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The Community Epidemiology of Underage Drinking: Variation Across Communities in Relations of Risk to Alcohol Use

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Abstract

To test the assumption embedded in state-of-the-art, community assessment and decision-making regarding prevention of underage drinking: that there is minimal variation in the way that risk and protective factors (RPF) are associated with underage drinking across communities. Three large datasets provided the same measures of adolescent alcohol use and RPFs. Multilevel ordered-logistic regression models were carried out separately for each data-set and separately for males and females in 8th and 10th grades, testing random slopes for each RPF index. Predicted school-level coefficients were derived from these models, representing the association between RPFs and alcohol use. The variation in associations between RPFs and alcohol use across schools was greatest for antisocial peer risk and community protection; the lowest variation across schools was found for family cohesion and individual antisocial behavior. Ranges in predicted coefficients indicate large differences across schools for many RPFs. Bivariate correlations indicated that school-level associations vary across RPFs in expected directions. Policy makers should recognize that the magnitude of associations between RPFs and adolescent alcohol use vary considerably across communities, and that such variability is greater for certain RPFs than others. These findings have implications for policies regarding how prevention resources are targeted within and across communities.

Research on risk factors predicting adolescent substance use has generated replicable results indicating that a range of risk and protective factors (RPFs) are linked to early substance use. Based on these findings, numerous prevention programs have been developed that target a range of risk factors, with varying degrees of success. A logical, coherent, and persuasive model for assisting communities in deciding which risk factors to target with which programs was developed 20 years ago by David Hawkins and Richard Catalano: Communities That Care (CTC; Hawkins and Catalano 1992). The core principles of the CTC model have been incorporated into U.S. federal initiatives for the prevention of substance use and other problem behaviors. It is our intent to examine a key assumption of this approach—namely that risk and protective factors are equally salient across communities. Due to the importance of the question, and the potential for different answers across datasets due to differing samples and procedures, we address this question with parallel analyses of three large datasets. Further, we believe this approach can serve as an example for other areas of public health in which prevention decisions are made for communities yet risk factors have been studied largely at the individual level—e.g., obesity, cancer, cardiovascular disease, child maltreatment. Finally, estimates of the effects of risk factors on problem behaviors should account for the clustering of risk and substance use at

the community level; in examining the degree of variability in risk-outcome associations, we are also able to provide estimates of the predictiveness of risk factors taking such clustering into account.

In the last two decades, increasing interest has been focused on the effects of neighborhoods and communities on children's and adolescents' health, academic performance, delinquency, and substance use (Brooks-Gunn et al. 1997; Ennett and Haws 2010; Ennett et al. 1997; Hogan and Kitagawa 1985; Lee 2002; Leventhal and Brooks-Gunn 2000; Novak et al. 2006; Sampson et al. 2002a, b; Wilson 1987). Research on community effects in the area of substance use and antisocial behavior is still at an early stage and findings to date have been inconsistent, ranging from findings of no influence, limited influence, or strong influence on levels of substance use (Allison et al. 1999; Andreas and Watson 2010; Ennett et al. 1997; Newcomb and Felix-Ortiz 1992). Moreover, findings regarding differences between communities in the elevation or severity of risk factors or substance use rates may vary across different risk factors and substances (Ennett et al. 1997). However, the emerging body of work on such community differences has only intermittently touched on the issue we address in this paper: whether the *relations* between risk factors and outcomes vary across communities.

CTC and C-Dx (Community Diagnosis)

One practical reason for examining patterns of health at the community level (defined variably, ranging from school catchment areas, neighborhoods to counties) is that the community is the level at which public health programs are typically implemented. In some cases, the intervention itself occurs at the level of the community—as in the case of “environmental” interventions such as community-based enforcement of age limits for alcohol purchase, traffic checks for driving under the influence, and so forth (Holder et al. 2000; Wagenaar 2000). Yet, even for interventions directed to individuals (e.g., a nurse's home visit to a pregnant mother), practicalities usually entail an organized community-level entity (for example, an agency, hospital, or school) implementing the program. Although some implementing organizations (e.g., schools) admit or encourage more civic influence on decision-making, resource allocation, and implementation than other organizations (e.g., for-profit health care providers), no community-based organization is completely isolated from the formal and/or informal influence of other local actors. Further, many intervention selection and resource allocation decisions are made either by municipalities or by higher-level entities such as counties or states based on community needs and the flow control of federal and state funds.

CTC aims to infuse prevention science principles into a community's approach to preventing adolescent behavior problems such as substance use, risky sex, school dropout, and violence (Hawkins and Catalano 1992). Each CTC community creates a “Prevention Board”—a local coalition of activists, residents, agency staff, and political decision makers—that undertakes an assessment of local RPFs. For the past decade, we have been studying dimensions of the CTC process such as community readiness, technical assistance, and sustainability (Feinberg et al. 2002, 2004a, b, 2008). The model is elegant and both a randomized efficacy trial and quasi-experimental effectiveness study have shown improvements in population-based outcomes for youth (Feinberg et al. 2007a, 2010; Hawkins et al. 2007). CTC is now disseminated internationally in Canada, Australia, and several European countries.

The advances in community prevention led by the development of CTC have been generalized in an emerging best practice we call “Community Diagnosis” (C-Dx). In this model, communities systematically assess and identify risk factors that are elevated

compared to national and state norms, and then select preventive interventions targeting those elevated risk factors. This approach is currently being disseminated in the U.S. by the Center for Substance Abuse Prevention (CSAP); not only does CSAP own and disseminate CTC materials, but the C-Dx model forms the basis of CSAP's strategic prevention framework. The C-Dx model has been recognized and incorporated into community prevention policy initiatives sponsored by the Justice and Education Departments, as well as the Office of National Drug Control Policy.

Implicit Assumptions

It has been noted that there are several assumptions built into the C-Dx model that serve a simplifying function in the translation of science to practice (Feinberg 2012). However, if these assumptions are not valid, the C-Dx model might be refined in order to achieve even stronger outcomes for communities. In a prior empirical paper, we examined one of those assumptions: whether individual risk and protective factors have equivalent influence on alcohol use (Jones et al., A multi-domain approach to understanding risk for underage drinking, unpublished). Our analyses across five large data-sets indicated that some RPF indices, such as antisocial peer associations and individual antisocial attitudes, may have a large influence whereas others had a much smaller potential influence. Those results indicated that assessing the simple elevation of a risk factor would be insufficient as a guide to making decisions, as a risk factor may be elevated but only modestly predictive of alcohol use. This work, both in the range of RPFs and the number of communities/youth included in analyses, represents the most comprehensive assessment of the relative magnitudes of RPFs in the US for alcohol use of which we are aware.

In the current paper, our aim is to empirically examine a second assumption—the consistency assumption—embedded in the prevalent form of the C-Dx model. Our tendency as scientists is to seek universal laws, and the vast majority of research assumes the existence of “universal” pathways from risk factors to behavior problems that are robust across community contexts. However, proceeding on the assumption of universal relations across communities may impede the discovery of important local relations (Biglan et al. 2000). The influential ecological model of Bronfenbrenner would direct our attention to just such context-driven differences (Bronfenbrenner 1986); in fact, some believe it would be surprising if risk factors operated the same way regardless of community context (Gardner et al. 2010; Pickett 2001). Relations between risk and outcomes may not be universal because of (a) idiosyncratic ways that risk factors are distributed and impact outcomes that are dependent on local history and culture; or (b) systematic differences across one or more dimensions of local context such as rurality/urbanicity, average socioeconomic status (SES), social disorganization, economic growth and decline, social capital, or prevalence of the problem behavior (Cleveland et al. 2010).

Substantial variability in the associations between risk and behavior problems would present a challenge for local decision makers and policy makers. In the C-Dx model, communities seek to target risk factors that are most influential in their community or region, and typically define elevation of risk factors on the basis of a comparison with a wider population of communities. If the assumption of consistency in associations between RPFs and problem behaviors across communities is not valid, then a risk factor that is elevated in comparison to other communities may not be a desirable prevention target if it is not strongly linked to behavior problems. In other words, decision makers may need to know just how influential a risk factor is for a specific community in addition to how highly elevated it is in that community.

In previous work, we illustrated this problem through an examination of risk and ATOD (Alcohol, Tobacco, or Other Drugs) use among preadolescents in three communities (Ridenour and Feinberg 2007). We found that the levels of risk factors not only varied across communities, but also that the *associations* between risk factors and outcomes were often significantly different across the small sample of three communities. We then described how prevention strategies would be formulated differently for the three communities based on both differences in levels and within-community associations of risk and outcomes. However, this illustration was essentially a case study and there is a need for a more rigorous examination of the consistency assumption.

Others have investigated whether contexts such as school and community environments modify the impact of some risk factors on adolescent behavior problems (Beyers et al. 2001; Ennett et al. 2008; Foshee et al. 2009). Such research typically examines either differences across types of communities (e.g., rural vs urban, high vs. low SES), or assesses cross-level interactions between risk at a proximal level (e.g., individual or family characteristics) and risk at a more distal level (e.g., school or community characteristics) (Kumar et al. 2002; Swaim 2003). For example, Chuang and colleagues (2009) found differences in links between risk factors (e.g., parental and peer substance use) and adolescent substance use across neighborhood types defined by a cluster analysis of rurality/urbanicity, SES, and race.

These studies provide preliminary evidence that risk and adolescent behavior problems are associated differently across communities. However, research to date has been limited to just a handful of investigations, with little if any replication of initial results across risk factors and outcomes. Moreover, these studies tend to test differences across specific types of communities or along specific contextual dimensions. Guided by this work, we take a more general approach to the issue.

The Current Paper

One obstacle in conducting research about differences between communities is the sheer number of communities that need to be included in a single study, along with sufficient sampling within communities to estimate within- and between-community effects. Such studies are expensive to mount. Moreover, the absence of random sampling at both the level of community and individual (except if a complete census of adolescents in schools is undertaken) may lead to biased estimates. In order to help overcome these barriers, we conducted secondary data analyses with three large school-based datasets, all utilizing the same measure of RPFs and substance use: The CTC Youth Survey. This strategy allows for assessing the consistency assumption in different datasets, collected by different investigators for different purposes.

In addition, this strategy allows us to estimate the effects of RPFs on problem behavior in three different large samples *after* taking into account the clustering of individual RPFs and alcohol use scores across communities. As most research on these topics has examined individual-level associations between RPFs and problem behaviors without regard to non-independence of data, these results will provide refined estimates of the salience of RPFs.

We selected alcohol use as the adolescent behavior problem of interest in this study because the relatively high rates of underage drinking compared to other substances allows for greater ease in analytic modeling. Moreover, underage alcohol use is particularly relevant to public health given its association with thousands of adolescent deaths each year as well as enormous fiscal costs to society. We recognize that findings for alcohol may be different than for other substances, and these results may not generalize to tobacco, illicit drugs, or other behavior problems.

Instead of examining differences between distinct sets of communities—defined either a priori or by a statistical process (e.g., clustering, latent class analysis) based on salient aspects of communities—we aim to assess whether there are overall differences in associations among communities. Thus, we first examined whether there was variability in the way these risk indices are related to outcomes across communities by testing for the significance of random slope terms in multilevel models.

As we have done in prior inquiries, we reduced the over 30 RPFs in the CTC Youth Survey to a more limited number of risk indices covering community disorganization and substance availability, lack of prosocial opportunities/ rewards in school, negative peer influence, poor parenting/ family relations, and adolescents' antisocial attitudes and behavior (Feinberg et al. 2007b). We also limited our investigations to youth in 8th and 10th grades (roughly ages 13 and 15) for practical reasons (i.e., low rates of substance use at earlier ages would impose analytic challenges, and the increasing likelihood of biased samples at older ages when higher-risk youth drop out of school). Finally, we analyzed boys and girls separately due to indications in prior work of differences in risk-outcome associations, as well as the complications that incorporation of gender interaction terms would involve in analytic models.

After deriving model-based estimates of random slopes and summarizing these findings across gender, age and dataset, we next investigated whether the influence of risk indices varied together across communities; in other words, if a factor is more influential in predicting alcohol use in one community than another, is there a greater likelihood that a second risk factor is also more influential in that community? In this scenario, where the slopes of risk factors are positively correlated across communities, it would seem that alcohol use in some communities would be more strongly predicted by all risk factors than in other communities. Such a finding might suggest greater systematic variability in risk, in outcomes, and/or in the association between risk and outcomes in some communities compared to other communities. A different scenario would be represented by a negative correlation among risk factor slopes, indicating that if a risk factor is more influential in one community, then other risk factors are likely to be less influential in that community. The final step in our analyses was to examine whether a set of available school and community variables are associated with variability in the RPF-alcohol use slopes across communities. These last analyses are intended to provide preliminary exploration of whether indices of school resources, community poverty, school size, or racial composition are linked to variability in the predictive-ness of RPFs across communities.

Method

We used RPF data from three datasets—the *Communities that Care Normative Database (CTC-ND)*, the *Pennsylvania Youth Survey (PAYS)* and the *Diffusion Project*—to address the study aims. Each dataset consisted of cross-sectional, school-based survey data collected from students in grades 8 and 10 using the Communities That Care Prevention Needs Assessment (CTC Youth Survey; CTC-YS), a broad assessment of RPF's and problem behaviors (Arthur et al. 2002).

The Communities That Care Youth Survey Normative Database was constructed from over 300,000 survey records in 23 states collected during 2000 and 2002 (Arthur et al. 2002; Glaser et al. 2005; Hawkins et al. 2004). *The Pennsylvania Youth Survey* is a bi-annual state-funded surveillance survey with a representative sample of school districts in Pennsylvania (although other schools can voluntarily participate in an additional 'piggy-back' sample). For the current project, the sample of 118,074 students from 2007 was used. *The Diffusion Project* involves 41 communities in seven states: Colorado, Illinois, Kansas,

Maine, Oregon, Utah, and Washington (Fagan et al. 2007). The project was designed to study the development and effectiveness of state and local prevention systems using data on risk factors as the basis for prevention program planning. Data used here were collected from public school students in years 1998, 2000, and 2002.

Measures

Recent alcohol use was measured with a single item that asked youth to indicate the number of occasions that they drank alcohol in the past 30 days (response scale: zero, 1–2 times, 3–5 times, 6–9 times, 10–19 times, 20–39 times, 40 or more times). Because the distributions for all three data-sets indicated low responses for higher levels of use (right skew), we combined the highest four usage categories resulting in a four-level ordinal outcome (i.e., 0, 1–2 times, 3–5, and 6 or more). As noted above, previous research demonstrated that combined indices of the 31 scales in the CTC-YS provided meaningful and useful measures of adolescent risk and protective factors (Feinberg et al. 2007b). Based on these results, we aggregated RPF scales and items into seven indices: Community Protection, School Protection, Peer Risk, Family Risk, Family Cohesion, Individual Antisocial Behavior, and Individual Antisocial Attitudes. All RPFs are on roughly the same scale (with a mean near zero), given that sub-scales were first standardized before aggregation.

Community Protection included two scales. Laws and norms favorable to drug use and firearms was measured with six items (e.g., “How wrong would most adults (over 21) in your neighborhood think it was for kids your age to drink alcohol?” =0.78). Five items were used to measure perceived availability of drugs and firearms (e.g., “If you wanted to get some cigarettes, how easy would it be for you to get some?” =0.84). These two scales were reverse-coded before aggregation, creating an index of ‘community protection’.

The *School Protection* domain included school commitment (7 items, e.g., “How interesting are most of your courses to you?” =0.80), school opportunities for pro-social involvement (e.g., 5 items, “I have lots of chances to be part of class discussions or activities” =0.63), and school rewards for prosocial involvement (e.g., 4 items, “My teachers praise me when I work hard at school” =0.69).

Antisocial Peer Risk was assessed using four scale indices: friends’ delinquent behavior, such as carrying a handgun (4 items, =0.86), friends’ use of alcohol and other drugs (4 items, =0.83), peer rewards for antisocial behavior (4 items, e.g., “What are the chances you would be seen as cool if you began drinking alcoholic beverages regularly, that is, at least once or twice a month?” =0.82), and gang involvement (4 items, e.g., “How many of your four best friends belongs to a gang?” =0.87).

Family Cohesion was measured by family attachment (4 items, e.g., “Do you feel very closer to your mother?” = 0.75), family opportunities for prosocial involvement (3 items, e.g., “My parents give me lots of chances to do fun things with them,” =0.78), family rewards for prosocial involvement (4 items, e.g., “Do you enjoy spending time with your father?” =0.77), family supervision (5 items, e.g., “If you skipped school, would you be caught by your parents?” =0.76), and family discipline (3 items, e.g., “If you skipped school, would you be caught by your parents?” =0.72).

Family Risk was represented by three scale indices including parental attitudes favorable to ATOD use (3 items, e.g., “How wrong do your parents feel it would be for you to smoke cigarettes?” =0.82), parental attitudes favorable to antisocial behavior (3 items, e.g., “How wrong do your parents feel it would be for you to pick a fight with someone?” =0.79), and family history of substance use and antisocial behavior (10 items, e.g., “Have any of your brothers or sisters ever smoked cigarettes?” =0.74).

Individual Antisocial Attitudes were measured by four scale indices. These were favorable attitudes toward antisocial behavior (5 items, e.g., “How wrong do you think it is for someone your age to steal anything worth more than \$5?” =0.82), favorable attitudes toward alcohol, tobacco, and other drug (ATOD) use (5 items, e.g., “How wrong do you think it is for someone your age to drink beer, wine or hard liquor (for example, vodka, whiskey or gin) regularly?” =0.86), low perceived risks of drug use (4 items, e.g., “How much do you think people risk harming themselves (physically or in other ways) if they: take one or two drinks of an alcoholic beverage (beer, wine, liquor) nearly every day?” =0.83), and belief in immoral order (4 items, e.g., “I think sometimes it’s okay to cheat at school,” =0.70).

The *Individual Antisocial Behaviors* aggregate index included sensation seeking (3 items, e.g., “done something dangerous because someone dared you to do it,” =0.79), and rebelliousness (3 items, e.g., “I ignore rules that get in my way,” =0.74) and social skills (4 items, “You are at a party at someone’s house, and one of your friends offers you a drink containing alcohol. What would you say or do?” =0.63).

In order to consider how important school context predictors may impact the association between RPF and drinking, we utilized school data aggregated by the National Center for Educational Statistics (NCES) (U.S. Department of Education 2010). We utilized four variables reflecting community poverty (percent free/reduced lunch), size of the school district (total number of students), school resources (teacher-student ratio), and school demographic characteristics (percent white). These variables were selected given their importance at the school level while also being available within all three datasets; we used separate years of NCES data to match the mid-point year of the data collection timeframe for the three project datasets.

Statistical Analysis

We used multi-level ordered logistic regressions executed within SAS Proc Glimmix to accommodate the ordinal nature of the outcome as well as the nested data design (individuals within schools); these models generated log-odds coefficients for each RPF that represented the prediction of the level of alcohol use. The model incorporated a single equation predicting the four levels of alcohol use (represented by three equations with three estimated thresholds in addition to regression coefficients for each RPF). This strategy relies on the proportional odds assumption being met (Agresti 2002), whereby the prediction of alcohol use by model covariates has the same form for all levels of use. Preliminary analyses with the CTC-ND dataset indicated that the assumption was met.

The community level in our models was distinguished by school, using school ID as the clustering variable. It was determined from prior investigations (Jones et al., A multi-domain approach to understanding risk for underage drinking, unpublished) that certain RPFs had a curvilinear relationship with the likelihood of alcohol use; that is, as risk increased to high levels (or protection decreased to low levels), the linear prediction of higher probability of alcohol use tapered off. Specifically, the models included quadratic fixed-effects terms for Community Protection, Antisocial Peers, Family Risk, Antisocial Attitudes and Antisocial Behavior indices. We included youth-reported school grades as a control variable. Preliminary analyses indicated that a majority of RPF to outcome associations was significantly different for boys and girls; we thus carried out separate analyses by dataset, grade, and gender. These results also indicated that random intercept variation across schools was always significant; thus a random intercept term was specified for all models. Analyses were carried out separately for each project dataset, grade and gender combination. Because of the size of the datasets and complexity of the models, we were unable to derive random slopes for all RPFs in a single model. Thus, separate regression models were

implemented that included fixed effects for all seven RPFs, a random intercept, and a random slope for a *single* RPF. Thus, a total of 28 models were executed for each dataset; for each of the four gender/grade combinations, we implemented seven separate models in which each RPF was specified as having a random slope. A covariance test within SAS's Proc Glimmix was used to determine whether there was significant variation in the random slope term.

From each model, school-specific predicted odds-ratio coefficients for the random parameters—best linear unbiased predictions (BLUPs)—were obtained using ODS output in SAS. Using these estimates, we examined the distributions of the risk factor-to-outcome associations across schools, as well as bivariate correlations of the RPF-to-outcome associations. Fisher's Z transformation was utilized in averaging correlations across datasets, grades, and gender. Finally, we assessed associations between the NCES variables and the BLUP coefficients.

Results

Descriptive statistics are presented in Table 1 showing average values and ranges on the RPFs; the number of schools providing data from each project is also listed in this table. As noted, each aggregate RPF was created from subscales within that domain. Since subscales were standardized prior to aggregating (mean=0; SD = 1), means shown in Table 1 are close to zero. Ranges indicate positive skew for certain risk factors (e.g., Family Risk and Antisocial Peer risk in the CTC-ND dataset). Number of students ("level-1" units) providing data for our models were as follows: Grade 8, female—CTC-ND=25,089, PAYS = 11,309, Diffusion= 9,538; Grade 10, female—CTC-ND=20,995, PAYS=10,517, Diffusion=9,496; Grade 8, male—CTC-ND=23,019, PAYS= 10,800, Diffusion=8,524; Grade 10, male—CTC-ND= 18,078, PAYS=9,671, Diffusion=8,571.

The results of the multi-level models indicated that schools exhibited substantial variation in the association between the risk factors and adolescent alcohol use. For each of the seven RPF indices, random slope terms represented variation significantly different from zero in a proportion of models (across data sources, grade, and gender) that exceeded what would be expected by chance (i.e., 5% of models). In five of the seven cases, significant results were found for at least 50% of the models (see Fig. 1). This was particularly the case for the Antisocial Peers risk factor, with significant random slopes in over 90% of the models. Significant random slopes were found in roughly 60% of the models for School and Community Protection.

Table 2 provides a summary of the school-specific coefficients (i.e., BLUPS) obtained from the random components in each of the multi-level models. (Note that we do not present other parameters generated by the multi-level ordered logistic models—such as threshold values or intercept variance—given our focus on slope estimates.) For each dataset, the table shows the range of these coefficients across schools as well as the mean. (We note that in 10 of the 84 models—roughly 12%—the random slope parameter was unable to be estimated due to nonconvergence of the analytic model). In general, there is a high degree of consistency in coefficient ranges across datasets for each RPF. Although we executed models separately by grade and gender given differences in fixed effect estimates, we did not find patterns of statistical significance for the random slope tests across these levels and therefore summarize results across dataset and grade/gender. The breakdown by grade and gender (averaged across dataset) is provided in an Appendix (Table A.1; available online); the ranges across these grade/gender combinations appear to be highly consistent for each RPF.

The factor with the largest percentage of significant tests (see Fig. 1) of random slope variation—Antisocial Peer Risk— also demonstrated higher coefficients in each of the three datasets as displayed by the ranges and averages in Table 2. In addition, the range for Antisocial Peer Risk coefficients is relatively large compared to other RPFs, and is similar across datasets. To illustrate these findings using the CTC-ND sample, results indicate that (averaging across schools) for every one-unit increase in the Antisocial Peer risk factor index, the odds for a higher level of drinking are 2.7 greater, conditional on other predictors in the regression model. (Higher level of drinking in the proportional odds model represents a contrast between higher levels of drinking versus lower levels cumulatively across the scale—0 drinks versus any drinks, 1 or fewer drinks versus more than 1, and so on). These odds ratios vary across schools (and across projects) from a low of 1.4 to 5.3. Thus, the results are consistent in indicating that the Antisocial Peer Risk index is most predictive of alcohol use, the random slope for this factor is significant in most models, and the range of regression coefficients for this index across schools is relatively large.

The bivariate associations of the school-specific coefficients for different RPFs are exhibited in Table 3. The Table shows the average across grade/gender combinations and datasets. At least two-thirds and often all of the correlations comprising each average were significant ($p < .05$). In all cases except one, the correlations comprising each average were in the same direction—i.e., all positive or all negative (the one exception is due to correlations for School Protection that were in different directions for eighth grade females across two datasets). The results suggest that the school-specific associations are generally correlated: Correlations in school-specific coefficients between risk factors are positive, correlations between coefficients for protective factors are positive, and correlations between coefficients for a risk and a protective factor are negative. For instance, the more strongly a risk factor is linked to alcohol use in a school, the more strongly other risk factors tend to be linked to *greater* alcohol use as well, and the more strongly protective factors tend to be linked to *less* alcohol use. Although associations appear to be high amongst most RPFs, correlations of school-specific coefficients for School Protection with other RPFs are noticeably lower (with absolute values of correlations ranging from .18 to .28), due to the issue described above. Average associations among school-specific coefficients for all other RPFs ranged from .24 to .68.

To assess the relation between school characteristics and the strength of risk factor to alcohol use associations, we computed correlations between four variables available through the NCES (teacher-student ratio, number of students, percent free/reduced lunch, percent white) and the school-specific coefficients. These correlations were calculated separately for the four gender/ grade combinations in each of the three datasets. We then averaged the correlations across the gender/grade combinations within each dataset, and finally averaged the dataset-averaged correlations for an overall average correlation matrix. The overall average correlations between the four school variables and the school-specific coefficients were small, ranging from -0.15 to 0.20 . We noted somewhat larger correlations for one dataset: Of the 28 average correlations for the Diffusion dataset ($28 = 4 \text{ school variables} \times 7 \text{ RPFs}$), 8 were of greater absolute value magnitude than $r = 0.20$. Six of those eight larger correlations involved student-teacher ratio: Larger student-teacher ratios were negatively correlated with school-specific coefficients for Community and Family Cohesion protective factors ($r = -0.29$ for both), and positively correlated with Antisocial Peer and Antisocial Attitudes ($r = .43$ for both), family risk ($r = .40$), and antisocial behavior ($r = .23$).

Discussion

This report tests an assumption embedded within the predominant approach to assessing and targeting community risk. The assumption that a risk or protective factor is consistently

linked to underage drinking across different communities has been a simplifying assumption in the approach we are calling the Community Diagnosis model (C-Dx). Our approach has been to test this assumption in a systematic manner, utilizing three large datasets that use the same comprehensive and valid measure of youth risk, protection, and alcohol use. We examined several RPF indices, each created based on the aggregation of multiple, reliable scales reported on by youth in mid-adolescence.

Before discussing the implications of the results for the consistency assumption, we first note that the effects of the RPFs on alcohol use (Table 3) both control for the influence of the other RPFs and accounting for school-level variability. These findings in themselves represent an advance over considerable prior research. Overall, the estimates for the three different datasets are quite consistent with each other, regarding both the range of effects found at the school levels as well as their magnitude. However, we noticed differences across datasets for the two RPF indices with the strongest effects across all three datasets—Antisocial Peer and Antisocial Attitudes—for which the differences in maximum values were especially pronounced between the PAYS and Diffusion datasets. However, we also note that across all three datasets, there is a consistent ranking of effects: Community Protection has a small effect, whereas School Protection and Family Cohesion have negligible effects on alcohol use. Family Risk and Antisocial Behavior have small effects, whereas Antisocial Peer and Antisocial Attitudes have large effects on alcohol use. (For further elaboration of the influence of the association of linear, non-linear, and interactive effects of these RPFs on alcohol use, see Jones et al., A multi-domain approach to understanding risk for underage drinking, unpublished).

The overall results suggest that the assumption of consistency across communities is not valid, although the evidence was stronger for some indices than others. In the context of our different models by gender and grade within each dataset, some RPF indices such as antisocial peer association show significant statistical evidence of variability across communities most of the time, while others such as individual antisocial behavior show significant variation in only one out of about five models tested. For all RPF domains, however, the rate of significant findings substantially exceeds the number of significant findings one would expect by chance. Moreover, these results may be somewhat conservative; in preliminary univariate models (results not shown) in which we only included one RPF index, there was a considerably stronger likelihood of significant variability across communities (i.e., random slope).

The question of how important such variability across communities is cannot be determined by findings of statistical significance alone. Thus, we also examined the magnitude of the differences in RPF-to-alcohol use associations across communities. For antisocial peer association, the odds ratio of an increase to a higher level of alcohol use ranged from about 1.4 to over 5 across communities. On the one hand, odds-ratio values in this entire range indicate that antisocial peer association is a fairly strong risk factor for alcohol use within all communities. On the other hand, values in the lower portion of this range overlap with odds-ratio ranges of other risk factors; for example, the range of values for family risk range from about 1.1 to 2.5. Although school-specific odds ratios for these two RPF indices are correlated (almost .60), any particular community may exhibit a low odds-ratio for one of these RPF domains and a high value for the other. Thus, without exploring school-specific data, we cannot generalize average relations across communities.

Notably, we did find strong evidence that school-specific coefficients—which represent the strength of the RPF to alcohol use association—varied across schools. The implication of this finding is that some communities tend to have strong associations between RPFs and alcohol use, and others tend to have weak associations. On the other hand, our initial

exploration of which school and community dimensions may be linked to the strength of RPF-alcohol use associations did not provide a clear answer. Averaged across the three datasets, the strength of these links was quite small and variable. There were moderate-sized findings for one school variable in only one of the three datasets. For the Diffusion dataset, teacher-student ratio was moderately correlated with the predictiveness of most of the RPFs, such that larger teacher-student ratios were linked to stronger RPF predictiveness of underage drinking (i.e., greater negative relations between protective factors and use, and greater positive relations between risk factors and use). The role of teacher-student ratios for these communities does not seem to reflect a broader context of community resources, as the level of poverty in a community (as indexed by the percent of students participating in free or reduced lunch programs) was minimally linked to the predictiveness of RPFs. Moreover, although the data in the Diffusion dataset were most carefully collected as part of an investigator-driven research project, this was also the smallest dataset of the three. Given the null results for the other two datasets, we conclude that these data do not point to a clear school or community factor related to the predictiveness of RPFs with respect to underage drinking. However, further theoretical development and empirical inquiry into these issues is warranted.

Consistent with our prior findings on the fixed effects of these indices, the school protection index was not strongly associated with alcohol use on the whole. However, despite an overall negligible association with alcohol use, the magnitude of this association often varied substantially across communities—ranging from odds ratios of about .71 to 1.70. This finding indicates that, after accounting for other RPFs, school protection predicts less alcohol use in some communities but more use in others. Such negative and positive associations are found for family cohesion as well. These findings are consistent with our previous work, which showed that unexpected associations sometimes emerged for these two protective factors after controlling for other RPFs in multiple regression models (Jones et al., A multi-domain approach to understanding risk for underage drinking, unpublished).

In addition, the school-specific coefficients for school protection were only modestly associated with corresponding random coefficients for other RPF indices. We are not sure why this RPF was not related to other RPFs at the school level, but the explanation may not relate to the protective nature of the construct, as relations among school-specific coefficients for family cohesion demonstrated strong relations with other school-specific RPF coefficients.

Limitations

There were several limitations of this research. First, these results may not generalize to adolescent use of other substances or to problem behaviors. Second, all model outcomes and predictors came from adolescent self-report, which may be subject to bias. Where results indicated small effects, it may be that other measurement approaches would yield different results. For example, we believe that a focus on school climate (i.e., feelings of safety vs. threat of victimization) may be a useful addition to the school protection measures utilized in the three data sources we utilized. Third, we focused just on two age groups (grades 8 and 10), and we did not consider how associations may differ when factoring in other background variables such as race and family income. Fourth, we utilized multi-level regression modeling, but different modeling approaches (e.g., Bayesian) may be utilized in future work to assess consistency across units. Fifth, we were unable to examine random slopes for all variables simultaneously due to limitations of available software. Sixth, we did not explore here whether certain dimensions of communities account for variability in the salience of RPFs; we intend to pursue such investigations in future work. Finally, given that the data from the three datasets used here were cross-sectional, the direction of effect between RPFs and alcohol use cannot be determined.

Implications for Public Health Decision Making

Overall, these results indicate that the simplifying assumption that a risk factor is equally influential across communities is likely invalid. This conclusion is based on the proportion of models exhibiting statistically significant variability across communities, as well as the ranges of odds ratios across communities for prediction of alcohol use. These findings suggest that the C-Dx model could become even more effective if a community not only assesses which risk factors are elevated (or protective factors are low), but also how strong the links are between these factors and underage drinking in the community. This approach would of course introduce greater complexity to the assessment and decision-making process. Before such changes to the C-Dx model are attempted, we suggest several further steps.

First, these findings should be replicated with other data-sets; ideally with representative samples. Second, these analyses should be undertaken with different outcomes, as the C-Dx model is not typically employed to target alcohol use alone, but other substance use and behavior problems (e.g., aggression, drop-out) as well. Third, attempts should be made to assess whether there is consistency in associations between RPFs and behavior problems within subsets of communities. For example, it may be that communities that are similar along certain dimensions—such as level of poverty, social capital, urbanicity—function similarly such that RPFs are equally salient in that set of communities. In other words, there may be characteristics of communities that systematically explain the strength of associations between RPFs and behavior problems. As we noted above, several studies have found such systematic influences of community context on the salience of RPFs (Beyers et al. 2001; Chuang et al. 2009; Ennett et al. 2008; Foshee et al. 2009). If sets of communities can be defined where RPFs operate similarly, then it may be possible to contextualize community assessment in terms of a referent group rather than assessing each community individually. Thus, with the evidence provided by this study across three datasets and seven RPFs, we recommend a broad inquiry into whether features of community context systematically modulate the salience of RPFs for alcohol use.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Fig. 1.

Percentage of models (across data source, grade, and gender) with significant ($p < 0.05$) random slope variation, by risk/protective factor (RPF) index. At the top of each bar is listed the number of significant random slopes/number of models. (There were a total of 12 models for each RPF random slope, across datasets/gender/grade, but not all models converged)

Table 1

School-level descriptive statistics of risk and protective factor indices

Dataset:	PAYS (N0178 schools)			CTCND (N=947 schools)			Diffusion (N=119 schools)		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
RPF index									
Community protection	-0.03	-0.88	0.85	-0.05	-2.63	1.28	-0.10	-0.81	0.27
School protection	0.03	-0.53	1.71	-0.06	-1.35	1.39	0.00	-0.61	0.49
Antisocial peer	-0.02	-0.62	0.87	0.02	-0.68	2.76	0.07	-0.23	0.77
Family cohesion	0.00	-0.73	1.04	-0.04	-2.06	1.19	-0.03	-0.26	0.20
Family risk	0.00	-0.78	0.51	0.00	-0.88	4.02	0.13	-0.23	1.57
Antisocial attitudes	-0.02	-0.90	0.43	0.02	-1.05	1.94	0.11	-0.31	1.06
Antisocial behaviors	0.00	-1.09	0.43	-0.02	-0.92	1.53	0.07	-0.32	1.31

School-specific odds ratios for risk and protective factors (RPF) predicting 30-day alcohol use, averaged across grade and gender

Table 2

Dataset:	PAYS			CTCND			Diffusion		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
RPF index									
Community protection	0.71	0.49	1.03	0.65	0.37	0.98	0.66	0.50	1.17
School protection	1.03	0.82	1.30	1.04	0.78	1.34	1.10	0.71	1.70
Antisocial peer	1.93	1.38	2.77	2.66	1.55	4.29	2.56	1.66	5.34
Family cohesion	1.07	0.84	1.33	1.11	0.86	1.43	1.04	0.81	1.55
Family risk	1.50	1.13	1.80	1.70	1.15	2.25	1.77	1.26	2.53
Antisocial attitudes	1.68	1.22	2.26	2.19	1.51	3.27	2.60	1.53	5.30
Antisocial behaviors	1.52	1.14	1.99	1.57	1.26	1.95	1.50	1.36	1.85

Values refer to odds ratios derived from school-specific log-odds coefficients in multilevel ordered logistic regression models; models conducted separately for each combination of grade (8th and 10th) and gender (boys and girls) within each dataset

RPF Risk/Protective factor; CTCND Communities That Care Normative Database

Table 3

Inter-correlations among school-specific risk/protective factors-alcohol use associations/slopes (proportion of all models where correlations were statistically significant at $p < 0.05$ shown in parentheses); and correlations of the school-specific associations with National Center for Educational Statistics variables

Risk/Protective factors	1	2	3	4	5	6	7
1. Community protection	–						
2. School protection	0.18 (.100)	–					
3. Antisocial peer	–0.54 (.90)	–0.06 (.100)	–				
4. Family cohesion	0.37 (.75)	0.24 (.100)	–0.50 (.89)	–			
5. Family risk	–0.48 (.90)	–0.03 (.91)	0.57 (.92)	–0.38 (.67)	–		
6. Antisocial attitudes	–0.65 (.100)	–0.28 (.100)	0.68 (.100)	–0.53 (.100)	0.66 (.100)	–	
7. Antisocial behaviors	–0.32 (.88)	–0.09 (.78)	0.56 (.78)	–0.24 (.100)	0.57 (.89)	0.50 (.100)	
School-level variables:							
8. Teacher-student ratio	–0.06	–0.02	0.20	–0.15	0.20	0.17	0.01
9. Total students	–0.02	–0.05	0.10	–0.03	0.05	0.11	–0.01
10. Percent free/reduced lunch	0.04	–0.06	–0.12	0.04	–0.09	–0.08	0.02
11. Percent white	–0.05	0.02	0.13	–0.15	0.08	0.09	–0.01

All correlations averaged across grade, gender, and dataset