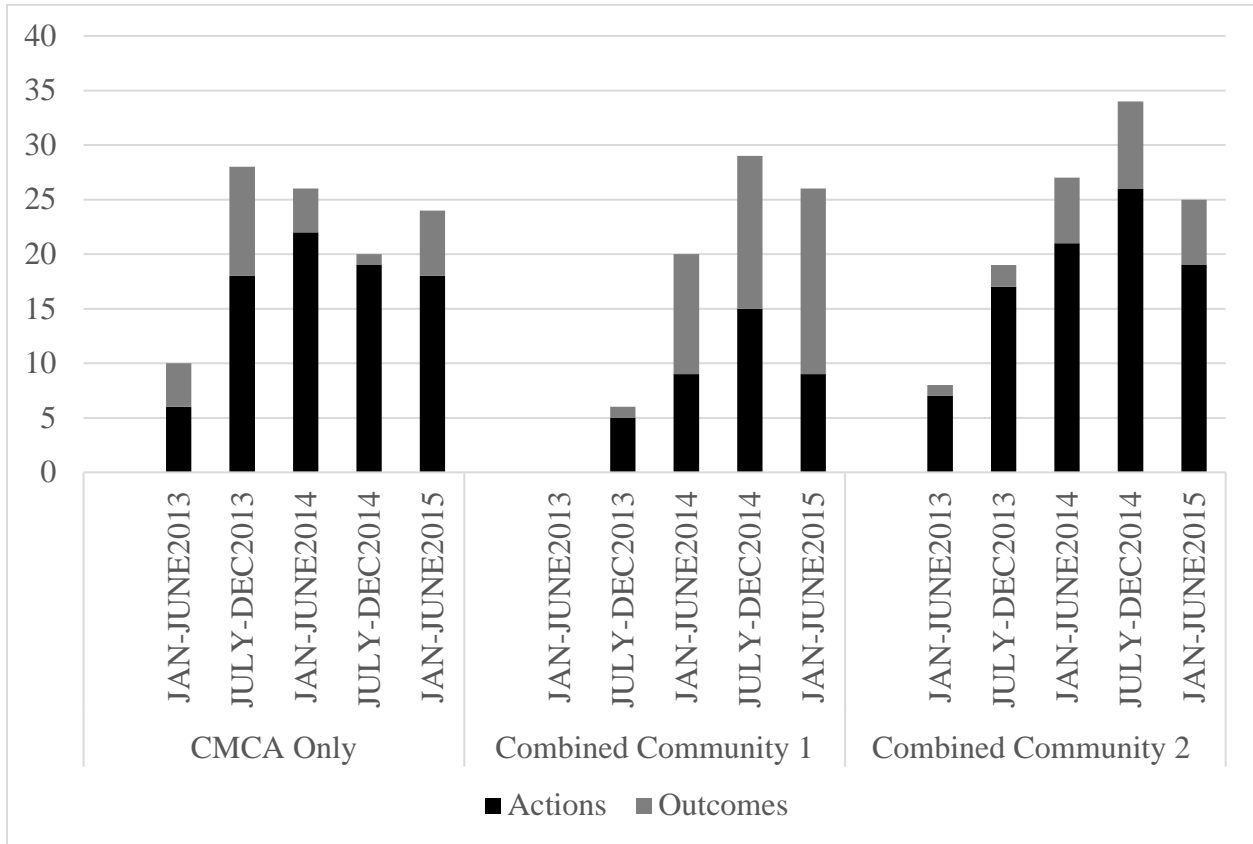
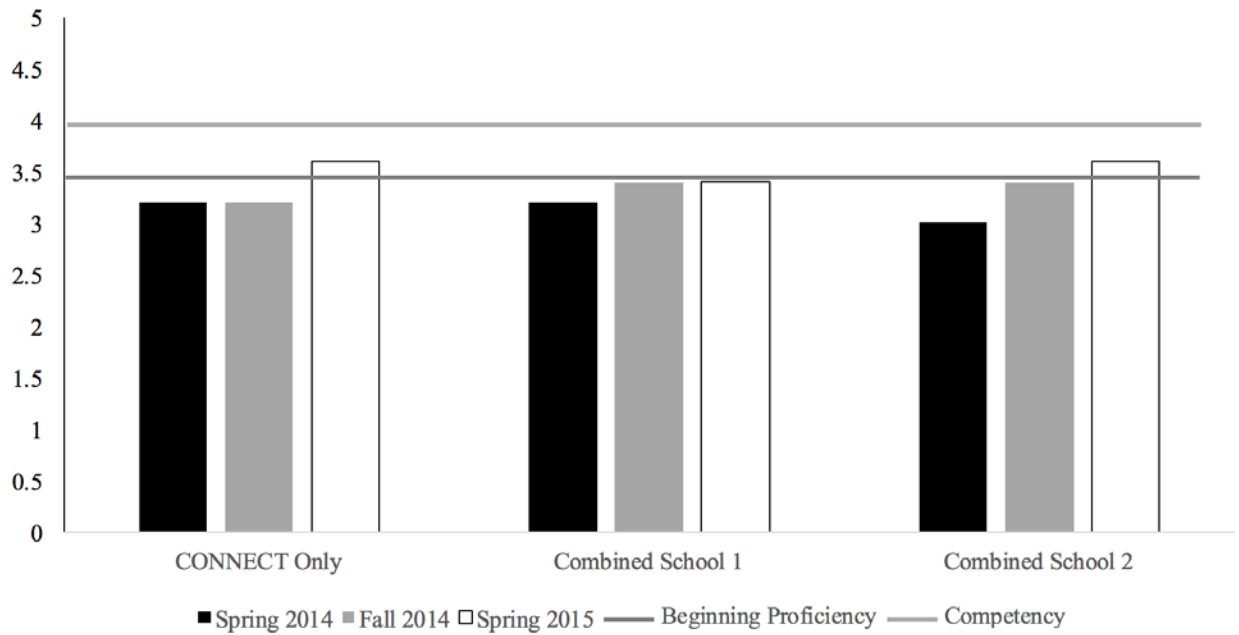


Figure B. CMCA Implementation Outcomes Time Period and Community.



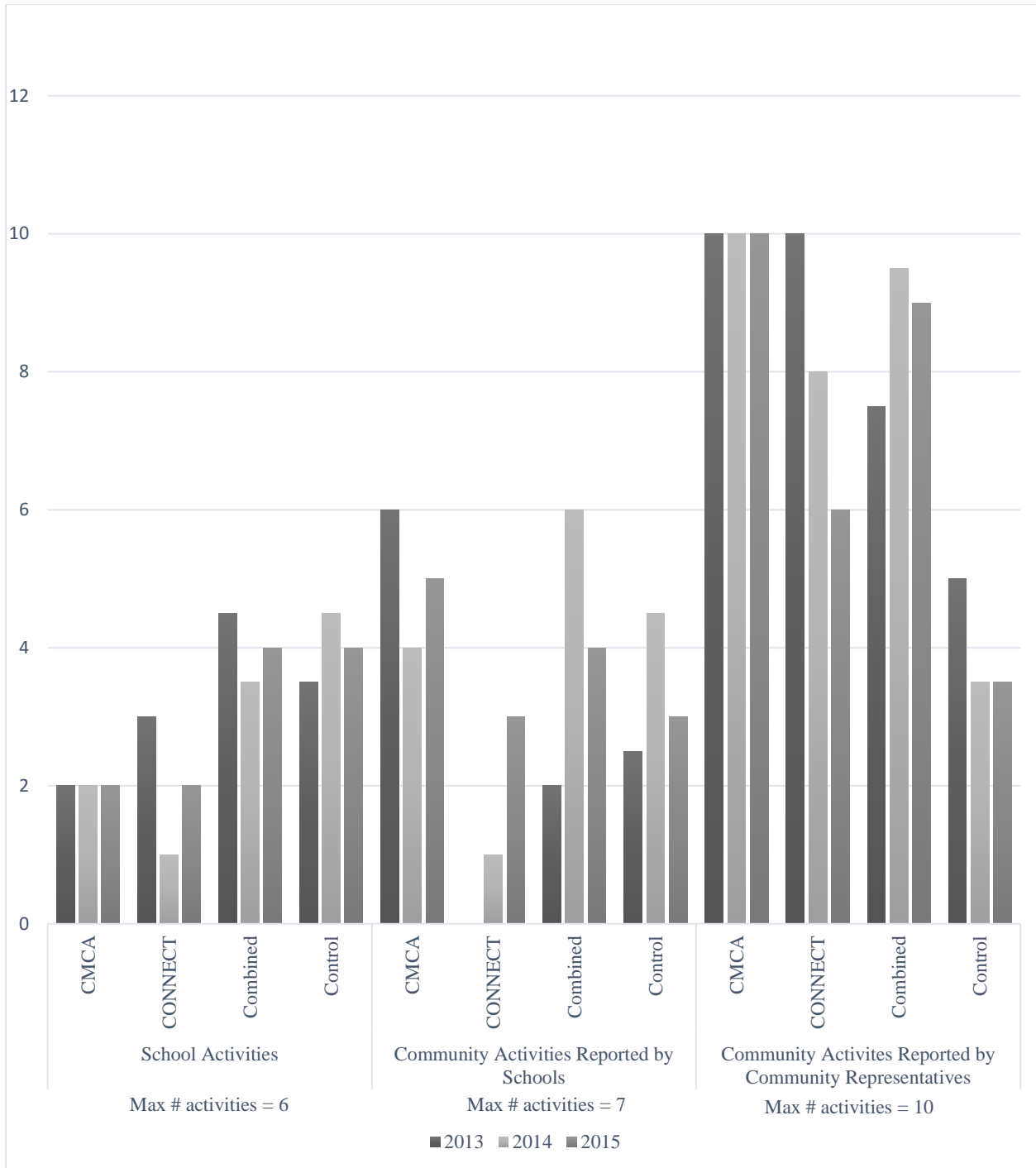
Note. CMCA Community Action Teams reported actions and outcomes throughout the intervention time period. Each Community Organizer recorded their Action Team activities at least weekly using a standardized computer-based monitoring system. Example actions include gaining support from a key stakeholder, increasing police patrols, increasing police compliance checks of alcohol outlets. Example outcomes include media campaigns, new police procedures institutionalized, parental interventions to reduce social access to alcohol, and new local ordinances regarding compliance checks.

Figure C. CONNECT Coach Motivational Interviewing Skills Assessment by Time and School.



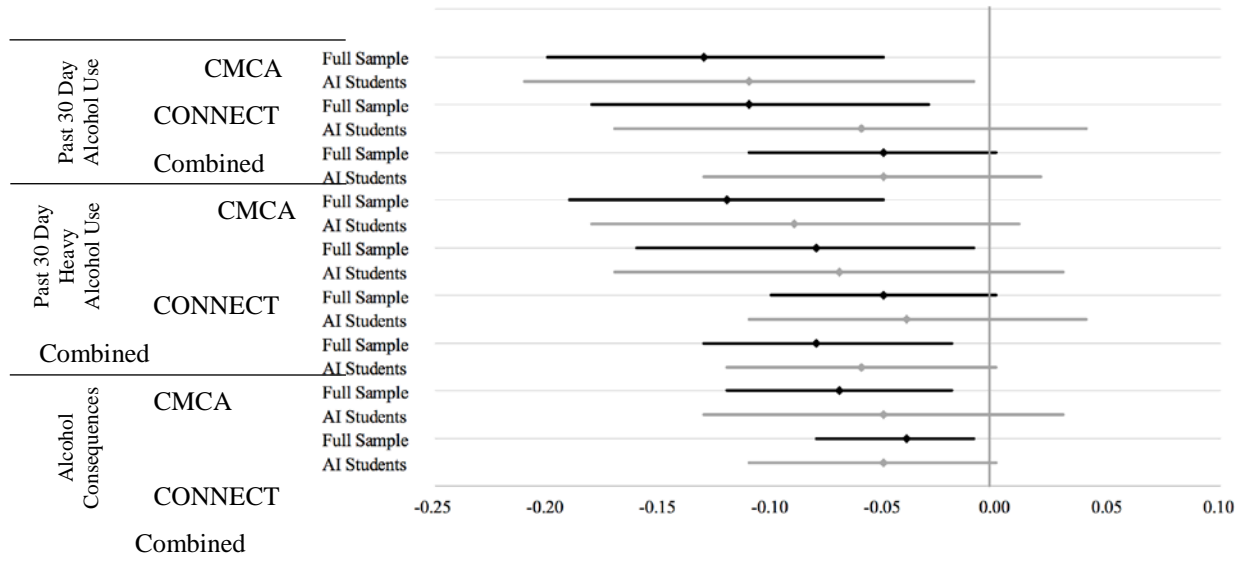
Note. Three times during the intervention phase, all CONNECT Coaches were videotaped conducting a simulated encounter with a student actor. The video-taped mock encounters were coded and rated for core motivational interviewing skills (score range 0-5) using the Motivational Interviewing Treatment Integrity coding system.<sup>18</sup>

Figure D. Alcohol Prevention Activities in Study Schools and Communities.



Note. The combined and control counts are the average across the 2 schools/communities assigned to those conditions.

Figure E. Intervention Effects for American Indian Students Compared to the Full Sample.



Note. Estimates shown are change in probability (or POMS for alcohol consequences) with 95% CIs for American Indian (AI) students compared to the full sample. Given budget constraints, the trial was intentionally designed without adequate power to detect race-specific effects. But, given high interest in the AI population, we conducted secondary analyses restricted to AI students. Results showed intervention effects among AI youth very similar to results for the full sample.