A Multidomain Approach to Understanding Risk for Underage Drinking: Converging Evidence From 5 Data Sets

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Underage alcohol use is a leading public health problem in the United States. By the end of high school, more than 75% of youths have consumed alcohol, and each year underage drinking results in 5,000 deaths of those younger than 21 years. Moreover, early drinking is strongly associated with later alcohol abuse and dependence in adulthood, with enormous personal and societal costs including increased violence, traffic fatalities, lost productivity at work, and medical problems.1

To help focus prevention and intervention efforts, researchers have identified dozens of risk and protective factors associated with adolescent alcohol use.2 The many studies of these factors could be used to support a wide range of possible intervention approaches. However, there are challenges in sorting through so many identified risk factors, and different studies utilize, define, and measure risk factors differently.3 Therefore, it is currently difficult to integrate the body of research to assess which risk and protective factors are most important, at what ages, and for which youths.

In previous work, we utilized conceptual and empirical strategies to aggregate more than 30 risk and protective factors from the Communities That Care Prevention Needs Assessment (CTC Youth Survey) into a limited number of indices, representing risk and protection in the major domains of the adolescent’s environment: community, school, peer, and family—along with risky attitudes and behaviors exhibited by the individual adolescent him- or herself.4 Such aggregation, although simplifying multifaceted factors, has been successfully deployed in other fields such as personality research.5,6

We utilized the aggregated risk and protective factor indices to examine associations between these factors and substance use with data from a large-scale survey of adolescents in Pennsylvania.7 Results showed a greater association between individual and peer risk factors and substance use than with family, community, and school factors. Such patterns would have been more difficult to detect utilizing the larger number of risk and protective factor scales. However, given that findings can vary across samples and measures, the generalizability of a single study is uncertain.

We examined the associations between risk and protective factor indices representing key domains and adolescent alcohol use within 5 large data sets. Three of the 5 utilized the CTC Youth Survey, and we created parallel indices from adolescent-reported measures available in the other 2 data sets. After conducting analyses separately by data set, we aggregated results by using meta-analytic techniques.

In addition, we assessed the frequent implicit assumption that relations between risk and protective factors and alcohol use take a linear form. Certain forms of curvilinear relations may indicate that the impact of risk reaches a limit; in other words, increasing level of risk may predict increasing alcohol use until a certain point, above which increasing risk does not contribute further to use. Such effects (including the reverse, in which a risk factor is only linked to use above a certain value) would have important implications for intervention by helping to specify which youths are at elevated likelihood for use.

Secondly, numerous studies have found evidence for interactions between risk factors predicting problem behaviors.8,9 Interactions between risk factors are important information for prevention. If certain risks are especially problematic in the presence of other risk factors (or in the absence of protective factors), then such information could help preventionists target youths or communities at particular risk. However, interaction effects are notoriously fickle—that is, interaction findings are often sensitive to different measures, samples, and procedures. Only infrequently do multiple studies examine the interaction of the same risk factors; thus, the generalizability of any interactions detected is uncertain. We examined the consistency (i.e., robustness) of 2-way interactions between the risk and protective factor indices in predicting alcohol use with the 5 data sets (each of which includes multiple communities).

**Objectives.** We examined the independent and combined influence of major risk and protective factors on youths’ alcohol use.

**Methods.** Five large data sets provided similar measures of alcohol use and risk or protective factors. We carried out analyses within each data set, separately for boys and girls in 8th and 10th grades. We included interaction and curvilinear predictive terms in final models if results were robust across data sets. We combined results using meta-analytic techniques.

**Results.** Individual, family, and peer risk factors and a community protective factor moderately predicted youths’ alcohol use. Family and school protective factors did not predict alcohol use when combined with other factors. Youths’ antisocial attitudes were more strongly associated with alcohol use for those also reporting higher levels of peer or community risk. For certain risk factors, the association with alcohol use varied across different risk levels.

**Conclusions.** Efforts toward reducing youths’ alcohol use should be based on robust estimates of the relative influence of risk and protective factors across adolescent environment domains. Public health advocates should focus on context (e.g., community factors) as a strategy for curbing underage alcohol use.


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In sum, we used multiple large data sets to examine the consistency of the links between risk and protective factors in the major domains of the adolescent environment and alcohol use. The research was directed toward the following questions: (1) How strongly do key domains of adolescents’ ecologies (individual attitudes and behavior, family, peer, school, and community) predict alcohol use, both independently and in concert? For example, do distal factors within school and community domains influence use beyond more proximal individual factors? (2) Are there curvilinear components to these associations? (3) Do the risk and protective factors interact in predicting alcohol use? We structured analytic models to accommodate the ordinal nature of the outcome as well as the nested data design (individuals within schools).

METHODS

We focused on grades 8 and 10 for several reasons. First, similar measures of both the outcome—alcohol use within the past 30 days—and the key risk and protective factors were available for 8th- and 10th-grade students across 5 separate project data sets. Furthermore, grades 8 and 10 represent important developmental periods to examine drinking behaviors. Grade 8 represents an age when many youths are first trying alcohol; the level of use is high enough to facilitate analysis with a measure of alcohol use that is more fine-grained than a yes-or-no response and, thus, results can be compared with those from older age groups. Grade 10 represents an age when alcohol use is relatively common among youths, and nonrandom missing data because of school drop-out is not as problematic as it is for later grades.

Three of the 5 data sets used in this study consisted of cross-sectional school-based survey data using the CTC Youth Survey, a broad self-report assessment of risk and protective factors and problem behaviors, developed by researchers affiliated with the Seattle Social Development Research Group10 (Table 1). We utilized 1 of the data sets (from the Pennsylvania Youth Survey [PAYS]) in our previous work aggregating the risk and protective factor scales into a limited number of domain indices.4 The Communities That Care Youth Survey Normative Database (CTC-ND) was constructed from more than 300 000 survey records in 23 states collected during 2000 and 2002 to monitor communities’ levels of youths’ risk and protection factors and substance use.10–12 The PAYS is a biannual surveillance survey of a representative sample of school districts in Pennsylvania (other schools can voluntarily participate in an additional “piggy-back” sample). For the current project, we used the sample of 118 074 students from 2007. The Diffusion Project involves 41 communities in 7 states.13 The project was designed to study the effectiveness of state and local prevention systems by using epidemiological data on risk factors as the basis for program planning and monitoring. Data used here were collected from public school students in years 1998, 2000, and 2002.

Two other data sets came from longitudinal, school-based, randomized prevention trials. Promoting School–University–Community Partnerships to Enhance Resilience (PROSPER) was designed to test a new model of collaboration and dissemination of empirically validated programs for youths and families, and involved 28 Iowa and Pennsylvania communities.14 We utilized data collected from 2 cohorts collected across 2005 through 2008. The Adolescent Substance Abuse Prevention Study (ASAPS) was designed to evaluate the effectiveness of a school-based substance abuse prevention program targeting 7th- and 9th-grade students. Data were collected across 2002 through 2004 from 19 529 students in 83 public school districts in several regions.15

Measures

To measure alcohol use, all surveys except PROSPER asked youths to indicate the number of occasions (within a range) that they drank alcohol over the past 30 days using the same response scale. Because the distributions indicated low responses for higher levels of use, we combined the highest 4 categories resulting in a 4-level ordinal outcome (zero; 1–2 times; 3–5 times; and ≥6 times). In the PROSPER survey, we again combined higher categories to create a 3-level ordinal scale (not at all, 1 time, and a few times or more).

To measure risk and protective factor indices, on the basis of our previous work,4 we created 7 risk and protective factor indices (community protection, school protection, peer risk, family risk, family protection, individual antisocial behavior, and individual antisocial attitudes) from the scales in the CTC Youth Survey in each of the 3 data sets utilizing that instrument. (We standardized scales with SD = 1 before averaging to create each risk and protective factor index.) We created parallel measures of these indices in ASAPS and PROSPER by using comparable risk and protective factor items and scales (Appendix A, available as a supplement to the online version of this article at http://www.aph.org). However, comparable measures of antisocial behavior were not available in ASAPS, and comparable measures of family risk and community protection were not available in PROSPER.

Statistical Analysis

Preliminary analyses indicated that a majority of risk and protective factors to outcome associations were significantly different across gender and age. We carried out separate analyses by grade (8th and 10th) and gender because final models were too complex to also include grade and gender as simultaneous moderators of the risk and protective factor indices, curvilinear terms, and gender or grade interaction terms. As we conducted analyses separately for each grade and gender subsample within each data set, we centered the risk and protective factor indices within each subsample so that the mean was zero for each grade and gender combination. Therefore, a value of zero on any risk or protective factor indicates that the individual is roughly at an average level of risk or protection for his or her grade and gender.

Given the ordinal nature of the outcome, we used multilevel ordered logistic regressions executed within SAS Proc Glimmix version 9.2 (SAS Institute Inc, Cary, NC); we specified a random intercept to represent variation in the outcome on average across schools. We included the youths’ reported school grades as a control variable in regression models. After executing separate regression analyses by project data set (for each grade and gender), we used meta-analytic techniques to aggregate regression model results (coefficients) across the data sets while accounting for variation in these results. Specifically, we first converted coefficients from the separate data set analyses.
to odds ratios, and then we aggregated using an inverted weighting method based on study-specific coefficient standard errors. We used the Q test to assess study heterogeneity and thus determine the appropriate method for calculating mean effect sizes (i.e., odds ratios) as well as significance levels.16

RESULTS

We first conducted a series of “univariate” regression models in which each risk and protective factor was the sole predictor of alcohol use (in addition to the academic grade control variable). The coefficients from these models were proportional odds ratios, indicating the odds of higher levels of alcohol use for each unit increase in the predictor. Table 2 displays the coefficient for each risk or protective factor separately for each grade and gender subsample; we averaged coefficients across the 5 data sets by utilizing the meta-analytic method described previously. Where the Q test indicated heterogeneity across data sets, we used random effect meta-analytic techniques to determine mean effect sizes and tests of significance; otherwise we used fixed effect techniques. Results indicated that, as expected, higher levels of protective factors—community, school, and family protection—and lower levels of risk factors—antisocial peers, family risk, and antisocial attitudes—and behavior—were associated with lower levels of alcohol use. Coefficients were consistently significant (P < .01) across all grade and gender subsamples. Although all associations were fairly strong (with odds ratios of at least 2 for risk or <0.5 for protection), community protection was the strongest protective factor, and antisocial peers and antisocial attitudes were the strongest risk factors.

Curvilinear and Interaction Effects

We explored curvilinear associations between risk and protective factors and alcohol use in a 2-stage procedure. First, we tested higher-order (quadratic and cubic) terms for each risk and protective factor in the univariate models, separately by data set. Second, we then examined those higher-order coefficients that were significant in the univariate models together in a model that included all linear risk and protective factor index terms. We conducted this larger model for each grade and gender subsample separately by data set (4 grade and gender subsamples × 5 data sets = 20 models). We set a criterion for retaining higher-order coefficients for a final model: the higher order term had to be significant in at least 30% of the stage 2 models; this criterion was set to ensure that effects were significant across more than 1 of the 4 gender–grade combinations for each risk and protective factor. If a cubic term was consistently significant, the quadratic term for that factor was also retained in the final model.

On the basis of this preliminary investigation, we developed a final model that included all linear risk and protective factor terms, as well as the cubic (and quadratic) terms for 3 indices: antisocial peers, family risk, and antisocial attitudes. For risk and protective factors where the cubic term was not retained, we reran models to check for significant quadratic associations utilizing the same 30% criterion. We retained quadratic terms (but not cubic) in the final model for community protection and antisocial behavior indices.

We also assessed whether 2-way interactions between risk and protective factor indices were consistently significant for predicting alcohol use (based on the 30% criterion across subsamples and data sets). We added all 2-way interactions between risk and protective factors to the model containing all linear risk and protective factor terms and the retained higher-order terms. Three 2-way interactions emerged as consistently significant and thus we included these in the final model: community × family risk; community × antisocial attitudes; and antisocial peers × antisocial attitudes.

Final Model Results

Table 3 provides the across data set mean estimates (as well as tests of heterogeneity) for the final models including all linear risk and protective factor index scores and retained curvilinear terms and interactions as predictors of alcohol use. Across grade and gender, antisocial peers, family risk, antisocial attitudes, and antisocial behavior were significantly positively associated with alcohol use whereas community protection was associated with lower levels of alcohol use (P < .01) when we controlled for all other predictors. These results

### TABLE 1—Summary of 5 US Project Data Sets With Measures of Alcohol Use Among 8th and 10th Graders

<table>
<thead>
<tr>
<th>Study</th>
<th>Research Design</th>
<th>Sample Characteristics</th>
<th>Sample Size</th>
<th>Schools or Districts, No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTCS-Normative Database</td>
<td>Surveillance</td>
<td>School-based, national normative</td>
<td>10,898</td>
<td>2,509 schools</td>
</tr>
<tr>
<td>Diffusion Project</td>
<td>Surveillance</td>
<td>Community-based, in CO, IL, KS, ME, OR, UT, and WA</td>
<td>11,309</td>
<td>10,898 schools</td>
</tr>
<tr>
<td>PROSPER</td>
<td>Randomized trial</td>
<td>School-based, in IA and PA</td>
<td>1,087</td>
<td>10,800 schools</td>
</tr>
<tr>
<td>ASAPS</td>
<td>Randomized trial</td>
<td>School-based, 6 regions in United States</td>
<td>1,087</td>
<td>10,800 schools</td>
</tr>
</tbody>
</table>

Note: ASAPS = the Adolescent Substance Abuse Prevention Study; CTCS-YS = Communities That Care Youth Survey; PAYS = the Pennsylvania Youth Survey; PROSPER = Promoting School–University–Community Partnerships to Enhance
Family protection was associated with reduced alcohol use only for girls in grade 8 (odds ratio OR = 0.93; P < .05). For school protection, the results from 2 models were opposite of the result from the corresponding univariate models: when we controlled for all other risk and protective factors, school protection was associated with higher likelihood of alcohol use in the final models among both 10th-grade girls (OR = 1.04; P < .05) and boys (OR = 1.09; P < .01). (Separate model results across data sets for both single risk and protective factors and the final models can be found in the appendices, available as supplements to the online version of this article at http://www.ajph.org.)

Significant curvilinear associations in the final models suggest that the strength of the association between risk and protective factors and alcohol use was not consistent across levels of risk for some risk and protective factors in certain grade–gender subgroups (Table 3). Figure 1 provides an example plot of the curvilinear association, depicting the antisocial peers factor predicting alcohol use for 8th-grade girls in the CTC-ND data set. The figure shows how the positive association between the risk factor and alcohol use eventually levels off at about 1 on the risk and protective factor scale, which corresponds to the 90th percentile of antisocial peers risk; the association becomes positive again at roughly the 97th percentile of risk. Other risk and protective factor domain models with cubic terms yielded similar curvilinear patterns. Where only the cubic coefficient was significant, the pattern was similar but without the return to a positive association between the factor and alcohol use for those with most extreme risk. This finding indicates that although associations between risk and protective factors and alcohol use are linear for the majority of youths, for those at very high levels of some risk and protective factors, there is little or no relation between the risk and protective factors and use. For example, at a high level of peer risk, a further incremental increase in peer risk is not associated with further increase in likelihood to drink.

Two of the 3 interactions included in the final model demonstrated significant effects across data sets, both involving antisocial attitudes: community protection × antisocial attitudes (except 10th-grade boys) and antisocial peers × antisocial attitudes. Figure 2 (using 8th- and 10th-grade boys from the PAYS data set) provides graphic examples of these interactions. Results indicate that if community protection is low (or if peer risk is high), the predicted probability of alcohol use is higher overall and the association between antisocial

### Table 1—Mean Proportional Odds Ratios Across 5 US Data Sets for Univariate Models Predicting 30-Day Alcohol Use by Gender and Grade

<table>
<thead>
<tr>
<th>Risk or Protective Factor</th>
<th>8th-Grade Girls</th>
<th>10th-Grade Girls</th>
<th>8th-Grade Boys</th>
<th>10th-Grade Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean OR</td>
<td>P</td>
<td>Mean OR</td>
<td>P</td>
</tr>
<tr>
<td>Community protection</td>
<td>0.27</td>
<td>.89</td>
<td>0.35</td>
<td>.59</td>
</tr>
<tr>
<td>School protection</td>
<td>0.47</td>
<td>.83</td>
<td>0.56</td>
<td>.03</td>
</tr>
<tr>
<td>Antisocial peer</td>
<td>5.37</td>
<td>&lt;.001</td>
<td>4.43</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Family protection</td>
<td>0.41</td>
<td>&lt;.001</td>
<td>0.52</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Family risk</td>
<td>3.62</td>
<td>&lt;.001</td>
<td>2.51</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Antisocial attitudes</td>
<td>5.51</td>
<td>&lt;.001</td>
<td>4.42</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Antisocial behavior</td>
<td>3.77</td>
<td>&lt;.001</td>
<td>3.12</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Note. OR = odds ratio. All mean ORs significant at P < .01. P values were determined by the Q test and represent significance test for whether studies were determined to be heterogeneous.

### Table 2—Mean (Weighted Proportional) Odds Ratios Across 5 US Data Sets for Full, Multivariate Model Predicting 30-Day Alcohol Use Among 8th and 10th Graders

<table>
<thead>
<tr>
<th>Variable</th>
<th>8th-Grade Girls</th>
<th>10th-Grade Girls</th>
<th>8th-Grade Boys</th>
<th>10th-Grade Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academic grades</td>
<td>1.00</td>
<td>.11</td>
<td>0.99</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Community protection</td>
<td>0.66**</td>
<td>.5</td>
<td>0.74**</td>
<td>.03</td>
</tr>
<tr>
<td>School protection</td>
<td>1.04</td>
<td>.03</td>
<td>1.04**</td>
<td>.23</td>
</tr>
<tr>
<td>Antisocial peer</td>
<td>3.44**</td>
<td>&lt;.001</td>
<td>3.23**</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Family protection</td>
<td>0.93**</td>
<td>.01</td>
<td>1.00</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Family risk</td>
<td>2.23**</td>
<td>&lt;.001</td>
<td>1.86**</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Antisocial attitudes</td>
<td>2.46**</td>
<td>&lt;.001</td>
<td>2.23**</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Antisocial behavior</td>
<td>1.69**</td>
<td>&lt;.001</td>
<td>1.53**</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Quadratic

<table>
<thead>
<tr>
<th></th>
<th>8th-Grade Girls</th>
<th>10th-Grade Girls</th>
<th>8th-Grade Boys</th>
<th>10th-Grade Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td>0.85**</td>
<td>.47</td>
<td>0.83**</td>
<td>.92</td>
</tr>
<tr>
<td>Antisocial peer</td>
<td>0.60**</td>
<td>&lt;.001</td>
<td>0.61**</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Family risk</td>
<td>0.68**</td>
<td>.63</td>
<td>0.69**</td>
<td>.07</td>
</tr>
<tr>
<td>Antisocial attitudes</td>
<td>0.74</td>
<td>&lt;.001</td>
<td>0.75**</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Antisocial behavior</td>
<td>0.91**</td>
<td>.64</td>
<td>0.96**</td>
<td>.52</td>
</tr>
</tbody>
</table>

Cubic

<table>
<thead>
<tr>
<th></th>
<th>8th-Grade Girls</th>
<th>10th-Grade Girls</th>
<th>8th-Grade Boys</th>
<th>10th-Grade Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Antisocial peer</td>
<td>1.09**</td>
<td>.01</td>
<td>1.12</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Family risk</td>
<td>1.04</td>
<td>.01</td>
<td>1.05</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Antisocial attitudes</td>
<td>1.06</td>
<td>&lt;.001</td>
<td>1.03</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

2-way interactions

<table>
<thead>
<tr>
<th></th>
<th>8th-Grade Girls</th>
<th>10th-Grade Girls</th>
<th>8th-Grade Boys</th>
<th>10th-Grade Boys</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community protection × family risk</td>
<td>1.00</td>
<td>.22</td>
<td>0.99</td>
<td>.01</td>
</tr>
<tr>
<td>Community protection × antisocial attitudes</td>
<td>0.85**</td>
<td>.38</td>
<td>0.88**</td>
<td>.43</td>
</tr>
<tr>
<td>Antisocial peer × antisocial attitudes</td>
<td>1.13*</td>
<td>&lt;.001</td>
<td>1.22*</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Note. OR = odds ratio. *P < .05; **P < .01. P values were determined by the Q test and represent significance test for whether studies were determined to be heterogeneous.
attitudes and alcohol use is much stronger. Conversely, the association between antisocial attitudes and alcohol use appears less important for youths at a lower level of contextual (i.e., community or peer) risk. Thus, the presence of contextual risk appears to exacerbate the effect of antisocial attitudes on alcohol use.

Sequential Models
Because more proximal domain risk and protective factors (e.g., individual attitudes and behaviors) theoretically should mediate the impact of more distal domains, we conducted a set of sequential regressions starting with the most distal factor (i.e., community) followed by subsequent models that added the next most proximal domain factor(s) (i.e., school, peer, family, individual) to understand the additional unique contribution of each domain. For this, we used only CTC-ND, PAYS, and Diffusion Project data sets because they included the same number of risk and protective factors for each domain. We used likelihood-ratio tests to test for significant model improvement for each addition of domain risk and protective factors. We again conducted analyses separately by data set and subsample. The first test examined whether community protection improved model fit over the model with just the academic grade control variable. The next model added school protection, with each subsequent model adding additional domain risk and protective factors.

Model comparison results showed that, in every case, the inclusion of the more proximal domain risk and protective factors significantly improved model fit; that is, each domain contributed to explaining additional variance in the outcome beyond variance accounted for by domains already entered into the model in previous steps. Investigating the relative contribution of domain risk and protective factors in explaining variance in alcohol use was not possible with the multilevel ordered logistic models. Instead, we estimated pseudo-$R^2$ by utilizing parallel standard ordered logistic regression. Table 4 provides the average $R^2$ estimates representing the contribution of each domain when added to the model; results were very similar for the 3 data sets.

DISCUSSION

Our results build on numerous important research studies that have demonstrated links between dozens of risk and protective factors and underage drinking. An important novel contribution of this report is the estimation of links from key domains of aggregated risk and protective factors to alcohol use across several large data sets, gathered by different researchers, using different methods, from different populations. This approach allows for a greater degree of confidence in generalizability of results. Moreover, we systematically examined curvilinear relations between risk and protective factors and alcohol use as well as interactions among risk factors, yielding new information about the ways these factors are linked to underage drinking. Alcohol use levels and risk and protective factors (including community influence) were all derived from adolescent survey data.

Linear Effects of Risk and Protective Factors

The results from the univariate regression models show associations in the anticipated direction: risk factors are associated with greater alcohol use and protective factors with less use across grade and gender. Although Q-tests sometimes indicated significant heterogeneity of results across data sets, these...
findings were likely attributable to the large sample sizes that increased the sensitivity of these tests; the actual estimated effect sizes were strikingly similar across data sets. Moreover, results were largely consistent across grade and gender, with coefficients for each domain in close range across grade–gender combinations.

The consideration of all risk and protective factor domain indices together in the final models allowed us to observe the relative contribution of each risk and protective factor predicting alcohol use while controlling for the others. In these models, several risk and protective factors were found to have strong associations with alcohol use: antisocial peer association, family risk, individual antisocial attitudes and behaviors, and community protection. These results were generally consistent with a previous meta-analysis of bivariate associations of risk factor scales with alcohol use. Although the odds ratios were smaller in the final model than in the univariate models (as one would expect), the decreased importance of the protective factors in the school and family domains were especially notable. Surprisingly, these 2 domains were linked to slightly higher alcohol use in certain models when we controlled for other risk and protective factors (e.g., among 10th-grade youths; Table 3). In social network analyses with the PROSPER data set, colleagues have found that early and midadolescent friendship groups whose members use alcohol are more cohesive than other such groups. The implication from these sets of findings is that adolescent alcohol use may emerge to some extent in relation to cohesive social relations. On the whole, however, these results suggest that family and school protective factors may not have as much bearing on adolescent drinking relative to other factors, such as peer relations or family or school risk factors.

Finally, sequential analyses revealed that all domain indices significantly improved prediction of use when introduced into models beginning with distal factors, although some factors (most notably, school protection) did not substantially increase predictive power. That is, adding the school protection factor contributed little in terms of explaining variance in the outcome above and beyond the community protective factor. However, we urge greater attention to measurement of school protection and risk; for example, the effective delivery of school-based prevention programs was not assessed here although research indicates that such programs can alter drinking trajectories.

Although the variance explained by the community protective factor was largely attributable to it being the first factor entered into the model, we also note that the community index was among the strongest predictors of use in the univariate models, and was the strongest protective factor in the final models. Thus, it appears that the community environment—represented variously across data sets (Appendix A, available as a supplement to the online version of this article at http://www.ajph.org)—is an important domain to understand more fully and to target through prevention programming. These results also

![Image of plots showing predicted probability of at least 1 alcoholic drink in past 30 days for (a) 10th-grade boys and (b) 8th-grade boys: Pennsylvania Youth Survey data set.](image-url)
showed that family domain risk and protective factors increased the variance explained by about 0.04 when entered before the peer domain index; however, the family domain accounted for less variance when entered after the peer domain index. This pattern of findings supports a view of the impact of the family domain operating via its influence on peer association, as has been argued by developmental scholars who view family processes as setting the stage for adolescent relations with the outside world.20,21

Curvilinear and Interactive Effects of Risk and Protective Factors

We found evidence for curvilinear relations between several of the risk and protective factors and underage drinking that have not been widely acknowledged previously. Although such curvilinear effects may be attributed to problematic characteristics of the measures, such findings may simply reflect that the linear prediction of alcohol use reaches a limit; that is, although the association between risk or protection and use exists throughout most of the range of a risk or protective factor, after a certain point the factor no longer predicts further increased increments in drinking. (Although, where cubic effects were significant, the risk and protective factor indices predicted increased alcohol use again for the very small percentage of youths at extremely high risk.) It is possible that, for some factors, differences in risk scores among those at highest risk (or lowest protection) do not predict differences in alcohol use. The attenuation of this association at high levels of risk should be noted by researchers examining high-risk populations.

One possible explanation for the curvilinear effects we found is that other contextual factors help determine the level of use for those at higher risk. For example, we found evidence of interactions between risk and protective factor domains in 2 cases, both involving antisocial attitudes. Those results imply that individual attitudes may have greater influence on alcohol use when youths are exposed to risky surroundings (e.g., peers or community risk). In other words, antisocial attitudes might be especially powerful in leading youths to use alcohol in the presence of antisocial peers; or where there are not sufficient social deterrents toward drinking, there are few positive community role models, or there is easy availability of alcohol. These findings support our call for increased focus on the role of community environments, as well as peer environments, in influencing underage drinking. Although some researchers have been studying community influence on substance use,22-25 we need even greater understanding of mechanisms and pathways through which contexts affect individual behavior.

There were several limitations in this research. First, we utilized adolescent self-report measures, which may be influenced by biases. Moreover, we used self-report data for all domain indices, so even more distal factors (e.g., community characteristics) were based on youths’ report. Future studies should consider alternative sources of measurement for these factors—such as archival data or surveys of adult residents—which may lead to different results. In general, certain risk and protective factors may be less well represented by the survey measures than others. For instance, the measure of school protection may not capture important aspects of school climate. (However, Derzon also found weak relations for this factor and substance use in a meta-analysis incorporating studies with a range of school-related measures.26) We did not examine differences across racial and ethnic groups, but plan to pursue such analyses in future work. Finally, we examined cross-sectional data and, thus, cannot rule out the possibility that alcohol use influenced the risk and protective factors.

Conclusions

Despite these limitations, we note that the estimates of the influence of risk and protective factors on underage drinking generated by this study are particularly robust given the large sample sizes and varied research designs employed in the data sets utilized. Thus, these results confirm the importance of individual, family, and peer risk factors on youths’ alcohol use and suggest that public health proponents increase the focus of prevention efforts on community-level factors. The small number of significant interactions and the largely linear nature of the associations through the majority of the distribution suggest that the linear, main effects of these risk and protective factor domains capture a large portion of the predictiveness in these measures—although, when present, curvilinear associations deserve attention. These results also suggest that prevention efforts that reduce levels of risk should have an impact on alcohol use even at low levels of risk, supporting the rationale for universal prevention programming.

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Contributors

D. E. Jones helped conceptualize the analytic strategy, executed statistical analyses, prepared the initial written draft, led revisions of the article, and prepared the final version of the article. M. E. Feinberg co-led writing for the initial draft and revisions of the article, provided original ideas for research design, and helped guide analytic strategy. M. J. Cleveland helped conceptualize the analytic strategy, executed statistical analyses, and contributed to the writing for the initial draft and final preparation of the article. B. Rhoades Cooper helped execute statistical analyses and contributed to preparation of the article.

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Human Participant Protection

All procedures for the secondary data analyses used in this research were approved by the Penn State institutional review board.

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