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Demographic Moderation of the Prediction of Adolescent Alcohol Involvement Trajectories

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Abstract
Several school- and family-based preventive interventions target and effectively reduce adolescent alcohol misuse. However, whether demographic groups achieve equal success with these interventions is unclear. In particular, most interventions target younger adolescents, and program effectiveness tends to be measured with majority White samples; subgroup analyses are rarely reported. We analyze longitudinal data from a sample of $N = 6189$ adolescents (40% Black, 60% White; 50% female) in 6th through 12th grade to quantify the degree to which age, race, and gender moderate the associations between seven well-known risk and protective factors (RPFs) that serve as common intervention targets. The RPFs that we study are drawn from social learning theory, problem behavior theory, and social control theory, including individual factors (positive alcohol expectancies and deviant behavior), family context (perceived parental involvement, perceived parent alcohol use, and access to alcohol), and peer context (descriptive and injunctive norms). Multilevel growth models allow us to conduct the demographic subgroup moderation analysis. Results suggest that these well-studied RPFs explain alcohol involvement to varying degrees, but they explain substantially more variation in alcohol involvement by White adolescents compared with Black adolescents. We find differential patterns of significance and of leading predictors of alcohol involvement as a function of age, race, and gender and the interactions thereof. These results indicate that the prevention field needs to better understand the RPFs affecting minority and high school youth in order to provide a stronger basis for alcohol prevention efforts.

Keywords Adolescent · Alcohol · Trajectories · Subgroups · Tailored interventions

Adolescent alcohol use is prevalent among youth in the USA. The 2017 Youth Risk Behavior Survey finds that 15.5% of students had their first drink by age 13 and 29.8% of high school students had used alcohol within the last month. Roughly 13% of high school drinkers are classified as "binge drinkers" (Kann et al. 2018).

There are a variety of risk factors for adolescent alcohol use. Preventive interventions tend to focus on potentially modifiable factors, namely individual and interpersonal factors. Preventive intervention programs abound, and several efforts have been made to identify and classify the most effective programs (Carney and Myers 2012; Griffin and Botvin 2010; Tripodi et al. 2010). Universal, school-based approaches are commonly favored for government-funded youth prevention because school attendance is mandatory in the USA and such approaches offer the opportunity to reach large youth populations, while keeping costs low (Midford 2010; Newton et al. 2012; Stephens et al. 2009).

Risk and Protective Factors

Many youth-focused universal interventions target constructs from three well-supported theoretical frameworks: social learning theory (SLT), problem behavior theory (PBT), and social control theory (SCT). We briefly review the theoretical background of these theories and highlight modifiable constructs drawn from theories targeted by universal prevention programs.

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Social Learning Theory

SLT posits that adolescent alcohol use learned through social interactions that reinforce prosocial views of drinking (Bandura and Walters 1977; Petraitis et al. 1995). *Positive alcohol expectancies*, a component of SLT, are risk factors for alcohol use throughout development. Positive expectancies predict early onset of problem drinking and frequency of use through adulthood (Chartier et al. 2010; Jester et al. 2015; Montes et al. 2017; Patrick et al. 2009). Expectations about positive social and physiological effects of substance use are shaped by an individual's observations about others and by social reinforcement (Petraitis et al. 1995).

Modeling is another major component of SLT. In a review of 22 longitudinal studies of adolescent alcohol use, all but one find that interactions with alcohol-using peers are predictive of use (Leung et al. 2014). In particular, perceptions of substance use as normative or socially acceptable are predictive of use (Newton et al. 2012). Both *descriptive norms* (perceptions about peers' behavior) and *injunctive norms* (perceptions about peers' attitudes) affect adolescent alcohol use: Pedersen et al. (2017) find that both descriptive and injunctive norms are independently significantly associated with past year alcohol use, past month use frequency, past month drink quantity, and peak number of drinks for adolescents. Social learning also occurs between parents and children, because parents model both attitudes and substance use behaviors (Griffin and Botvin 2010). *Parental drinking* directly affects children's use and misuse of alcohol (Van Ryzin et al. 2012; Vermeulen-Smit et al. 2012). In school settings, universal preventions draw from SLT by focusing on establishing norms and building positive peer affiliations (Foxcroft and Tsertsvadze 2012).

Problem Behavior Theory

PBT states that certain personality, environmental, and behavioral influences make some youth more psychologically prone to engage in socially deviant behaviors, including underage drinking (Jessor 1987). In support of PBT, Zucker (2008) finds that externalizing (i.e., *deviance*) is a consistent predictor of problem drinking outcomes from childhood through middle adulthood. Interventions incorporating problem behavior theory seek to mitigate the impact of deviant behavior as a risk factor for substance use by teaching cognitive-behavioral skills to adolescents to increase their ability to cope with stress, failure, anxiety, or low self-esteem (Botvin and Griffin 2004).

Social Control Theory

SCT states that tendencies toward deviant behavior are more likely to be acted on when an individual has weak interpersonal and social bonds (Elliott et al. 1985; Hirchi 1969; Petraitis et al. 1995). Strong bonds with role models, such as parents, encourage conventional behaviors and oppose deviance and substance use (Petraitis et al. 1995). In support of SCT, Van Ryzin et al. (2012) find that family relationship quality predicts the likelihood of use throughout an individual's transition from high school into early adulthood. Youth-focused prevention models often include a family component, because evidence suggests that *parental involvement* may influence substance use behaviors (Midford 2010). Family-based universal preventions typically focus on supporting the development of positive parental involvement by teaching parenting skills that include parental support, nurturing behaviors, and parental monitoring (Foxcroft and Tsertsvadze 2012).

Subgroup Differences

The concepts highlighted above continue to guide the development of adolescent interventions for alcohol involvement. Several universal interventions use these theories and constructs and have had moderate success in positively affecting adolescent alcohol outcomes; however, the prevention field lacks adequate information on basic demographic subgroup differences in RPFs and on subgroup differences affecting intervention effectiveness (Foxcroft and Tsertsvadze 2012). Evaluation reports often aggregate results on program effectiveness, making it difficult to assess how well interventions operate across subgroups and which subgroups were considered in the analysis: unreported subgroup effects may mask disparities in how well interventions prevent alcohol misuse across demographic groups. Such disparities are particularly concerning because preventive efforts are not equally distributed. Cultural minority adolescents are both less likely to receive preventive interventions and more likely to experience higher levels of substance-related consequences than are White adolescents (Ewing et al. 2012; Walker et al. 2003), even after considering lower baseline levels of use among younger minority adolescents (SAMHSA 2014; Witbrodt et al. 2014).

Developmental status, race/ethnicity, and gender have been suggested as moderating factors in predicting substance use trajectories (Bolland et al. 2016; Danielsson et al. 2010). Longitudinal studies examining associations between moderating demographic factors and trajectories of use have been identified as a necessary area for future research (Park et al. 2018). We attend to this call, using a large, longitudinal, community sample of adolescents in grades 6 through 12 to describe trajectories of alcohol involvement as a function of developmental status, race, and gender. To better understand how universal preventive interventions may perform across demographic subgroups, we examined the effects of

commonly intervened-on RPFs on adolescents. All factors were drawn from SLT, PBT, and SCT. Our goal is to systematically analyze subgroup differences to provide information for tailoring preventive interventions and to identify groups for whom more information about key RPFs is needed.

The sections that follow characterize the current state of knowledge on race, gender, and development-related differences in trajectories of adolescent alcohol involvement and differences among groups in the effects of RPFs on these trajectories.

Racial Identity

Several recent longitudinal studies provide support for racial differences in drinking trajectories (Cooper et al. 2008; Dauber et al. 2011; Flory et al. 2006). For instance, Dauber et al. (2011) classify adolescents into one of several drinking trajectories: abstainers, experimenters, increasers, decreasers, heavy drinkers, or problem drinkers. Within these trajectories, subgroup analyses reveal differences by race: White adolescents are more likely to be frequent or heavy drinkers, whereas Black adolescents are more likely to be abstainers, experimenters, or decreasers. Additionally, research shows that White adolescents tend to be younger at first alcohol use and have higher rates of average use, underage use, and binge drinking (Wallace and Muroff 2002), but that older Black adolescents "catch up" with White adolescents (Clark et al. 2013).

In addition to differences in trajectories, salient risk factors predict that class membership differs by race. For example, Martineau and Cook (2017) find that a lack of future orientation is a more salient predictive risk factor for Black and Hispanic adolescents, whereas peer alcohol use is more salient for White youth. In general, cross-sectional studies also support the findings that traditional psychosocial predictor variables are less strongly associated with substance use among Black adolescents (Bradizza et al. 1999; Gottfredson and Koper 1996; Newcomb and Bentler 1986; Park et al. 2018).

Gender

Evidence that adolescent trajectories of use vary by gender is mixed (Bolland et al. 2016; Chassin et al. 2002; Chen and Jacobson 2012; Wiesner et al. 2007). Male and female adolescents (ages 12–17) report similar rates of past year drinking at 19.4% and 24.1%, respectively (SAMHSA 2016). However, evidence suggests that gender-specific risk profiles arise by age 18 and contribute to adult gender disparities in alcohol use. For example, increased risk for physical and sexual assault may prevent females from engaging in heavy drinking at rates comparable to males (Schulte et al. 2009). Weichold et al. (2014) find that having a poor parental relationship is a more salient risk factor for predicting problematic alcohol trajectories in males, whereas impulsivity and an association with deviant peers is more salient for females. Likewise, Kelly et al. (2011) find that family conflict is predictive of lifetime use for adolescent girls but is not associated with use among adolescent boys. However, some risk factors (parental alcohol use, deviant behavior at school) remain predictive factors for both genders.

Developmental Stage

Evidence suggests that the optimal period for intervening in RPFs differs by developmental stage, often through interaction with other demographic variables. Chen and Jacobson (2012) find that the critical intervention period falls earlier for White and Hispanic adolescents, whereas Black adolescents use less and onset later. Findings also support that predictors of alcohol use may vary in importance by an adolescent's developmental stage. For example, maternal drinking is a significant predictor of use between ages 14–16, but is replaced by maternal attachment by ages 16–18 (Tyler et al. 2007). Case (2007) finds that the significance of 5 of 11 risk factors depends on adolescent age and gender.

Method

Participants and Procedures

The data used here came from the Context Study, which was designed to support investigation of individual and contextual factors that influence the development of substance use and other problem behaviors from early to late adolescence. The Context Study uses an accelerated cohort-sequential design that enrolled three cohorts of adolescents in grades 6, 7, and 8 from three complete school districts in three primarily rural North Carolina counties. Beginning in Spring 2002, students were surveyed in their schools every 6 months across seven data collection waves (except that wave 7 was conducted 12 months after wave 6). Because of a change in administration unrelated to our study, one of the three school districts did not participate in waves 6 or 7. Wave 7 occurred in Fall 2005. Strategies used to retain schools included an incentive ($1000/school) provided to schools for each wave of participation that could be used for any purpose the school chose (typically the purchase of supplies); an annual report for each of the three school districts that provided aggregated data on the prevalence of substance use and violent behaviors; and ongoing communication with school district personnel and school principals to thank them for their participation, coordinate the next wave of data collection, and provide each district/school with the annual report (and offers assistance in using information in the report for grant applications or health education planning purposes).

The top three rows of Table 1 illustrate the study design. In wave 1, adolescents were enrolled in all 13 middle schools in the three study school districts. Beginning with wave 2, when the oldest cohort of adolescents transitioned to high school, the school sample added all six high schools in the districts. Students were permitted to enter the study in any wave, and, in our sample, we did not exclude participants who were absent for previous waves. At each of the seven waves, adolescents completed a self-report battery that assesses mental health, peer and family relationships, and alcohol and substance use.

The current analytic sample includes data from $N = 6954$ unique participants. Of these, 50% were male; 40% identified as Black; and 60% identified as White. We excluded students with other racial identities because detecting racial differences is central to our analysis, and sample sizes in the other ethnic/racial groups are small. Participants responded to an average of 4.26 survey waves (range = 1 to 7; SD = 1.96). Black adolescents, the oldest cohort, males, adolescents whose parents had lower education levels, and adolescents from high schools 5 and 6 had significantly more missing data than did other adolescents in the study. We used multilevel multiple imputation to impute missing predictor and response values (Enders et al. 2016). Covariates and observed alcohol involvement scores informed the imputation values. Refer to the technical appendix for more information on retention rates, a detailed attrition analysis, and more information on the multilevel multiple imputation procedure.

Measures

Table 1 includes descriptive statistics for all the measures used in this study.

Control Variables

We controlled for high school membership (because the 13 middle schools fed to the 6 high schools without crossover), cohort (grades 6, 7, and 8 in wave 1), household structure (i.e., ever one-parent or always two-parent household), and the maximum education reported for either parent across all waves.

Demographic Predictors

Demographic measures include semester in school (ranging from the Spring of grade 6 to the Fall of grade 12), self-reported gender, and self-reported racial identity (Black or White). Gender and racial identity were effects coded with female and White as the base groups. The semester was centered on the Spring of grade 6 and was incremented one point for each semester increase.

Alcohol Involvement

The dependent variable, alcohol involvement, is a psychometric measure that includes indicators of alcohol consumption (i.e., quantity of use and frequency of use, binge drinking, getting drunk, getting drunk while alone, and being hungover in the past 3 months) and related consequences (e.g., unwanted sexual situations, getting in trouble with parents). A unidimensional set of items ($\alpha = .91–.94$ across all waves) is used to generate factor score estimates from a moderated nonlinear factor analysis (MNLFA) model (Bauer and Hussong 2009; Curran et al. 2014) so that we could accommodate measurement noninvariance in the relationship between items and alcohol involvement across demographic groups, including across semesters in school. Accounting for measurement noninvariance reduces the possibility that bias in structural parameters might arise as a result of differences in measurement, and doing so improved score precision (Bauer and Hussong 2009; Millsap 1998). See the technical appendix for more details on this approach.

Perceived Parental Involvement

A subset of items were taken from the "responsiveness" (e.g., "(S)he wants to hear my problems") and the "demandingness" (e.g., "(S)he tells me times when I must come home") subdimensions of the Authoritative Parenting Index (Jackson et al. 1998). Adolescents were asked to report on both mothers and fathers when applicable. Four response options ranged from "not at all like him/her" to "a lot like him/her." As expected, items on the Authoritative Parenting Index were best described by two factors: responsiveness and demandingness. We constrained the measurement models for maternal and paternal responsiveness and demandingness to be configurally invariant, indicating that these models have the same meaning, but we allowed factor loadings and item thresholds to vary by parent. Factor score estimates generated by each of these scales were averaged across both factors and across both parents to create a single measure of parental involvement. Doing this allowed us to accommodate different household structures. Alpha coefficients for items measuring parental involvement ranged from .82 to .86 across all waves.

Perceived Parental Alcohol Use

In each wave, adolescents separately reported on their mother's and father's drinking, with items asking "About how many days a week do you think (s)he drinks now?" Four response options ranged from "none" to "5–7 days." A "do not know" option was also included. To accommodate different household structures, we averaged mother and father drinking frequency. Because of sparse data patterns, we

Table 1 Descriptive statistics by school semester and grade level: mean (SD) or percent

	S6	F7	S7	F8	S8	F9	S9	F10	S10	F11	F12
Waves	1	2	1, 3	2, 4	1, 3, 5	2, 4, 6	3, 5	6, 7	4, 5	6, 7	7
No. of school districts	3	3	3, 3	3, 3	3, 3, 3	3, 3, 2	3, 3	2, 2	3, 3	2, 2	2
N	1595	1546	3040	3000	4265	3566	2814	2870	1262	1390	552
Parent education*	3.04 (1.57)	3.10 (1.56)	3.06 (1.55)	3.09 (1.53)	3.04 (1.53)	3.04 (1.50)	3.02 (1.51)	3.00 (1.50)	3.02 (1.50)	2.95 (1.48)	2.99 (1.45)
Black*	42%	41%	42%	41%	40%	39%	39%	43%	37%	50%	47%
Male*	50%	50%	48%	48%	48%	48%	49%	48%	49%	46%	45%
One parent*	18%	18%	19%	18%	18%	20%	19%	20%	19%	20%	20%
Alcohol involvement	− .02 (.48)	.27 (.55)	.48 (.52)	.70 (.57)	.86 (.55)	1.05 (.60)	1.15 (.59)	1.25 (.57)	1.35 (.57)	1.35 (.52)	1.46 (.53)
Perceived parental involvement	.23 (.71)	.15 (.74)	.13 (.75)	.08 (.77)	.01 (.77)	− .01 (.76)	− .08 (.79)	− .05 (.78)	− .07 (.79)	− .09 (.79)	− .10 (.79)
Perceived parental alcohol use	.56 (.74)	.60 (.74)	.62 (.74)	.66 (.76)	.65 (.76)	.67 (.76)	.67 (.78)	.65 (.76)	.66 (.76)	.58 (.74)	.57 (.73)
Injunctive norms	.25 (.43)	.33 (.47)	.37 (.48)	.45 (.50)	.49 (.51)	.58 (.51)	.64 (.52)	.64 (.52)	.69 (.52)	.66 (.51)	.72 (.52)
Descriptive norms	.80 (.93)	1.02 (1.02)	1.15 (1.05)	1.29 (1.08)	1.41 (1.07)	2.10 (1.10)	2.22 (1.09)	2.33 (1.08)	2.45 (1.03)	2.51 (1.02)	2.54 (1.05)
Positive expectancies	.44 (.66)	.53 (.71)	.57 (.74)	.65 (.78)	.68 (.78)	.79 (.81)	.86 (.82)	.86 (.83)	.91 (.83)	.85 (.82)	.85 (.80)
Deviance	−.13 (1.29)	−.03 (1.59)	.26 (1.33)	.47 (1.34)	.66 (1.23)	.92 (1.15)	1.03 (1.06)	1.18 (1.09)	1.38 (.92)	1.49 (1.06)	1.56 (.77)

F, Fall; *S*, Spring; Spring of grade 11 was not assessed for any participant so this column is omitted from the table

*Time invariant measures

reduced response options to "0" (no parent alcohol use), "1" (an average of 1–2 days per week), and "2" (an average of 3 or more days per week).

Ease of Access to Alcohol

Participants were asked "If you wanted to, how easy or hard would it be for you to get alcohol (beer, wine, wine coolers, liquor?" Four response options ranged from "very easy" to "very hard." Ennett et al. (2016) show this item is indicative of tolerant parental alcohol socialization.

Injunctive Norms about Alcohol Use

In each wave, students were asked to name up to five of their closest friends. Then they were asked to consider these five individuals and rate how many of them drink alcohol (four response options ranged from "none" to "most or all") and how these friends would feel if the participant drank alcohol or got drunk from drinking alcohol. The four-point response options to the latter questions ranged from "dislike it a lot" to "like it a lot." Responses to the three items were averaged. The predictive utility of these social network measures was established by Ennett et al. (2006).

Descriptive Norms about Alcohol Use

Students were asked "At your school, about how many students your age do you think drink alcohol (beer, wine, wine cooler, or liquor)?" The five response options ranged from "almost none" to "almost all." This item was patterned after similar widely used items used in multiple substance use prevention program evaluation studies.

Positive Alcohol Expectancies

Students were prompted with the following question: "Do you believe that drinking alcohol one or more days would bring you…" Seven response options ranged from "only good things" to "only bad things." Because of sparseness, we collapsed response options to "0" (completely negative), "1" (more negative than positive), or "2" (neutral or positive).

Deviant Behavior

Deviance was measured by seven unidimensional items from the Problem Behavior Frequency Scale (Farrell et al. 2000). For each of these items, students reported the frequency with which they engaged in each of the following behaviors during the past 3 months: skipped school, cheated on a test, damaged property, been in a fight with hitting, threatened to hurt a teacher, threatened someone with a weapon, and hit/slapped someone else. Five response options ranged from "none" to "10 times or more." Cronbach's alpha for items on this scale ranged from .75 to .90 across all waves. MNLFA-based factor score estimates were generated from these items (see the technical appendix).

Data Analysis

Data were restructured to allow the developmental stage to be indexed by semester in school, rather than by wave (Biesanz et al. 2004). Missing data induced by this restructuring were handled using a full information maximum likelihood estimator; as mentioned above, all data that were truly missing were imputed using multilevel multiple imputation in M*plus* (v. 8.1) (see technical appendix). Trajectory models were estimated using SAS Proc Mixed to allow for random effects of individuals. Nesting of students within the six high schools was accounted for using fixed effects.

The technical appendix details our modeling strategy. Briefly, the first step in data analysis was to identify the functional form of change over time for alcohol involvement. We chose to estimate a piecewise linear trajectory model that enabled us to model the discontinuity in trajectory slopes in middle and high school. All models included fixed and random intercepts, fixed and random slopes for grade and semester, fixed effects of dummy-coded school level, and a fixed interaction term between school level and grade. Because only six high schools were in the sample, school membership was included as a fixed (rather than random) effect.

To model demographic differences in trajectories of alcohol involvement, we included the main effects of race, gender, their interaction, and their interactions with semester and school level (i.e., middle or high). RPFs were included in the model as time-varying effects predicting concurrent alcohol involvement, along with interactions between RPFs and grade and semester, demographics, and all three-way interactions between each RPF and all possible combinations of grade and semester and demographics. We permitted three-way interactions, but higher-order interactions were not tested.

Because seven RPFs were assessed in an exploratory manner, we used the Benjamini-Hochberg procedure to retain a false discovery rate (FDR) of 5%. Thissen et al. (2002) describe how to implement this procedure. Because interactive effects were included in our models, the FDR correction was applied to a likelihood ratio test (LRT) comparing the deviance of a model without the RPF to the deviance of a model with the main effect of the RPF and all interaction terms involving that variable. To accomplish this with multiple imputed datasets, we computed the average deviance obtained across imputations and conducted an LRT on those averages. We interpreted interactions associated with RPF models for which the likelihood ratio test remained significant after applying the FDR correction. We graphically probed significant interactions to aid with the interpretation that we present here.

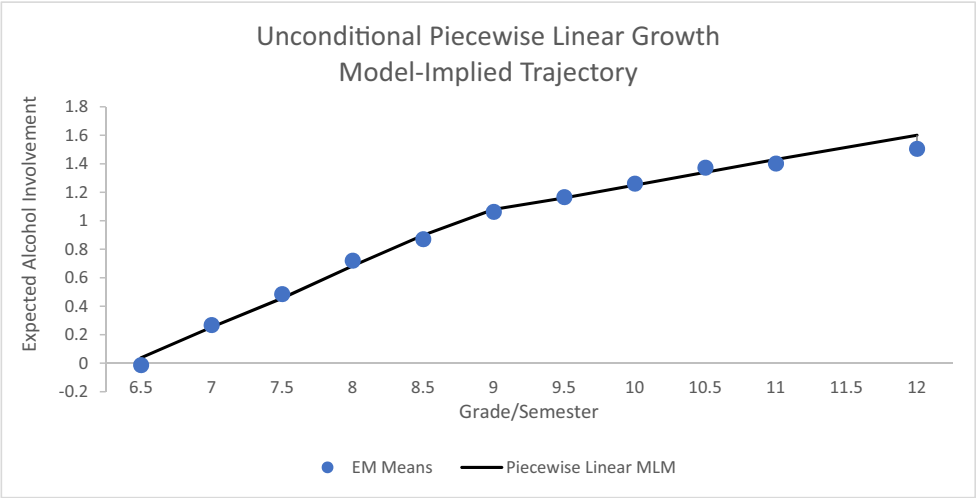

Fig. 1 Piecewise trajectory model for alcohol involvement with knot point between middle and high school. Expectation maximization (EM) means are included as points to demonstrate goodness of fit of the trajectory model to the data

For a purely descriptive comparison of variance in alcohol involvement that was explained by the full set of hypothesized predictors, we ran post hoc analysis with all RPFs simultaneously included in a model predicting alcohol involvement in stratified subsamples of adolescents that were defined by the following criteria: middle school versus high school, White versus Black, and male versus female. To eliminate data dependence in this descriptive post hoc analysis, we randomly sampled one middle school observation per individual and one high school observation per individual. We calculated the R^2 in alcohol involvement for the multiple regression in each of the eight subgroups that controlled for parental education, household structure, school membership, cohort, and semester.

Results

Trajectories of Alcohol Involvement

After we identified the optimal form for the unconditional piecewise linear growth model (see Fig. 1), we added covariates and demographic predictors. In this model, alcohol involvement increased faster during middle school than during high school, but involvement continued to increase throughout this developmental period for all subgroups. Adolescents living in a single-parent home tended to have higher levels of alcohol involvement (β = .17; SE = .02), and parental education was slightly protective (β = − .04; SE = .01). Black adolescents reported lower levels of alcohol involvement in the Spring of grade 6 (β = − .18; SE = .01), and they also had slower rates of growth in alcohol involvement over time (β = − .06; SE = .01). Of note, however, levels of alcohol involvement were not so low among Black-identified adolescents so as to preclude prediction due to a restricted range. Male students had lower levels of alcohol involvement than did females in the Spring of grade 6 (β = − .22, SE = .03), but their alcohol involvement grew at a faster rate per semester (β = .02; SE = .01). The interaction between race and gender was not significant.

After examining group-level differences in alcohol trajectories, we tested for group-level moderation of RPFs for alcohol involvement. All LRTs comparing models with and without RPFs as moderators remained statistically significant after applying the Benjamini-Hochberg FDR correction; thus, we interpreted all moderator effects. Table 2 includes a full summary of model results. All RPFs had a significant effect on alcohol involvement in the expected direction. Significant moderation effects have been described in the text.

Positive Alcohol Expectancies

Positive expectancies about alcohol were positively associated with alcohol involvement (β = .30; SE = .01) consistently over time, but there were significant main effects of race and gender, along with a significant interaction between race and gender, such that the effect of positive alcohol expectancies was β = .18 for all Black adolescents, regardless of gender, but there was a stronger effect of positive expectancies for White males than for White females (β = .34 for White males vs. β = .30 for White females).

Deviance

Deviance consistently predicted increased alcohol involvement over time (β = .16; SE = .02). This effect was not moderated by racial identity, but the effect was weaker for males (moderation β = − .06; SE = .02, implying an effect of .10 for males).

Table 2 Results of multilevel growth models predicting alcohol involvement from risk and protective factors (RPF), moderated by adolescent demographic characteristics

	Parental involvement		Parent alcohol use		Ease of access		Injunctive norms		Descriptive norms		Positive expectancies		Deviance	
Predictors	Est	SE	Est	SE	Est	SE	Est	SE	Est	SE	Est	SE	Est	SE
Intercept	***.42***	.03	***.45***	.03	***.44***	.03	***.45***	.03	***.48***	.03	***.43***	.03	***.51***	.03
Semester	***.32***	.01	***.32***	.01	***.30***	.01	***.30***	.01	***.29***	.01	***.30***	.01	***.30***	.01
School level	***.08***	.02	***.08***	.02	**.07**	.02	*.05*	.02	**−.07**	.02	.04	.02	**.07**	.02
Semester × school level	***−.18***	.01	***−.18***	.01	***−.17***	.01	***−.17***	.01	***−.17***	.01	***−.17***	.01	***−.18***	.01
Race	***−.17***	.03	***−.16***	.03	***−.17***	.03	***−.19***	.03	***−.24***	.03	***−.18***	.02	***−.21***	.03
Gender	***−.19***	.03	***−.21***	.03	***−.22***	.03	***−.23***	.02	***−.17***	.03	***−.25***	.02	***−.25***	.03
Semester × race	***−.05***	.01	***−.06***	.01	***−.05***	.01	***−.05***	.01	***−.04***	.01	***−.04***	.01	***−.05***	.01
Semester × gender	***.02***	.01	***.02***	.01	**.02**	.01	***.02***	.01	**.02**	.01	*.01*	.01	***.02***	.01
School level × race	−.04	.03	−.03	.03	−.03	.03	−.02	.03	.06	.03	−.02	.03	−.03	.03
School level × gender	−.05	.03	−.06	.03	−.04	.03	−.05	.03	−.04	.03	−.04	.03	−.05	.03
Race × gender	−.05	.03	−.03	.03	−.03	.03	−.02	.03	−.06	.03	−.02	.03	−.01	.03
RPF	***−.11***	.01	***.13***	.01	***.16***	.01	***.17***	.02	***.24***	.01	***.30***	.01	***.16***	.02
RPF × semester	.01	.004	.00	.004	.00	.005	*−.01*	.001	.00	.01	.00	.002	.01	.003
RPF × school level	−.03	.02	.03	.02	.01	.02	.03	.02	.03	.02	.02	.02	.01	.02
RPF × race	***.07***	.02	**−.05**	.02	*−.04*	.02	***−.07***	.02	***−.13***	.02	***−.12***	.01	**−.06**	.02
RPF × gender	−.01	.02	*.04*	.02	*.04*	.01	.02	.02	*.04*	.01	**.04**	.01	.00	.02
RPF × semester*race	.00	.002	*−.01*	.001	−.01	.002	.00	.01	.00	.004	.00	.003	.00	.002
RPF × semester × gender	*−.01*	.004	.00	.003	.00	.01	.01	.004	.00	.004	.00	.01	.00	.004
RPF × race × gender	−.02	.02	−.01	.03	−.04	.02	.00	.02	.00	.02	*−.04*	.02	.00	.02

Italicized cells are significant at $p < .05$. Bolded cells are significant at $p < .01$. Bolded and italicized cells are significant at $p < .001$

Perceived Parental Involvement

Perceived parental involvement was consistently protective against alcohol involvement over time for females (β = − .11; SE = .01), but the effect slightly decreased each semester for males (β = − .01; SE = .00). Additionally, the protective effect of parental involvement was not as strong for Black adolescents (moderation β = .07; SE = .02, implying an effect of parental involvement of − .04 for Black adolescents).

Perceived Parental Drinking

Students who perceived higher levels of parental alcohol consumption reported higher levels of alcohol involvement (β = .13; SE = .01). However, this effect was weaker for Black adolescents (moderation β = − .05; SE = .02) and stronger for males (moderation β = .04, SE = .02). The effect of perceived parental alcohol use on student alcohol involvement slightly decreased over time for Black adolescents (β = − .01; SE = .00), but the effect stayed constant over time for White adolescents.

Ease of Access to Alcohol

Ease of access to alcohol predicted increased alcohol involvement (β = .16, SE = .01), especially for males (moderation β = .04; SE = .01), but less strongly for Black adolescents (moderation β = − .04; SE = .01). The magnitude of the effect of access to alcohol did not change over time.

Injunctive Norms

Adolescents who perceived higher levels of peer approval for their own alcohol use reported more alcohol involvement. This effect was strongest in the Spring of grade 6 (β = .17; SE = .02), and it decreased each semester (β = − .01, SE = .00). The effect of injunctive norms was not as strong for Black adolescents (moderation β = − .07; SE = .02).

Descriptive Norms

Beliefs about alcohol consumption among classmates increased alcohol involvement (β = .24; SE = .01). This effect was consistent over time, but it was weaker among Black adolescents (moderation β = − .13; SE = .02) and stronger among males (moderation β = .04; SE = .01).

Variance in Alcohol Involvement Explained by Demographic Group

We found large variation in how well the seven RPFs (together with the control variables) explained alcohol involvement and both similarities and differences with respect to leading explanatory drivers of alcohol involvement across these groups (Table A3).

The models consistently explained less variation in alcohol involvement among Black adolescents (R^2 ranging from .31 to .38 for Black adolescents and from .44 to .53 for White adolescents) when compared with their White counterparts in the same semester and of the same gender. Furthermore, alcohol involvement among high-school-aged students was more poorly explained by this set of predictors than was alcohol involvement among middle-school-aged students (R^2 ranging from .31 to .45 for high school and from .38 to .53 for middle school). There were no consistent effects of gender on variance explained.

Discussion

Our goal was to explore subgroup differences in patterns and the degree to which established RPFs commonly targeted by preventive interventions predict alcohol involvement. An additional contribution of the study was that we measured alcohol involvement using a MNLFA, thereby mitigating the possibility that the observed subgroup moderation effects are artifacts of measurement noninvariance.

The RPFs considered here explained a moderate level of variation in alcohol involvement, with about equal variance explained for males and females, but with substantially less variance explained for Black-identified adolescents and for older adolescents.

Across all groups, the most common factors targeted by prevention programs—positive alcohol expectancies and normative beliefs about peer alcohol use—were significantly, uniquely associated with alcohol involvement. However, the strength of the associations was attenuated for high school students and Black adolescents. The positive alcohol expectancies predictor was a consistent leading predictor of effect size. Injunctive norms were also significantly associated with alcohol involvement for all groups, except for Black males in middle school. Although some unique effects of parental involvement were significant, these predictors consistently exhibited weak, unique effects across all subgroups. Whereas injunctive and descriptive norms were stronger predictors of alcohol involvement for White compared with Black adolescents, perceived parental alcohol use and the ease of access to alcohol were more predictive for Black than for White adolescents.

Racial disparities in prediction of alcohol involvement based on a comprehensive set of established RPFs point to a need for additional research focusing on Black adolescents. It might be argued that the disparity in predictive power of the model may come from Black adolescents reporting lower levels of alcohol involvement (cf Gottfredson and Koper

1996). However, many Black adolescents participate in underaged alcohol use, and use grows over time from grades 6 to 12, and our use of a psychometric approach to score alcohol involvement produced a measure with substantial continuous variation across all groups. This argument is further counteracted by our finding that more variation in alcohol involvement was predicted among younger adolescents, who use alcohol at substantially lower rates than do older adolescents.

In 2008, the National Institute on Drug Abuse established a strategic goal of reducing and eliminating ethnic and racial disparities, including efforts to understand the causes of drug abuse across racial groups and improve preventive programs for these groups. Similarly, the National Institute on Alcohol Abuse and Alcoholism established reducing health disparities as a strategic goal for 2017–2021, citing evidence that racial and ethnic minorities who use alcohol are at higher risk for problematic drinking than are Whites who use alcohol. Results from our analysis suggest that racial disparities persist in how effectively preventive intervention programs reduce alcohol involvement. These findings underscore the importance of conducting randomized control trials of preventive interventions with nonhomogenous samples, powering the studies on detection of subgroup differences, and reporting whether interventions are effective for certain subgroups. This recommendation is in line with the principles of reporting degree of generalizability and conducting population subgroup analyses that were put forth in the Next Generation Standards of Evidence for Prevention Science (Gottfredson et al. 2015). Methodological concerns aside, meta-analyses have shown that although school-based programs exert statistically consistent effects on substance use, effect sizes are small (Midford 2010; Soole et al. 2008; White and Pitts 1998).

Our results suggest that these already small effect sizes may be attenuated for Black and older adolescents. Further research on tailoring interventions to subgroups could increase combined effect sizes. For example, one popular evidence-based school program (LifeSkills Training) finds that culturally tailoring universal curriculum significantly increases the effectiveness of a general skills intervention (Botvin et al. 1995). Preventive interventions targeting alcohol involvement among Black adolescents should begin to consider a broader range of RPFs not usually made the focus of school-based prevention programs. Growing evidence supports differences in RPFs by race and ethnicity. Choukas-Bradley et al. (2015) find that popularity and alcohol use are associated for White and Latino adolescents, but not Black adolescents. Terling Watt and McCoy Rogers (2007) also find that Black females are less influenced by peers than are White females, and Black males are more influenced by supportive families than are White males. Although further research is warranted, existing evidence suggests a wide variety of potential explanations for racial differences in alcohol use, including differences in alcohol norms, attributions, consequences, community values, and the cultural meaning of alcohol use (Choukas-Bradley et al. 2015; Seffrin 2016; Terling Watt & McCoy Rogers 2007). Additionally, Terling Watt and McCoy Rogers (2007) find that although Black and White adolescents differ in their sociodemographic profiles, including these factors as controls does not eliminate differences between Black and White adolescents in alcohol use. The authors conclude by cautioning against studies that control for race and ethnicity or socioeconomic status and then consider their results to be applicable to all subgroups (Terling Watt & McCoy Rogers 2007). Moving forward, preventive intervention evaluations should be mindful of the potential for moderating effects by race and ethnicity when analyzing and reporting outcomes.

In addition to racial disparities in predicting adolescent alcohol involvement, we also found differences by developmental stage. Even though younger adolescents reported less alcohol involvement, the RPFs that we investigated were more effective for predicting the alcohol involvement of younger youth. This finding aligns with fewer preventive interventions existing to target high school students compared with middle school students. In a review of 127 interventions, Spoth et al. (2008) find only one promising intervention for high school populations. This intervention focused on providing motivational activities to avoid drug use, teaching self-control, communication, acquiring resources, and decision-making strategies (Rohrbach et al. 2010). Interventions for high school students may benefit from a focus on different risk and protective factors than those presented in this analysis.

Limitations

Our intention was to use secondary data from a large, diverse, longitudinal study to model demographic moderation of the effects of theoretically based RFPs for alcohol involvement often targeted by prevention programs. The causal effects of the RPFs that we studied have been well established, but the effects we estimated were cross-sectional and exploratory. Thus, the relative magnitude of the causal component of estimated predictor effects may not follow the same rank ordering as the correlation-based predictor effects that we estimated. Nevertheless, we would not expect for this limitation to affect our statistical conclusions about subgroup differences in predictor effects. Furthermore, although the Context Study included a comprehensive set of measures, we were not able to test all possible RPFs that have been identified in the literature. For instance, we did not have a measure of alcohol refusal skills, a known predictor of alcohol use among younger adolescents and a frequent target of prevention programs (Newton et al. 2014).

Not all adolescents responded to every wave for which they were eligible, and demographics were associated with attrition. We incorporated all study covariates (including demographics known to be associated with missingness) and all

observed measures of alcohol involvement into our multilevel multiple imputation models. As such, we have minimized bias associated with conditionally random missingness (i.e., missing at random) and with non-random, trajectory-based missingness (i.e., random coefficient non-random missingness; Gottfredson et al. 2017).

Although we used cutting-edge psychometric methodology to minimize measurement bias when possible, some constructs were measured with a single item; thus, estimated effects of these construct may have been attenuated or biased by differential measurement properties across demographic groups. Additionally, all measures were based on adolescent self-reporting. To the extent possible, over- or underreporting of alcohol use and related constructs was minimized through the use of anonymous surveys. The RFP measures were intended to measure adolescent perceptions, so self-reporting was an appropriate format for collecting this information. Another measurement-related limitation was the alcohol involvement score, because the dependent variable was skewed right for younger grade levels. In turn, the precision of the predictor effects and their standard errors may have been suboptimal in these earlier grades.

A final limitation of this study, and a potential future direction, is that the effects of RPFs represented *aggregate* effects; that is, we did not use person mean centering to parse variation in RPFs into stable, between-person components and time-varying, within-person components (Raudenbush and Bryk 2002). The implication of this simplifying decision is that time-varying predictors comprise an amalgamation of stable traits and situational characteristics. The decision to retain aggregated effects was made because model complexity was already high and the question of parsing within-person and between-person effects of RPFs was not central to our research question.

Conclusion

Results presented in this manuscript are drawn from analyzing a large, diverse, longitudinal sample of adolescents and suggest that the effects of "universal" risk and protective factors on alcohol involvement widely vary across demographic groups, notably by racial identity, age, and gender. Results suggest that more research on RPFs among Black adolescents is needed. Undoubtedly, the same is true for youth of other minority groups. If the goal of reducing and eliminating racial disparities in substance use is to be met, such research is needed for guiding the development of interventions that consider subgroup differences, ultimately improving program effectiveness.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval The study was approved by the UNC Institutional Review Board.

Informed Consent All participants in this study consented to participate after parents assented.

Disclaimer The content of this manuscript is solely the responsibility of the authors and does not represent the official views of the NIH.

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