

Longitudinal Outcomes of a Smartphone Application to Prevent Drug Use Among Hispanic Youth

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ABSTRACT. Objective: This trial tested the efficacy of a smartphone application (app) designed to prevent drug use among Hispanic youth. **Method:** Participants were recruited through online advertising and youth service agencies. The baseline sample ($N = 644$) had a mean age of 14.1 years, was primarily female (60%), and resided in 31 U.S. states and Puerto Rico. Youth assented to study participation and received parental permission to participate. Youth were randomly assigned to an intervention arm or a measurement-only control arm. Intervention-arm youth completed 10 prevention program sessions via a smartphone app. Following intervention delivery, all youth completed posttest and 1-, 2-, and 3-year follow-up measures. **Results:** Analyzed within an Arm by Time interaction model, follow-up data showed that compared with control-arm youth, intervention-arm youth reported (a) less increase in

alcohol use from baseline to 2-year follow-up; (b) less increase in marijuana use from baseline to 2- and 3-year follow-ups; and (c) less increase in polydrug use from baseline to 1-, 2-, and 3-year follow-ups. Compared with youth in the control arm, intervention-arm youth reported (a) less depressed mood and improved skills for refusing offers of alcohol and tobacco at posttest; (b) higher self-efficacy and social self-efficacy at 1-, 2-, and 3-year follow-ups; (c) improved skills for refusing offers of marijuana at 2- and 3-year follow-ups; (d) higher media literacy at 2- and 3-year follow-ups; and (e) better coping skills at 3-year follow-up. **Conclusions:** These longitudinal findings suggest that Hispanic youth can profit from tailored, skills-based content delivered via a smartphone app to prevent drug use. (*J. Stud. Alcohol Drugs*, 82, 668–677, 2021)

YOUTH WHO USE ALCOHOL, tobacco, and marijuana face serious social, emotional, educational, and vocational problems (Castellanos et al., 2016; Gonzalez-Guarda et al., 2014), and those who engage in polydrug use are particularly prone to drug use disorders in adulthood (Moss et al., 2014). Although drug use is an avoidable cause of these serious problems, not all youth use drugs at the same rate or require the same interventions. Hence, research investment must consider and be tailored to the needs of different populations.

Data from *Monitoring the Future* and the *Youth Risk Behavior Surveillance System* reveal rates of drug use among Hispanic youth that are worrisome and warrant attention. In middle school, 15.5% of Hispanic youth report past-year drug use, compared with 10.3% of their non-Hispanic White peers and 13.1% of their non-Hispanic Black peers (Johnston et al., 2019). Rates of past-month alcohol use, binge drinking, marijuana use, and vaping marijuana among Hispanic middle school youth also exceed those of their non-Hispanic peers (Johnston et al., 2019). In high school, Hispanic youth outpace their non-Hispanic peers on lifetime use of alcohol, synthetic marijuana, cocaine,

methamphetamines, MDMA/Ecstasy (3,4-methylenedioxymethamphetamine), steroids, and vaping (Centers for Disease Control and Prevention [CDC], 2018). Others find similar patterns for Hispanic high schoolers' current use of marijuana, synthetic marijuana, prescription opioids, and cocaine (Jones et al., 2020). Moreover, even at similar or lower rates of use, as Hispanic youth become adults, they experience more drug-related problems (e.g., injuries, accidents, health issues, legal consequences), particularly compared with their White counterparts (Witbrodt et al., 2014; Zapolski et al., 2017).

Hispanic and non-Hispanic youth share etiological risk and protective factors for drug use. Such risk factors include peer influences, stress, underdeveloped problem-solving and coping skills, developmental factors, depression, anxiety, and negative role models. Protective factors include self-efficacy, social self-efficacy, and media literacy (Cardoso et al., 2016; Hawkins et al., 1992; Kopak, 2014; Zapata et al., 2016). However, for Hispanic youth, drug use etiology also includes discrimination (Rogers et al., 2020), acculturation (Schwartz et al., 2014), family influences (De La Rosa et al., 2015; Moreno et al., 2017), and access to illicit substances (CDC, 2018). This etiological knowledge has fostered prevention efforts to reduce drug use and related risky behaviors among Hispanic American youth.

Among the most effective drug abuse prevention programs for youth—Hispanic or otherwise—are those that build social competency skills (i.e., social, emotional, and cognitive skills that allow youth to make healthy decisions;

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Flay & Allred, 2010). One such skills-based drug use prevention program, called *keepin' it REAL* (kiR), is tailored for Hispanic youth (Gosin et al., 2003). Several evaluations of kiR have found positive program effects including reduced gateway drug use and improved drug use norms, attitudes, and resistance strategies at 2 years after intervention (Hecht et al., 2003) and lower rates of alcohol use (Marsiglia et al., 2012). In addition, numerous family-based approaches to preventing substance abuse among Hispanic youth have similarly shown positive outcomes (Estrada et al., 2019; Marsiglia et al., 2016; Pantin et al., 2003; Prado et al., 2012; Sale et al., 2005; Santisteban et al., 2003).

Challenges remain, however, in scaling up these and similar prevention programs to efficiently and inexpensively reach Hispanic youth. Widespread dissemination of the aforementioned school- and family-based interventions is commensurate with costly and burdensome implementation demands. To have an impact on youth drug use, Hispanic or otherwise, additional programming that is engaging, nimble, easy to disseminate, and cost effective is warranted.

The use of technology could offer one promising approach to improve the reach of drug use prevention programs to all youth. Indeed, considerable research attests to the efficacy of such platforms to reach large numbers of youth (MacDonell & Prinz, 2017). However, nearly all of the technology-delivered prevention programs rely on computers (Schinke & Schwinn, 2017). This is problematic for Hispanic youth because their households have lower levels of computer ownership than Black and White households (Perrin & Turner, 2019). Smartphones, by comparison, are owned at roughly the same rates in American homes, regardless of race or ethnicity, making them ideal to reach Hispanic youth.

Guided by our prior work tailoring skills-based drug use prevention content for subgroups of youth (Schwinn & Schinke, 2010; Schwinn et al., 2015, 2019), and others' aforementioned work with Hispanic youth, this study developed a smartphone-based drug use prevention program for Hispanic youth. The program aimed to enhance youth's acquisition of social competency skills (i.e., refusal skills, goal setting, problem solving, media literacy, coping, managing mood, and self-efficacy) through content that is reflective of, and resonant with, Hispanic culture. Study hypotheses were that youth who received the program would report reduced past-month drug use and improved risk and protective factors (i.e., the social competency skills targeted in the intervention) relative to control-arm youth.

Method

Sample

The consenting and randomized study sample was $N = 678$ Hispanic youth (Figure 1). Youth were recruited nation-

ally through partnerships with Hispanic-affiliated youth services community-based organizations (86%) and schools (6%) as well as through online advertising (7%). The sample included youth from 31 U.S. states and Puerto Rico.

Whether youth and parents heard of the study through their community-based organizations, schools, or an online advertisement, all interested youth and their parents were directed to a study website. The study website included informational videos for youth (in English) and for parents (in English and in Spanish). The website also described the study's purpose, objectives, procedures, and eligibility criteria for youth (i.e., identifying as Hispanic, proficient in English, ages 12–15 years, and having access to a smartphone). Youth and their parents were informed that all study participants would be asked to complete five online surveys and that randomly selected youth would be asked to interact with a program aimed at helping them manage their teen years in healthy ways.

Interested youth and parents electronically submitted a contact information form with youth and parent email addresses and a home mailing address. Youth and parents were then separately emailed a description of the study's procedures, duration, risks, confidentiality, and honoraria. To ensure informed assent and parental permission, youth and their parents completed separate online quizzes on the study's procedures, risks, and voluntary nature. Only after answering the quiz questions correctly were youth and their parents able to submit their respective assent and permission forms with electronic signatures, making youth eligible for study enrollment.

Procedure

Through block randomization ($k = 10$) to ensure roughly balanced study arms, 342 youth were assigned to the intervention arm, and 336 youth were assigned to the measurement-only control arm. After all youth completed baseline measures online, youth randomly assigned to the intervention arm were directed to complete the 10-session intervention. Following intervention delivery, youth in both arms completed posttest and 1-, 2-, and 3-year follow-up measures. For completing baseline and posttest measurements, youth received \$25 gift cards; for 1-, 2-, and 3-year follow-up measurements, youth received \$50 gift cards.

In the months between completing the baseline and posttest measures, youth assigned to the intervention arm received notifications to complete their intervention sessions via email, telephone, text, and traditional mail; youth assigned to the measurement-only control arm did not receive these communications. Across all years of the study, youth in both arms received identical correspondence related to measurement completion and tracking procedures (i.e., quarterly updates to contact information, birthday cards, and holiday cards).

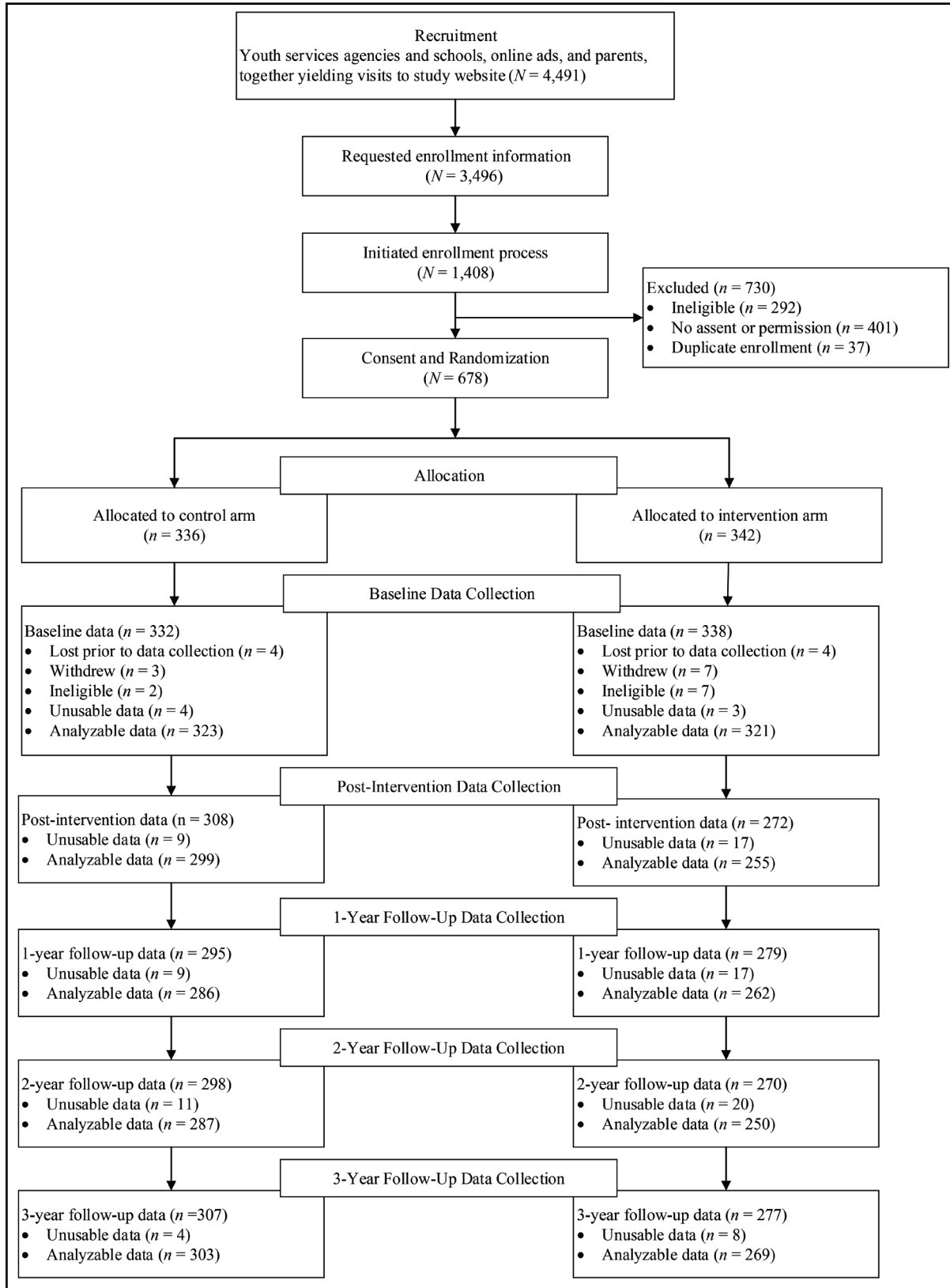


FIGURE 1. CONSORT (Consolidated Standards of Reporting Trials) flow diagram

Intervention

The prevention program, called *Vamos*, comprises 10 skills-based sessions aimed at equipping youth with the social competencies necessary to avoid drug use. The skills addressed include refusing offers to use drugs, goal setting, media literacy, coping, managing mood (anxiety, sadness, and anger), and self-efficacy. The format of each session is guided by social learning theory, motivational interviewing (MI), and bicultural competence. Social learning theory posits that people learn through observation, modeling, and rewards (Bandura, 1977). Accordingly, each session (a) provides youth with a description of the skill (delivered by the main narrators who are two age-mate peers named Jennifer and Mateo), (b) an opportunity to practice the skill (e.g., choose how a character responds, choose how they would respond, respond to brief writing prompts), and (c) feedback on the practice exercise.

Guided by MI theory (Miller & Rollnick, 2002), the session narrators use nonjudgmental language when prompting youth to practice a skill and when providing feedback on practice exercises. By nonjudgmentally posing questions about appropriate responses to problem situations, MI strategies can improve the likelihood that youth are internally motivated to make decisions to abstain from drug use (Añez et al., 2008; Jensen et al., 2011).

Last, bicultural competence is reflected throughout the sessions when illustrative scenarios and character dialogue reflect the dilemma Hispanic youth face while simultaneously reconciling the cultural norms and values of their families with those of their non-Hispanic peers and adults (Szapocznik & Kurtines, 1993). *Vamos* sessions acknowledge how youth's responses to situations can necessarily differ depending on the cultural context. For instance, in sessions related to refusal skills, youth reflect on and practice how they may respond to an offer to use alcohol in a Hispanic setting versus a non-Hispanic setting. The goal of reflecting skills acquisition through a bicultural lens is to increase youth's perceived ability to make their desires or preferences known in Hispanic settings as well as non-Hispanic settings (LaFromboise et al., 1993). Each *Vamos* session requires approximately 15 minutes; sessions are completed sequentially and limited to one per week. For details on the intervention, see Schinke et al. (2015).

Measurement

The online measures covered drug use behavior and the risk and protective factors targeted in the intervention. Each measure required approximately 15 minutes to complete.

Demographics. Youth reported age, sex, race, ethnicity, living arrangement, language spoken at home, and parents' highest level of education. Youth also responded to an acculturation measure (Unger et al., 2002; $\alpha = .79$).

Problem solving. Items from the Social Problem-Solving Inventory-Revised (D'Zurilla & Nezu, 1990; $\alpha = .94$) used six 4-point Likert-scaled questions. For example, "When I am attempting to solve a problem, I go with the first good idea that comes to mind" (0 = *strongly agree* to 4 = *strongly disagree*).

Coping skills. Twelve 4-point Likert-scaled items from the Brief COPE (Carver, 1997; $\alpha = .75$) assessed coping skills. Youth reported on self-distraction, active coping, destructive coping, positive reframing, and obtaining help from instrumental supports. For example, "During the past month, how often have you felt like you could not cope with all the things that you had to do?" (0 = *all the time* to 3 = *never*).

Media literacy. Six 4-point Likert-scaled items (Primack et al., 2006; $\alpha = .87$) assessed media literacy. Youth indicated their level of agreement with statements about product placement, inherent values in messaging, and advertisers' motivation. For example, "Ads often associate smoking and drinking to things like love, good looks, and power" (1 = *strongly disagree* to 4 = *strongly agree*).

Goal setting. Four items (Fearnow-Kenney et al., 2002; $\alpha = .76$) assessed the frequency and application of goal setting in relation to solving problems. For example, "I develop a plan for my important goals" (0 = *never* to 3 = *all the time*).

Self-efficacy. The Generalized Self-Efficacy Scale (Schwarzer & Jerusalem, 1995; $\alpha = .76-.90$) assessed self-efficacy. With five 4-point Likert-scaled items, youth reported their ability to achieve successful outcomes and manage difficult situations. For example, "When I am confronted with a problem, I can usually find several solutions" (1 = *strongly disagree* to 4 = *strongly agree*).

Social self-efficacy. The Social Self-Efficacy Scale (Muris, 2001; $\alpha = .85$) was used to assess youth's social self-efficacy. With four 4-point Likert-scaled items, youth reported their ability to negotiate social situations and produce successful social interactions. For example, "I am good at telling other people my age that they are doing something I don't like" (1 = *strongly disagree* to 4 = *strongly agree*).

Peer drug use. Youth reported on their close friends' drug use with seven 4-point Likert-scaled items. For example, "In the past month, how many of your closest friends have smoked cigarettes?" (0 = *none* to 3 = *all*).

Mood. Scales from the Brief Symptom Inventory (Derogatis, 1993) assessed anxiety ($\alpha = .79$) and depression ($\alpha = .86$). Four and five 5-point Likert-scaled items asked youth to rate the extent to which they were bothered by various symptoms. For example, "During the past month, how often have you felt hopeless about the future?" (0 = *not at all* to 3 = *all the time*).

Refusal skills. Youth's ability to refuse offers to use alcohol, marijuana, and tobacco was assessed with eighteen 4-point Likert scales (Bobo et al., 1985; $\alpha = .65-.77$) For example, "If someone wanted you to smoke marijuana and you didn't want to, how likely is it that you would tell them

you don't want to?" (1 = *definitely would not* to 4 = *definitely would*).

Drug use. Adapted from the CDC Youth Risk Behavior Survey (YRBS; CDC, 2005), items asked youth to report past-month alcohol, tobacco, marijuana, and other drugs (i.e., club drugs, cocaine, Ecstasy, hallucinogens, heroin, inhalants, methamphetamines, steroids, and prescription drugs). Test-retest reliability for YRBS items is $\alpha = .82-.95$ (Brener et al., 2013). Using drop-down menus, youth selected a number from the available range of "0 times" to "71 or more times." Polydrug use (use of two or more drugs in the past month) was computed from the items.

Data analysis

Data were cleaned and analyzed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY). Cases were identified for extreme scores on past-month drug use, unreliable patterns of drug use across measurement occasions, and endorsing use of a fake drug. Across all five surveys, 1%–5% of cases were considered unusable and removed. Listwise deletion was used for missing data. Baseline comparability of categorical demographic data was conducted using chi-squared tests of independence; two-sample *t* tests were used to assess comparability of the remaining measures. To estimate effects for the primary outcomes of past-month drug use, generalized estimating equations with robust estimators modeled intervention effects. An interaction term of Time \times Intervention, therefore, assessed intervention effects on youth's drug use over time from baseline to each measure at posttest and 1-, 2-, and 3-year follow-ups. Because of a high number of zero responses, the continuous data were dichotomized to 0 = no past-month use and 1 = 1 or more times of past-month use. A binary logistic link was used for these dichotomous outcomes. Because longitudinal observations within individuals were correlated, the AutoRegressive Order 1 covariance structure was applied. Models controlled for gender, age, and parental education level. Secondary outcomes were analyzed using generalized linear model (GLM) repeated measures to assess the Time \times Intervention interaction effect on these factors from baseline to each follow-up occasion, controlling for gender, age, and parental education level.

Results

At baseline (Table 1), youth in the intervention and control arms were comparable on demographic, acculturation, and drug use variables, with the exception of higher parental education levels for intervention-arm youth, $\chi^2(1, N = 644) = 4.17, p = .04$. All youth reported that they were Hispanic; 69% of youth were White, 14% were Black, and 17% were other. At baseline, youth had an average age

of 14.08 years ($SD = 1.11$), and 60% were female. Most youth lived with their mothers and fathers. Youth reported roughly equal percentages for whether the language spoken in their homes was Spanish, English, or a combination of the two.

Primary outcomes: Drug use

Results for past-month alcohol, marijuana, tobacco, and polydrug (use of two or more drugs) use appear in Table 2. Compared with youth in the control arm, intervention-arm youth reported a lesser increase in past-month polydrug use from baseline to 1-, 2-, and 3-year follow-ups (odds ratio [OR] = 0.56, 95% CI [0.34, 0.93], $p < .05$; OR = 0.54, 95% CI [0.32, 0.89], $p < .05$; and OR = 0.55, 95% CI [0.32, 0.93], $p < .05$, respectively). Youth in the intervention arm also reported a lesser increase in past-month marijuana use from baseline to 2- and 3-year follow-ups (OR = 0.33, 95% CI [0.12, 0.93], $p < .05$, and OR = 0.27, 95% CI [0.09, 0.80], $p < .05$, respectively) and compared with their control-arm peers. Past-month use of alcohol increased less among youth in the intervention arm compared with youth in the control arm only from baseline to 2-year follow-up (OR = 0.47, 95% CI [0.23, 0.99], $p < .05$). Across all statistically significant primary outcomes, the ORs suggest a small effect size (Chen et al., 2010).

Secondary outcomes: Risk and protective factors

Differences between arms on the risk and protective factors targeted in the intervention appear in Table 3. GLM analyses showed that compared with youth in the control arm, intervention-arm youth reported less depressed mood, $F(1, 548) = 4.67, p < .05$, and improved skills for refusing offers of alcohol, $F(1, 548) = 5.67, p < .05$, and tobacco, $F(1, 548) = 4.91, p < .05$, at posttest. At 1-year follow-up, and compared with youth in the control arm, intervention-arm youth had higher self-efficacy, $F(1, 542) = 5.12, p < .01$, and social self-efficacy, $F(1, 542) = 3.09, p < .05$. At 2-year follow-up, and compared with youth in the control arm, youth in the intervention arm had improved media literacy, $F(1, 531) = 3.54, p < .05$, self-efficacy, $F(1, 531) = 5.32, p < .001$, social self-efficacy, $F(1, 531) = 2.96, p < .05$, and skills for refusing offers of marijuana, $F(1, 531) = 3.19, p < .05$. Last, at 3-year follow-up, intervention-arm youth maintained improved media literacy, $F(1, 536) = 2.53, p < .05$, self-efficacy, $F(1, 536) = 3.61, p < .05$, social self-efficacy, $F(1, 536) = 2.65, p < .05$, skills for refusing offers of marijuana, $F(1, 536) = 2.35, p < .05$, and coping, $F(1, 536) = 2.48, p < .05$, when compared with youth in the control arm. The effect sizes of these secondary outcomes fell between very small ($d = 0.01$) and small ($d = 0.02$), with the exception of media literacy at 2-year follow-up ($d = 0.35$; Sawilowsky, 2009).

TABLE 1. Baseline comparability of control- and intervention-arm youth

Variable	Control (<i>n</i> = 323)	Intervention (<i>n</i> = 321)	<i>p</i>
Age in years, <i>M</i> (<i>SD</i>)	14.0 (1.09)	14.16 (1.12)	.06
Female, <i>n</i> (%)	196 (60.5)	194 (60.6)	.97
Race, <i>n</i> (%)			.39
White	242 (74.8)	205 (64.2)	
Black	37 (11.4)	56 (17.4)	
Other	45 (13.8)	59 (18.3)	
Living arrangement, <i>n</i> (%)			.38
Mother and father	201 (62.2)	206 (64.4)	
Single parent	87 (26.7)	89 (27.8)	
Grandparents; others	36 (11.1)	25 (7.9)	
Language spoken at home, <i>n</i> (%)			.49
Spanish only or mostly Spanish	108 (33.3)	113 (35.4)	
Spanish and English equally	90 (27.6)	96 (30.1)	
English only or mostly English	126 (39.0)	111 (34.5)	
Parental education, <i>n</i> (%)			.04
≤2 years of college	230 (71.1)	203 (63.4)	
>2 years of college	94 (28.9)	117 (36.6)	
Acculturation, <i>M</i> (<i>SD</i>)			
Separation	0.86 (1.34)	0.97 (1.35)	.30
Integration	4.29 (2.12)	4.18 (2.19)	.55
Assimilation	2.63 (2.59)	2.59 (2.15)	.81
Marginalization	0.18 (0.56)	0.19 (0.51)	.84
Drug use, ^a <i>M</i> (<i>SD</i>)			
Alcohol	0.19 (1.61)	0.28 (1.35)	.46
Marijuana	0.50 (5.63)	0.64 (4.94)	.76
Tobacco	0.02 (0.20)	0.02 (0.26)	.99
Illicit drugs ^b	0.01 (0.10)	0.02 (0.13)	.47

Notes: *M* values are observed averages. ^aInstances of use over past month; ^binhalants, Ecstasy, mushrooms, cocaine, methamphetamines, and heroin.

Process data

Youth were required to move through the intervention sessions in order. According to implementation data, 95% of intervention-arm youth completed one session, 86% of youth completed three sessions, 78% of youth completed six sessions, and 68% of youth completed all 10 sessions. On average, youth required 4.5 months (*SD* = 2.4) to complete the sessions. During intervention delivery, 82% of youth required additional reminders to complete the sessions. These reminders were conducted via telephone (43%), email (31%), text (20%), and paper mailings (6%). Youth interacted with the *Vamos* app via Android (36%) and iOS devices (64%). For youth who experienced difficulty with the app (e.g., storage capacity limitations, expired pre-paid phones), session content was made available on the *Vamos* study website.

Discussion

Study findings modestly support the efficacy of a drug use prevention program aimed at Hispanic youth and delivered via a smartphone application. Longitudinal data revealed that intervention-arm youth reported a lesser increase in alcohol use from baseline to 2-year follow-up, a lesser increase in marijuana use from baseline to 2- and 3-year follow-ups, and a lesser increase in polydrug use from baseline to 1-, 2-, and

3-year follow-ups when compared with control-arm youth. Intervention-arm youth also reported improved self-efficacy, social self-efficacy, and skills for refusing tobacco, alcohol, and marijuana compared with control-arm youth. Taken together, these findings point toward accrued behavioral and cognitive benefits from the app-based prevention program. The fact that study outcomes were still evident after 1-, 2-, and 3-year follow-ups further demonstrates the program's salubrious effects.

Because others have found that Hispanic adolescents have higher initial rates of drug use than their non-Hispanic peers, early prevention programs are of particular interest (Chen & Jacobson, 2012). Early adolescent marijuana use has been associated with impaired cognitive development, later drug use disorder symptoms, and diminished academic performance and perceived health (Mason et al., 2020). Similarly, early adolescent polydrug use is associated with school noncompletion and unprotected sex (Chan et al., 2016; Kelly et al., 2015) and increases the risk of drug dependence in young adulthood (Moss et al., 2014).

This study strengthens the value of skills-based approaches to prevent drug use among Hispanic youth found in others' work (Estrada et al., 2019; Marsiglia et al., 2016; Pantin et al., 2003; Prado et al., 2012; Santisteban et al., 2003). The *Vamos* program sought to reduce drug use by teaching youth skills to make healthier decisions around drug use. By guiding youth through culturally relevant vignettes and interac-

TABLE 2. Marginal estimate means (standard errors) of drug use outcome variables between intervention (tx) and control participants

Variable	Posttest			1-year follow-up			2-year follow-up			3-year follow-up		
	Control	Tx	OR	Control	Tx	OR	Control	Tx	OR	Control	Tx	OR
	M (SE)	M (SE)	[95% CI]	M (SE)	M (SE)	[95% CI]	M (SE)	M (SE)	[95% CI]	M (SE)	M (SE)	[95% CI]
Alcohol ^a	0.59 (0.23)	0.83 (0.23)	0.62 [0.31, 1.23]	1.40 (0.17)	1.53 (0.17)	0.55 [0.26, 1.15]	1.82 (0.16)	1.79 (0.18)	0.47* [0.23, 0.99]	2.23 (0.15)	2.43 (0.16)	0.60 [0.29, 1.24]
Marijuana ^a	0.76 (0.33)	1.40 (0.24)	0.55 [0.23, 1.31]	1.75 (0.22)	2.01 (0.20)	0.37 [0.13, 1.07]	2.28 (0.18)	2.41 (0.19)	0.33* [0.12, 0.93]	2.86 (0.16)	2.81 (0.17)	0.27* [0.09, 0.80]
Tobacco ^a	0.56 (0.58)	0.80 (0.58)	2.14 [0.22, 20.94]	1.51 (0.39)	1.30 (0.45)	1.01 [0.17, 6.58]	1.87 (0.33)	1.95 (0.33)	1.14 [0.29, 6.81]	2.13 (0.29)	2.47 (0.27)	1.82 [0.36, 9.19]
Polydrug use ^b	0.30 (0.18)	0.70 (0.14)	0.78 [0.48, 1.27]	0.83 (0.12)	1.01 (0.11)	0.56* [0.34, 0.93]	1.18 (0.11)	1.21 (0.11)	0.54* [0.32, 0.89]	1.51 (0.09)	1.56 (0.09)	0.55* [0.32, 0.93]

Notes: At posttest, control *n* = 299 and intervention *n* = 255; at 1-year follow-up, control *n* = 286 and intervention *n* = 262; at 2-year follow-up, control *n* = 287 and intervention *n* = 250; at 3-year follow-up, control *n* = 303 and intervention *n* = 269. OR = odds ratio; CI = confidence interval. ^aGeneralized estimating equation with robust estimator and binary logistic link assessed the effect of the intervention on drug outcomes from baseline to each of the follow-up measurements (i.e., posttest, 1-year, 2-year, and 3-year post intervention), controlling for demographic variables; ^bgeneralized estimating equation with robust estimator and Poisson link assessed the effect of the intervention on drug outcomes from baseline to each of the follow-up measurements (i.e., posttest, 1-year, 2-year, and 3-year post intervention), controlling for demographic variables. **p* < .05.

tive exercises focused on school issues, family tensions, peer influences, and quotidian choices, youth had the opportunity to practice and receive feedback on their learned skills in various types of situations. Underlying this approach is the assumption that skills acquisition is improved when the new material is applied to situations that culturally resonate with, and are developmentally indexed to, youth.

Improved scores on coping, media literacy, self-efficacy, and social self-efficacy suggest that intervention-arm youth acquired and integrated their learning. Likewise, the acquisition of refusal skills implies that the program's lessons were incorporated into intervention-arm youth's response repertoires. Improvements to these social competency skills will ideally antecede behavioral changes once youth enter

TABLE 3. Marginal estimate means (standard errors) of risk and protective factors between intervention (tx) and control participants

Variable	Posttest			1-year follow-up			2-year follow-up			3-year follow-up		
	Control M (SE)	Tx M (SE)	F(1, 548)	Control M (SE)	Tx M (SE)	F(1, 542)	Control M (SE)	Tx M (SE)	F(1, 531)	Control M (SE)	Tx M (SE)	F(1, 536)
Depression	0.75 (0.09)	0.99 (0.10)	4.67*	0.88 (0.09)	0.83 (0.11)	0.95	0.92 (0.10)	0.99 (0.11)	0.59	1.03 (0.10)	0.96 (0.12)	0.45
Anxiety	0.61 (0.09)	0.88 (0.11)	1.98	0.72 (0.10)	0.78 (0.11)	0.85	0.78 (0.11)	0.97 (0.12)	0.38	0.94 (0.11)	0.79 (0.13)	1.07
Coping	2.99 (0.04)	2.92 (0.04)	1.12	3.00 (0.02)	2.95 (0.02)	1.32	2.92 (0.04)	2.96 (0.05)	2.24	2.85 (0.05)	2.99 (0.07)	2.48*
Goal setting	2.06 (0.08)	1.97 (0.09)	1.76	2.10 (0.08)	1.98 (0.10)	2.10	2.17 (0.08)	1.89 (0.10)	2.01	2.24 (0.08)	1.95 (0.10)	2.04
Problem solving	3.19 (0.07)	3.07 (0.08)	0.02	3.21 (0.06)	3.09 (0.07)	0.08	3.10 (0.07)	3.11 (0.08)	0.77	3.18 (0.07)	3.17 (0.09)	0.97
Media literacy	3.07 (0.07)	3.35 (0.08)	3.56	3.17 (0.07)	3.42 (0.08)	2.39	3.08 (0.07)	3.51 (0.08)	3.54*	3.27 (0.07)	3.48 (0.08)	2.53*
Self-efficacy	3.07 (0.05)	3.00 (0.06)	0.36	2.98 (0.05)	3.10 (0.06)	5.12**	2.97 (0.05)	3.13 (0.06)	5.32***	3.09 (0.05)	3.15 (0.07)	3.61*
Social self-efficacy	3.15 (0.09)	2.85 (0.11)	0.16	2.94 (0.10)	3.15 (0.11)	3.09*	2.97 (0.09)	3.10 (0.11)	2.96*	3.07 (0.09)	3.18 (0.11)	2.65*
Peer use	0.28 (0.05)	0.36 (0.06)	1.16	2.85 (0.39)	2.53 (0.44)	0.24	0.58 (0.07)	0.49 (0.08)	0.36	0.57 (0.08)	0.73 (0.09)	0.73
Refusal skills												
Alcohol	2.67 (0.15)	3.05 (0.17)	5.67*	2.88 (0.15)	2.92 (0.17)	1.71	2.93 (0.14)	3.14 (0.17)	0.93	3.27 (0.14)	2.94 (0.17)	1.04
Marijuana	3.57 (0.08)	3.34 (0.09)	3.76	3.35 (0.09)	3.46 (0.10)	2.37	3.19 (0.09)	3.49 (0.11)	3.17*	3.04 (0.09)	3.37 (0.11)	2.38*
Tobacco	2.21 (0.16)	2.97 (0.18)	4.91*	2.60 (0.16)	2.90 (0.19)	1.22	2.79 (0.15)	3.00 (0.18)	1.45	2.95 (0.15)	3.02 (0.18)	0.87

Notes: Generalized linear model (GLM) repeated measures assessed the effect of intervention on risk and protective factors from baseline to each of the follow-up measurements (i.e., posttest, 1-year, 2-year, and 3-year post intervention), controlling for demographic variables. At posttest, control *n* = 299 and intervention *n* = 255; at 1-year follow-up, control *n* = 286 and intervention *n* = 262; at 2-year follow-up, control *n* = 287 and intervention *n* = 250; at 3-year follow-up, control *n* = 303 and intervention *n* = 269. **p* < .05; ***p* < .01; ****p* < .001.

the highest risk years for the onset of drug use. The lack of improvement to problem solving and coping is disappointing and puzzling given the nature of the program. Perhaps the intervention provided insufficient dosage, ineffective intervention content, insensitive measures, or some combination of these factors. That improvements in mood were undetected is less puzzling because of the refractory nature of these traits.

The strengths of this study include a relatively large sample of Hispanic youth living in 31 states and Puerto Rico, and the 1-, 2-, and 3-year follow-up measurement periods that tested the durability of the prevention program effects. Sample retention rates were sufficiently strong to permit conclusions about program efficacy. Delivering prevention program content via a smartphone app was a novel feature. This aspect of the study demonstrates a growing value because of youth's increased reliance on their phones for information, communicating with others, and completing schoolwork, as well as other tasks of daily living.

Several limitations accompany the interpretation of the study findings. When responding to measurement surveys, youth may not have accurately described their behavior, particularly their drug use (Brener et al., 2003). There also remains a possibility that Hispanic youth may have feared that disclosing illegal behavior could place them, their families, and their communities at risk (Richardson et al., 2003).

Another potential limitation was the higher levels of education and acculturation in this sample as compared with the general Hispanic population. One third of study youth spoke only English or mostly English at home, a slightly higher percentage than all U.S. Hispanic youth (Krogstad et al., 2015). Roughly one third of youth in the study reported that their parents had completed more than 2 years of college, compared with the 16% of all Hispanic adults in this country who have achieved the same level of education (Ryan & Bauman, 2016). Together, these data point toward a greater degree of acculturation for our sample than the general population of Hispanic American youth. Consequently, youth may have reacted to and applied *Vamos* program content in ways that would not typify other samples.

Furthermore, although our analyses were able to detect intervention effects for past-month drug use (primary outcomes) and several risk and protective factors (secondary outcomes), these effects were very small to small and did not elucidate any mediating causal pathways. Therefore, despite knowing that youth assigned to the *Vamos* program reported less polydrug use, marijuana use, and alcohol use across follow-up occasions, this study cannot explain whether or to what extent the observed changes in risk and protective factors caused the reductions in drug use. Whether the small effect sizes detected in drug use are attributable to contamination within the measurement-only control arm is uncertain, but not implausible. Despite efforts to limit messaging about the study's aim to prevent drug use—particularly within recruitment materials—youth assigned to the control arm may

nevertheless have garnered some benefit by participating in a project they perceived as positive to their development.

Balancing these weaknesses against the study's outcomes and strengths allows cautious optimism. By virtue of the study design, sample size, and follow-up period, the smartphone-based prevention app appears to have had a modest positive effect over time on youth's drug use and related risk and protective factors. This study will ideally be followed by more sophisticated and creative work to develop, test, and scale up robust drug use prevention programs for Hispanic youth. Whether delivered by smartphone or another device, these interventions, like the one tested here, must be responsive to Hispanic youth, longitudinally tested, and easy to disseminate.

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