Parents, Peers, Perceived Risk of Harm, and the Neighborhood: Contextualizing Key Influences on Adolescent Substance Use

Gregory M. Zimmerman 1 · Chelsea Farrell 2

Abstract Recent research has affirmed the need to examine contextual influences on adolescent substance use in a multilevel framework. This study examined the role of neighborhood opportunities for substance use in promoting adolescent substance use. Data came from two components of the Project on Human Development in Chicago Neighborhoods: the Longitudinal Cohort Study, consisting of interviews with youth and their primary caregivers across three waves of data with an average span of 4.5 years; and a Community Survey of neighborhood residents. Analysis used an Item-Response Theory-based statistical approach on 6556 substance use item responses from 1639 youth (49.0 % female) within 80 neighborhoods to assess the extent to which neighborhood opportunities for substance use had direct and indirect effects on adolescent substance use. Neither direct nor mediated effects of neighborhood opportunities for substance use on adolescent substance use were detected. But, analyses revealed moderating effects such that higher levels of neighborhood opportunities for substance use: (1) amplified the detrimental effects of parental substance use and peer substance use on youth substance use; and (2) attenuated the protective effect of adolescents’ perceived harm of substance use on adolescent substance use. The results suggest that the ways in which neighborhood characteristics impact adolescent behavior are nuanced. Rather than impact individual-level outcomes directly, neighborhood context may be particularly relevant by conditioning the effects of salient individual-level risk and protective factors for substance use.

Keywords Substance use · Neighborhood · Peer · Family · Perceived harm

Introduction

Adolescent substance use, which includes the use of alcohol, tobacco, marijuana, and more illicit drugs, is a relatively common practice. In 2014, as part of the Monitoring the Future (MTF) survey, 60.2 % of high school seniors and 44 % of 10th graders reported alcohol use in the past year; 35.1 % of 12th graders and 27.3 % of 10th graders reported marijuana use; and 15.9 and 11.2 % of 12th and 10th graders, respectively, reported more illicit drug use (Miech et al. 2015). While normative climates of alcohol and drug use vary across larger geographic contexts (see Thrash and Warner 2016), the high prevalence of substance use among school-aged youth makes it a significant public health concern.

The prevalence of youth substance use is particularly alarming given the documented relationship between youth substance use and maladaptive developmental outcomes. Youth who use alcohol and drugs are more likely to have poor educational attainment (Lynskey and Hall 2000) and to develop mental health issues, including psychological distress (Hansell and White 1991) and impaired cognitive functioning (Tapert et al. 2002). Other correlates of youth substance use include: risky sexual behavior (Ritchwood...
et al. 2015); human immunodeficiency virus (HIV) and acquired immune deficiency syndrome (AIDS) (Shoptaw et al. 2013); nonviolent offending and involvement in violence (Jennings et al. 2014); suicidal ideation, suicide attempt and suicide death (Poorolajal et al. 2015); and fatality (Jayasekara et al. 2014).

Prior research addressing the scope and consequences of youth substance use has focused disproportionately on individual factors. But, examining proximal individual factors relevant to adolescent substance use within family, peer, and neighborhood contexts enables a more comprehensive understanding of adolescent substance use (see Jackson et al. 2014). This premise is consistent with theory. The social development model, for example, integrates social control theory (Hirschi 1969) and social learning theory (Akers 1977) in asserting that social behavior is a product of factors across multiple units of socialization, including microsystems (families, peers) and developmental contexts (schools, communities) (see Hawkins and Weis 1985). Bronfenbrenner’s (1979) ecological systems theory echoes this sentiment by emphasizing complex layers of environment (microsystem, mesosystem, exosystem, macrosystem) that influence behavior. Consistent with these models, this study conceptualizes youth substance use as a function of theoretically relevant risk and protective factors in the multiple contexts (i.e., families, peer networks, and neighborhoods) that youth face daily.

It is also critical to recognize that these ecological domains do not necessarily operate independently. For example, neighborhood effects may operate indirectly through intervening variables at the individual level or may condition the effects of individual and interpersonal characteristics (see Jackson et al. 2014). Ultimately, a full understanding of youth substance use requires a consideration of the direct and indirect (e.g., mediating and moderating) mechanisms through which influential risk and protective factors at multiple spheres of influence operate.

Our study contributes to the literature by investigating the direct and indirect mechanisms through which neighborhood norms conducive to substance use impact adolescent substance use. We examine: (1) whether opportunities for substance use in the neighborhood have a direct effect on adolescent substance use; (2) whether the effect of neighborhood opportunities for substance use on adolescent substance use is mediated by parental substance use, peer substance use, and respondents’ perceived harm of substance use; and (3) whether neighborhood opportunities for substance use moderate the effects of parental substance use, peer substance use, and respondents’ perceived harm of substance use on respondent substance use.

We test our hypotheses (enumerated below) with data from the Project on Human Development in Chicago Neighborhoods (PHDCN). We begin by reviewing the existing literature on our focal independent variables before grounding our hypotheses in existing theory and research.

### The Relevance of Familial and Peer Contexts for Youth Substance Use

Existing literature has highlighted the role that families and peers play in the etiology of youth substance use. For example, Allison et al. (1999: 111) state: “In considering the influences of microsystems on adolescent substance use, familial and peer contexts have received the most extensive attention in the research literature.”

Pertaining to the familial context, parents’ attitudes toward substance use and parental alcohol and drug use have been identified as particularly relevant to youth substance use. Youth whose parents have favorable attitudes toward substance use are more likely to use substances themselves (e.g., Fagan et al. 2013), while adolescents’ expectations of parental disapproval for alcohol and drug use have been demonstrated as a protective factor for adolescent substance use (Scheer et al. 2000). Additionally, children of substance-using parents have an elevated risk for substance use themselves (see Allison et al. 1999), although it seems that gender may play a role in the parental modeling of substance use. For example, Ohannessian (2012) found that paternal problem drinking impacted substance use among boys, but not girls, while maternal problem drinking impacted substance use among girls, but not boys.

Evidence has also demonstrated a robust relationship between peer substance use and personal substance use. For example, youth substance use is positively correlated with peer group norms (Leifheit et al. 2015) and an individual’s perception of peer substance use (Zimmerman and Vasquez 2011). In addition, research has demonstrated that substance use within best friendships, peer cliques, and social crowds uniquely predict adolescents’ involvement with substance use (Hussong 2002), although the influence of best friendships may exceed the influence of social crowds (Urberg 1992). The strong relationship between peer and personal substance use is not surprising, given our understanding of the increasingly important role that peers play for child and adolescent development (Warr 2002).

In short, parental and peer substance use, and parental and peer attitudes about substance use, have a strong impact on youth substance use. As Donovan (2004: 529.e7) states: “The most consistent antecedent risk factors” for the initiation of adolescent substance use are “parental and peer approval and models for drinking and drug use.” But, attitudes, definitions, and perceptions represent the mechanisms through which observation and vicarious...
reinforcement become intention and behavior (Akers 1977). The perception that substance use has no immediate negative effects or consequences, a view that is promulgated by witnessing substance use and being exposed to attitudes favorable to substance use in familial and peer contexts, is thus a key correlate of youth substance use (see Zimmerman and Vasquez 2011). Accordingly, studies have found that perceiving substance use as negative or harmful acts as a deterrent to youth substance use (see Barkin et al. 2002; Wright et al. 2014). For example, Cleveland et al. (2008) found that the perceived risk of substance use was inversely associated with adolescent substance use, and Bachman et al. (1998) found that the perceived health risks of marijuana reduced the prevalence of adolescent marijuana use. There is thus a documented inverse relationship between adolescents’ perceived harm of substance use and subsequent substance use.

Neighborhood Effects on Youth Substance Use

As compared to research on individual, family, and peer factors, research examining the role that neighborhood characteristics play in the etiology of adolescent substance use is more nascent. Additionally, much of this research: (1) has not incorporated a multilevel design, which is necessary to appropriately model variation in youth substance use as a function of both individual and neighborhood covariates; and (2) has focused on structural characteristics, such as neighborhood disadvantage or joblessness, rather than on more proximal social processes (e.g., community norms and attitudes) linked to youth substance use (see Jackson et al. 2014).

Moreover, existing multilevel research examining the direct impact of neighborhood characteristics on individual-level substance use is inconsistent (see Fagan et al. 2015a). For example, Hoffman (2002) found that adolescents living in neighborhoods with a higher proportion of jobless men had an increased risk of drug use, while other studies have found an inverse relationship between disadvantage and substance use (e.g., Snedker et al. 2009; Sunder et al. 2007). Similarly, some studies have found that neighborhood norms conducive to substance use do not have a significant impact on adolescent substance use (e.g., Fagan et al. 2015b; Musick et al. 2008), while other studies have detected elevated levels of adolescent substance use in neighborhoods with norms favorable toward substance use (e.g., Van Horn et al. 2007) and in neighborhoods where residents perceive high levels of substance use (e.g., Brown et al. 2014; Duncan et al. 2014).

While evidence on the direct effects of neighborhood characteristics appears muddled, a stronger case has been made for examining the indirect processes (i.e., mediation and moderation) through which neighborhood characteristics operate. Indeed, conceptual frameworks in developmental psychology (Bronfenbrenner 1979) and reviews of the neighborhood effects literature elsewhere (see Jencks and Mayer 1990; Leventhal and Brooks-Gunn 2000) have emphasized that the effects of distal neighborhood characteristics are likely mediated by more proximal factors. Yet, in a review of multilevel studies on adolescent substance use, Jackson et al. (2014) found only a handful of studies that attempted to identify whether individual-level variables mediated the association between neighborhood characteristics and adolescent alcohol use. Moreover, the majority of these studies did not find significant mediating effects.

It is also possible that neighborhood characteristics moderate the effects of individual-level characteristics on adolescent substance use via cross-level interactions. There are examples of such moderation analyses in the literature. For example, Snedker et al. (2009) and Zimmerman and Vasquez (2011) found that neighborhood disadvantage and neighborhood opportunities for crime, respectively, moderated the relationship between peer substance use and adolescent substance use (albeit in different directions); Wright et al. (2014) found that neighborhood norms favorable to deviance moderated the effect of youth’s perceived harm of drug use on youth drug use; and Mayberry et al. (2009) found that a sense of belonging in the community moderated the role of peer influence and parenting characteristics (i.e., knowledge, communication, support, and values) on adolescent substance use. Yet, as Jackson et al. (2014) note, these studies represent only a small number of studies that have effectively conducted moderation analyses to determine whether neighborhood effects operate by amplifying or attenuating the effects of salient individual-level characteristics within the neighborhood.

Current Study

Ultimately, we argue that it is critical: (1) to use multilevel designs to examine all of the potential mechanisms—direct, mediating, and moderating—through which the neighborhood context operates; and (2) to define the neighborhood context by social processes that causally link structural neighborhood characteristics to individual-level variation in substance use. Accordingly, we use a multilevel design to investigate the direct and indirect effects of neighborhood opportunities for substance use on youth substance use via three sets of hypotheses.

The first hypothesis purports that there will be a direct effect of opportunities for substance use at the neighborhood level on individual-level variation in adolescent substance use. We expect adolescents living in neighborhoods that offer few opportunities for substance use to be insulated, relative to their counterparts, from outside
pressures to engage in substance use. We also expect these youth to have internalized definitions unfavorable to substance use that have been instilled by existing antijob drug norms in the neighborhood; in turn, definitions unfavorable to substance use will reduce alcohol and drug use. Conversely, in neighborhoods where youth have more opportunities for substance use, or have developed subcultures conducive to drug dealing or drug use (Anderson 1999), we expect availability processes, outside pressures, and definitions favorable to substance use to increase individual substance use. These processes may also be amplified because neighborhoods with more opportunities for substance use are often marred by socio-economic disadvantage and low levels of collective efficacy, environments in which residents may be less likely to effectively monitor and control adolescent substance-using behaviors (see Sampson et al. 1997).

Such a contextual effect is supported by Bronfenbrenner’s (1979) (bio)ecological systems theory and the social development model (see Hawkins and Weis 1985), under which variation in individual behavior is a function of larger ecological domains. In addition, the “neighborhood effects” literature has documented a number of community social processes that contribute directly to individual problem behaviors and developmental outcomes (see Sampson et al. 2002). These contextual effects are particularly salient among adolescents who are gaining autonomy and access to environments outside of the home.

The second hypothesis suggests that neighborhood opportunities for substance use may impact adolescent substance indirectly through three intervening variables: parental substance use, peer substance use, and adolescents’ perceived harm of substance use. Critical to the ecological model is the interplay between different levels of contexts (Bronfenbrenner 1979), and a key premise of social structure and social learning theory (Akers 2009) is that the larger social structure operates primarily through more proximal characteristics in the microsystem (e.g., individual, family, and peer factors). Such ideas are reiterated by Sampson et al. (2002) and Leventhal and Brooks-Gunn (2000) in their reviews of the neighborhood effects literature. Therefore, although we expect neighborhood opportunities for substance use to have a direct effect on youth substance use, we also expect neighborhood opportunities for substance use to operate more poignantly through the proximal, well-documented individual correlates of adolescent substance use discussed above. In this case, neighborhood opportunities for substance use would impact levels of parental substance use, peer substance use, and adolescents’ perceived harm of substance, which, in turn, would impact youth substance use.

The third hypothesis suggests that neighborhood opportunities for substance use will moderate the effects of parental substance use, peer substance use, and adolescents’ perceived harm of substance use on youth substance use. Specifically, we expect neighborhood opportunities for substance use to amplify the detrimental effects of parental substance use and peer substance use on youth substance use, and to attenuate the deterrent effect of adolescents’ perceived harm of substance use on adolescent substance use. This hypothesis is consistent with a vulnerability argument (see Mischel 2004), under which individuals predisposed to substance use will be more susceptible to alcohol and drug use when faced with temptations and provocations in the larger social context (see also Amaro 2014). For example, greater access to alcohol and drugs, and increased pressures for substance use in the neighborhood, may amplify the harmful effects of parental and peer substance use. Additionally, the protective effect of perceiving substance use as harmful may be suppressed in neighborhoods with more opportunities and pressures for substance use.

In short, we propose that neighborhood opportunities for substance use will have direct and indirect effects on youth substance use. Stated more formally, our principal hypotheses stipulate three sets of hypotheses. The first hypothesis posits that living in a neighborhood with more opportunities for substance use should increase the odds of youth substance use (Hypothesis 1). The second set of hypotheses suggest that the effect of neighborhood opportunities for substance use on youth substance use should be mediated by parental substance use (Hypothesis 2a), peer substance use (Hypothesis 2b), and adolescents’ perceived harm of substance use (Hypothesis 2c). According to the third set of hypotheses, neighborhood opportunities for substance use should have moderating effects such that living in a neighborhood with more opportunities for substance use should amplify the detrimental effects of parental substance use (Hypothesis 3a) and peer substance use (Hypothesis 3b) on youth substance use, and weaken the protective effect of adolescents’ perceived harm of substance use on youth substance use (Hypothesis 3c).

Methods

Study Sample

This study considers two of the PHDCN’s components: the Community Survey (CS) and the Longitudinal Cohort Study (LCS). The sampling strategy for these components revolved around 343 researcher-defined neighborhood clusters (NCs), constructed from Chicago’s 847 census tracts on the basis of geographic contiguity and internal (socioeconomic and racial/ethnic) homogeneity, and designed to approximate local neighborhoods. The CS was a probability sample of 8782 adults selected via a multi-
stage sampling design of city blocks within the 343 NCs, households within blocks, and one adult (18+) per household. For the LCS, a stratified random sample of 80 of the 343 NCs, and a simple random sample of households within these 80 NCs, identified over 6000 youth in seven age cohorts (i.e., youth within 6 months of their birth, 3rd, 6th, 9th, 12th, 15th, and 18th birthdays at baseline). This study examines all 1639 youth from cohorts aged 9 (N = 825) and 12 (N = 814) who were interviewed at wave 1; restricting the sample to these cohorts ensures that youth were under the legal drinking and smoking age at time of measurement of the dependent variable. Data were collected on youth and their primary caregivers via self-report surveys and structured interviews across three waves of data with an average span of 4.5 years; retention rates across these cohorts ranged from 85 to 87% at wave 2 and from 74 to 78% at wave 3. As discussed below, the independent variables were generated from waves 1 and 2 of the LCS, the CS, and the US census; the outcome was measured at wave 3.

Excluding subjects lost to attrition over the course of the study (28.9% of the sample) or to item-level missing data (13.8% of the sample) would have resulted in significant loss of statistical power and potential bias in model estimates. Although there was no evidence to suggest that respondents left the study systematically (Sampson et al. 2005), and no detectable patterns emerged between participants with and without complete data, missing data were imputed within NCs using chained equations in STATA 13. Independent, dependent, and auxiliary variables were included in the imputation models. Statistical models (see below) were estimated using maximum likelihood in HLM 7, which averaged coefficients and created robust standard errors across data sets, thereby addressing assumption violations (e.g., non-normality) (see Little and Schenker 1995; Royston 2005).

The final study sample includes reports on 6556 substance use item responses from 1639 respondents within 80 neighborhoods. The use of the PHDCN data is IRB-approved, and no data identifiable to a person were collected by the researchers. Study measures are described below. More detailed descriptions of all study measures, including means, standard deviations, ranges, and reliabilities, when applicable, are provided in Appendix 1.

**Measures**

**Adolescent Substance Use**

Respondents reported whether or not (1 = yes; 0 = no) they used four substances during the year preceding the wave 3 interview: alcohol (i.e., beer, wine, wine coolers, and liquor); tobacco; marijuana; and other illicit drugs (i.e., cocaine, crack, inhalants, psychedelics, heroin, amphetamines, barbiturates, and tranquilizers). The frequencies of alcohol, cigarette, marijuana, and illicit drug use were 30.8, 19.6, 15.9, and 2.3%, respectively. The dichotomous items, which exhibited unidimensionality (α = .67), were incorporated into a scale of substance use as described in the “Analytical Strategy” section below.

**Neighborhood Opportunities for Substance Use**

In the CS, neighborhood residents were asked to report how much of a problem (from 1 = “Not a problem” to 3 = “A big problem”) is: (1) drinking in public [in your neighborhood], and (2) people selling or using drugs [in your neighborhood]. These items reflect the extent to which the neighborhood presents opportunities and pressures for substance use. These highly associated items (r = .90) were summed to form an index on which higher values represent more neighborhood opportunities for substance use. The average neighborhood had moderate opportunities for substance use (3.7; range 2.1–5.4).

**Parental Substance Use**

Youth’s primary caregivers were asked at wave 1 about the family’s history with alcohol and drug abuse. A dichotomous measure of parental substance use was coded in the affirmative if drinking and/or drug abuse had ever caused the youth’s mother and/or father to have problems with health, family, employment, or the police. Roughly 15% (N = 243) of sample youth had at least one parent with a history of alcohol and/or drug abuse.

**Peer Substance Use**

Respondents reported how many of their friends (from 1 = “None of them” to 4 = “All of them”) used each of three substances in the year preceding the wave 2 interview: alcohol, tobacco, and marijuana. These items were summed (α = .80); on average, respondents reported low levels of peer substance use (4.2; range 3–12). Roughly 55% of sample respondents reported having no friends who used alcohol, cigarettes, or marijuana (corresponding to a value of three on the scale); 34% of respondents reported substance use among some of their friends (values of 4–6 on the scale); 8% reported substance use among most of their friends (values of 7–9 on the scale); and 3% reported substance use among almost all or all of their friends (values of 10–12 on the scale).

**Perceived Harm of Substance Use**

At wave 2, respondents reported the extent (from 1 = “Definitely no” to 4 = “Definitely yes”) to which
people would hurt themselves if they engaged in 14 substance-using behaviors: smoking 1+ pack of cigarettes a day; smoking marijuana regularly; smoking marijuana now and then; trying marijuana (once or twice); using inhalants regularly; trying inhalants; using heroin regularly; trying heroin; using cocaine regularly; using cocaine now and then; trying cocaine; having one or two drinks of alcohol nearly every day; having four or five drinks nearly every day; and having 5+ drinks twice a week. These items were summed (α = 0.88); on average, respondents reported high levels of perceived harm of substance use (42.7; range 14–56).

**Person-Level Control Variables**

The analysis includes several individual-level control variables relevant to adolescent substance use. Demographic variables include age (at wave 1), sex, race/ethnicity, and immigrant generational status. The mean age of sample respondents at the baseline interview was 10.6 years; 51% (n = 836) of sample respondents were male; the vast majority of sample respondents (roughly 95.8%) were Hispanic (n = 755; 46.1%), Black (n = 587; 35.8%), or White (n = 227; 13.9%); and 11.9% (n = 195), 32.5% (n = 532), and 55.6% (n = 912) of respondents were first, second, and third (or higher) generation immigrants, respectively.

Family-level variables measured at wave 1 include: family size (mean = 5.4); the respondent’s number of siblings (under 19) living in the same household (mean = 2.3); the number of years the respondent has lived at the same residence (mean = 6); household socioeconomic status (an index of parental income, education, and occupation); the primary caregiver’s employment status (n = 967; 59.0% employed); and family structure. Family structure was categorized as follows: living with two biological parents (n = 780; 47.6%); living with two parents, one or both non-biological (n = 304; 20.7%); living with one biological parent (n = 462; 28.2%); and living with one non-biological parent (n = 58; 3.5%).

Behavioral and cognitive characteristics include low self-control and prior substance use. Low self-control is a caregiver-rated measure of the youth’s lack of inhibitory control, present-orientation, sensation seeking, and lack of persistence at wave 1 (see Gibson et al. 2010). On average, youth had moderate levels of low self-control (2.7; range 1–4.6). Prior substance use measures the lifetime use of alcohol, cigarettes, marijuana, and illicit drugs prior to wave 2 (mean = .4; range 0–4). Including this lagged dependent variable in the models accounts for unobserved heterogeneity in the propensity towards substance use, which alleviates biased estimates of predictor effects and attempts to account for behavioral change over time (see Morgan and Winship 2007).

Four additional dummy variables are included in the models. We include a binary variable representing respondent transiency (1 = moved between waves 1 and 3 of the study; 0 = did not move) to examine whether (and control for the possibility that) the results differ for respondents living in the same residence throughout the study and for those who moved between waves of the study (n = 617; 37.6%). We include two binary variables representing whether respondents were missing data due to attrition between waves 1 and 3 of the study (n = 474; 28.9%) or missing data on at least one study covariate due to non-response (n = 227; 13.8%). Finally, to account for differences in alcohol and drug availability across respondents, we include a binary variable indicating whether a respondent was over age 17 at wave 3 (n = 175; 10.7%).

**Neighborhood-Level Control Variables**

The analysis includes several neighborhood-level control variables constructed from the 1990 decennial census and the CS (1994–1995). Measures of concentrated disadvantage, ethnic heterogeneity, and residential stability were constructed from the census (see Sampson et al. 1997). Concentrated disadvantage was calculated as a weighted factor regression score of percentage of families below the poverty line, percentage of households receiving public assistance, percentage of female-headed families with children, percentage of population unemployed, and median household income. Ethnic heterogeneity was constructed using Blau’s equation: $1 - \sum p_i^2$, where $p_i$ is the proportion of the population in each racial/ethnic group (White, Black, Native American, Asian, Hispanic, Other). This measurement strategy takes into account the relative sizes of the groups and the number of groups in the population. Residential stability is the standardized sum of the percentage of residents living in the same house as 5 years earlier and the percentage of owner-occupied homes.

Measures of the tolerance of substance use and collective efficacy were constructed from the CS. Consistent with prior measures of tolerance of deviance (see Sampson and Bartusch 1998), tolerance of substance use is a standardized scale of residents’ perceptions about how wrong it is (from 1 = “extremely wrong” to 5 = “not wrong at all”) for: teenagers around 13 years of age to drink, to smoke, and to use marijuana; and teenagers around 19 years of age to drink and to use marijuana. Higher levels on the scale (\(\alpha = .89\)) represent higher levels of tolerance of substance use in the neighborhood. Collective efficacy combines social cohesion and informal social control in the neighborhood. Social cohesion was measured by asking neighborhood residents to indicate on a five-point scale how
strongly they agreed that: this is a close-knit neighborhood, people are willing to help their neighbors, people in the neighborhood can be trusted, people don’t get along, and people in the neighborhood do not share the same values (last two items reverse-coded). Shared expectations for social control were measured by asking respondents how likely neighbors would be to: do something about kids skipping school, do something about kids defacing a building, scold a child for not showing respect, break up a fight in front of their house, and organize to keep a local fire station. As described in depth elsewhere (see Sampson et al. 1997), collective efficacy was constructed from these ten items using a linear item-response model to account for the number and difficulty of the items.

**Analytical Strategy**

As discussed in the “Measures” section above, our analysis focuses on whether respondents reported using alcohol, cigarettes, marijuana, and illicit drugs during the 12 months preceding the wave 3 interview. This measurement strategy allows us to use a multilevel Rasch model, an item response theory (IRT) model with logit form, to predict the odds of substance use. Recent research has argued convincingly that this approach is a suitable approach for modeling self-reported delinquent acts (see Raudenbush et al. 2003; Sampson et al. 2005), including substance use (see Zimmerman and Vasquez 2011). This approach: takes into account the varying frequency and seriousness of the substances in the study; focuses attention on the absence (zero) versus the presence (unity) of substance use, perhaps the most fundamental distinction in research on delinquency in general (see Osgood et al. 2002); overcomes the nonlinear nature of right-skewed offending variables by translating “the normal distribution on the latent trait to response probabilities that match their skewed observed distribution” (Osgood et al. 2002: 279); reduces the threat of finding artifactual interactive relationships; and simultaneously utilizes the benefits of item response theory and hierarchical linear models, applying item response theory to the dependent variable and modeling substance use as a function of individual and neighborhood characteristics.

The model has three levels, nesting 6556 substance use item responses at level 1 within 1639 individuals at level 2 and 80 neighborhoods at level 3. The level 1 model, representing the item response model, nests the substance use items within persons and incorporates them into a scale of substance use, a latent variable representing each person’s propensity towards substance use. This latent variable is interpreted on a logit metric and serves as the outcome variable for the level 2 (person) and level 3 (neighborhood) models. In the level 2 model, all individual-level factors predict substance use within neighborhoods. The level 3 model predicts individual variation in substance use with the neighborhood-level characteristics. To reduce collinearity and to make the results interpretable for an average person in the sample, all independent variables were standardized or grand mean centered (see Raudenbush and Bryk 2002).

The first hypothesis stipulates that living in a neighborhood with more opportunities for substance use should increase the odds of youth substance use. To investigate this hypothesis, we incorporate the neighborhood opportunities for substance use variable into level 3 of the multilevel, Rasch model.

To examine whether neighborhood opportunities for substance use has an indirect effect on adolescent substance use through each of the hypothesized mediators (hypotheses 2a–2c), we first estimate a series of two level hierarchical models regressing each of the mediators on neighborhood opportunities for substance use, along with the array of study covariates. These models generate raw regression coefficients (a in Fig. 1) for the effect of neighborhood opportunities for substance use on each of the mediators. Next, the raw regression coefficients for the associations between the mediators and the tendency toward substance use (b in Fig. 1) are calculated using the multilevel Rasch model with all study covariates (but note that the unstandardized mediators are included in the model one at a time). The indirect effects of neighborhood opportunities for substance use on adolescent substance use through each of the mediators is then calculated as the product $a \times b$.

To test whether these calculated indirect effects differ significantly from zero, we make use of the Monte Carlo method (MacKinnon et al. 2004). Although nonparametric bootstrapping (Efron and Tibshirani 1986) is a good option

![Diagram Image](image-url)
for testing mediation (Bauer et al. 2006), there is not consensus about the best way to use bootstrapping to test multilevel mediation, and testing indirect effects using HLM software is not straightforward (see Preacher et al. 2010). In such cases, “the MC [Monte Carlo] method should be considered a viable and competitive method for constructing CIs [confidence intervals] for simple and complex indirect effects” (see Preacher and Selig 2012: 94). Accordingly, 95 % confidence intervals for each of the hypothesized indirect effects are calculated using a Monte Carlo Method for Assessing Mediation (MCMAM) macro with 20,000 simulations in R 3.2.3 (see Selig and Preacher 2008).

Finally, we examine whether neighborhood opportunities for substance use moderate the effects of parental substance use, peer substance use, and the perceived harm of substance use on adolescent substance use. The moderation hypotheses (hypothesis 3a–3c) are tested by incorporating a series of cross-level interaction terms into the multilevel Rasch model.

Results

Examining the Direct Effect of Neighborhood Opportunities for Substance Use

Table 1 presents odds ratios (or exponentiated log-odds regression coefficients) and confidence intervals from the multilevel Rasch model discussed in the “Analytical Strategy” section above. Contrary to the first hypothesis, the odds of engaging in substance use are unaffected by neighborhood opportunities for substance use (OR .98; 95 % CI .87, 1.09).

Yet, the model reveals several salient correlates of youth substance use. Pertaining to the other focal independent variables, the odds of substance use are higher among youth residing in households with parental substance use (OR 1.36; 95 % CI 1.07, 1.74), reporting higher levels of peer substance use (OR 1.49; 95 % CI 1.28, 1.74), and perceiving lower levels of harm associated with substance use (OR .75; 95 % CI .70, .81). Regarding the demographic characteristics, the odds of substance use are higher among: male youth (OR 1.17; 95 % CI 1.02, 1.35); white youth, as compared to Hispanic (OR .65; 95 % CI .51, .82) and African American (OR .66; 95 % CI .51, .85) youth; and older youth (OR 1.40; 95 % CI 1.32, 1.49). Pertaining to the behavioral and cognitive factors, substance use is elevated among youth with lower levels of self-control (OR 1.07; 95 % CI 1.01, 1.15) and higher levels of prior substance use (OR 1.29; 95 % CI 1.13, 1.48). Regarding the neighborhood characteristics, increases in ethnic heterogeneity decrease substance use (OR .89; 95 % CI .83, .96).

Examining the Mediating Hypotheses

The results from the mediation analyses are shown in Table 2. Panel A shows the raw (unstandardized) regression coefficients for the effect of neighborhood opportunities for substance use on each of the hypothesized mediators (a in Fig. 1). The results indicate that the neighborhood opportunities for substance use variable is not significantly associated with parental substance use (OR .89; 95 % CI .83, .96), or the perceived harm of substance use (OR .75; 95 % CI .70, .81). Regarding the demographic variables, the odds of engaging in substance use are unaffected by neighborhood opportunities for substance use (OR .98; 95 % CI .87, 1.09).

Panel B in Table 2 shows the associations between each of the mediators and youth substance use (b in Fig. 1). The results are identical to those presented in Table 1 (i.e., each of the proposed mediators is significantly associated with youth substance use), except that Table 2 presents the raw regression coefficients for the focal individual-level variables.

Panel C shows the indirect effects of neighborhood opportunities for substance use on adolescent substance use through each of the proposed mediators (a \times b), as well as the 95 % confidence intervals for the indirect effects, estimated using the Monte Carlo Method for Assessing Mediation (MCMAM) macro, as discussed in the “Analytical Strategy” section above. The results indicate that each of the indirect effects is close to zero, and each of the 95 % confidence intervals encompasses zero. Thus, contrary to hypotheses 2a, 2b, and 2c, neighborhood opportunities for substance use does not impact adolescent substance use indirectly through any of the proposed mediators.

Examining the Moderating Hypotheses

We examine and find strong support for the moderating hypotheses (hypotheses 3a–c) in Table 3. The odds ratio for the cross-level interaction between parental substance use and neighborhood opportunities for substance use is significant and greater than one (OR 1.23; 95 % CI 1.01, 1.52), indicating that a one standard deviation increase in neighborhood opportunities for substance use increases the odds ratio describing the relationship between parental substance use and adolescent substance use by 68 % [(1.23–1)/(1.34–1) \times 100 %]. Consistent with hypothesis 3a, living in a neighborhood with more opportunities for substance use amplifies the detrimental effect of parental substance use on youth substance use.

Figure 2 graphically illustrates the relationship between parental and youth substance use by the level of neighborhood opportunities for substance use. As one moves from neighborhoods with fewer to more opportunities for substance use (from left to right in the figure), the disparity...
Table 1 Hierarchical item response regression of tendency toward substance use on independent variables (N = 6556 item responses, 1639 persons, 80 neighborhoods)

| Independent variables                                      | OR     | 95 % CI       |
|------------------------------------------------------------|--------|---------------|
| **Focal independent variables**                            |        |               |
| Neighborhood opportunities for substance use               | .98    | [.87, 1.09]    |
| Parental substance use                                      | 1.36*  | [1.07, 1.74]  |
| Peer substance use                                          | 1.49***| [1.28, 1.74]  |
| Perceived harm of substance use                             | .75*** | [.70, .81]     |
| **Demographic characteristics**                            |        |               |
| Male                                                       | 1.17*  | [1.02, 1.35]  |
| Race/ethnicity                                              |        |               |
| Hispanic                                                   | .65*** | [.51, .82]     |
| African American                                           | .66**  | [.51, .85]     |
| Immigrant generational status                               |        |               |
| First                                                      | 1.13   | [.83, 1.53]    |
| Second                                                     | 1.20   | [.96, 1.49]    |
| Age                                                        | 1.40***| [1.32, 1.49]   |
| **Family factors**                                         |        |               |
| Family structure                                           |        |               |
| Two parents, one/both non-biological                       | 1.15   | [.97, 1.36]    |
| One parent, biological                                     | 1.08   | [.71, 1.66]    |
| One parent, non-biological                                 | .90    | [.71, 1.15]    |
| Family size                                                | 1.00   | [.95, 1.05]    |
| Number of siblings                                         | 1.02   | [.96, 1.08]    |
| Years living at residence                                  | .99    | [.98, 1.01]    |
| Household socioeconomic status                             | 1.00   | [.90, 1.11]    |
| Primary caregiver employment status                        | 1.05   | [.88, 1.26]    |
| **Behavioral and cognitive factors**                       |        |               |
| Low self-control                                           | 1.07*  | [1.01, 1.15]   |
| Prior substance use                                         | 1.29***| [1.13, 1.48]   |
| **Neighborhood characteristics**                           |        |               |
| Neighborhood disadvantage                                  | .93    | [.81, 1.07]    |
| Ethnic heterogeneity                                        | .89**  | [.83, .96]     |
| Residential stability                                       | .96    | [.86, 1.07]    |
| Tolerance of deviance                                      | 1.02   | [.94, 1.10]    |
| Collective efficacy                                         | 1.06   | [.96, 1.16]    |

The level 1 model produces relative severities of the four items. The model also controls for “other” race (ns), two dummy variables representing imputed data (ns), residential mobility across waves (ns), and participants over age 17 at wave 3 (p < .05).

OR odds ratio, CI confidence interval

* p < .05; ** p < .01; *** p < .001. p values were determined by two-tailed test

a Reference category = White; b Reference category = Third (or higher) generation immigrant; c Reference category = Two parents, both biological

in the probability of substance use between youth with and without substance-using parents increases, indicating that the relationship between parental and adolescent substance use is amplified in neighborhoods with more opportunities for substance use. In fact, a simple slope analysis (not shown here) indicates that the effect of parental substance use on youth substance use is significant in neighborhoods with high (OR = 1.83; 95 % CI 1.21, 2.77; p < .01) and middle (OR 1.34; 95 % CI 1.06, 1.69; p < .05) levels of opportunities for substance use, but not significant in neighborhoods (OR .98; 95 % CI .68, 1.41; p > .05) with low levels of opportunities for substance use.

Table 3 also indicates, consistent with hypothesis 3b, that the relationship between peer and respondent substance use is amplified in neighborhoods with more opportunities for substance use. The odds ratio for the cross-level interaction between peer and respondent substance use (OR 1.10; 95 % CI 1.03, 1.19) suggests that a
one standard deviation increase in neighborhood opportunities for substance use increases the odds ratio describing the relationship between peer and respondent substance use by 21 % [(1.10–1)/(1.47–1) × 100 %].

Figure 3 depicts the relationship between peer and adolescent substance use by the level of neighborhood opportunities for substance use. As one moves from neighborhoods with fewer to more opportunities for substance use, the disparity between different categories of substance-using peers increases. For example, in a neighborhood with low opportunities for substance use, the predicted probability of substance use among respondents with some substance-using peers is 18 %, while the probability of substance use among respondents who indicated that most of their peers engaged in substance use is 25 %, a difference of 7 %. In a neighborhood with high opportunities for substance use, the predicted probability of substance use among respondents with some substance-using
peers is 20%, while the probability of substance use among respondents who indicated that most of their peers used substances is 37%, a difference of 17%. The disparities are even greater when comparing respondents who had no substance use among their peers versus respondents whose peers all engaged in substance use. These disparities provide a clear picture of the nature of the moderating effect of neighborhood opportunities for substance use on the peer effect: the relationship between peer and adolescent substance use is amplified in neighborhoods with more opportunities for substance use.

Finally, Table 3 reveals a marginally significant cross-level interaction between the perceived harm of substance use and neighborhood opportunities for substance use (OR 1.07; 95% CI 1.00, 1.15), indicating, consistent with hypothesis 3c, that the protective effect of perceiving alcohol and drugs as harmful is weakened in neighborhoods with more opportunities for substance use. Simple slope analysis (not shown here) indicates for a one standard deviation increase in the perceived harm of substance use, the odds of respondent substance use decrease by 33% (OR .67; 95% CI .59, .77; p < .001) in neighborhoods with low opportunities for substance use, by 26% (OR .74; 95% CI .69, .80; p < .001) in neighborhoods with average opportunities for substance use, and by 18% (OR .82; 95% CI .72, .94; p < .01) in neighborhoods with high opportunities for substance use.

**Sensitivity Analyses**

The robustness of the findings was examined in several sensitivity analyses. First, one could argue that the use of alcohol, cigarettes, and marijuana is relatively normative during adolescence, but the use of more illicit substances (e.g., cocaine, crack) is not. We therefore modeled the outcome without illicit drug use. To provide an additional check on the robustness of the findings, we also modeled each of the four substances in separate hierarchical logistic models. Appendix 2 presents the results from these sensitivity analyses with respect to the moderation analyses, given that the moderating effects represented the key significant findings in the manuscript.

The results from the full model in Table 2 are substantively unchanged when excluding illicit drug use from the outcome (Model 1 in Appendix 2). With respect to the disaggregated outcomes, the results pertaining to peer substance use and the perceived harm of substance use are quite consistent. For alcohol (Model 2), the results are markedly similar to those presented in Table 2. Across the rest of the outcomes (Models 3–5), peer substance use and the perceived harm of substance use remain significant, direct predictors of respondent substance use. In addition, neighborhood opportunities for substance use moderate the effect of peer substance use in the tobacco model (Model 3) and the effect of the perceived harm of substance use in the tobacco (Model 3), marijuana (Model 4), and illicit drug

---

**Fig. 2** The relationship between parental substance use and the predicted probability of substance use is amplified for individuals living in neighborhoods with more opportunities for substance use. Notes: The figure ranges from 1.5 standard deviations below the mean (i.e., “Low”) to 1.5 standard deviations above the mean (i.e., “High”) of neighborhood opportunities for substance use (range –1.87 to 1.99).

**Fig. 3** The relationship between peer substance use and the predicted probability of substance use is amplified for individuals living in neighborhoods with more opportunities for substance use. Notes: The figure ranges from 1.5 standard deviations below the mean (i.e., “Low”) to 1.5 standard deviations above the mean (i.e., “High”) of neighborhood opportunities for substance use (range –1.87 to 1.99). Peer substance use ranges from 3 to 12, with values of 3, 4–6, 7–9, and 10–12 representing “No Peers Use,” “Some Peers Use,” “Most Peers Use,” and “Almost All or All Peers Use,” respectively. Roughly 55% of sample respondents reported having no friends who used alcohol, cigarettes, or marijuana; 34% of respondents reported substance use among some of their friends; 8% reported substance use among most of their friends; and 3% reported substance use among almost all or all of their friends.
use (Model 5) models. Conversely, we observe disparate results pertaining to parental substance use across most of the outcomes. Perhaps this reflects the time lag between wave 1 (when parental substance use is measured) and wave 3 (when the outcomes are measured)? Nonetheless, the sensitivity analyses pertaining to peer substance use and the perceived harm of substance use give us confidence in the robustness of the results across the substances considered in this study.

Second, we examined whether other neighborhood variables moderated the effects of our focal individual-level variables on respondent substance use. Here, we limit the discussion to neighborhood tolerance of substance use, another neighborhood social process related specifically to substance use measured via the PHDCN’s Community Survey. Results of the sensitivity analyses indicate that neighborhood tolerance of substance use does not statistically moderate the effects of parental substance use (OR 1.03; 95% CI 0.78, 1.36), peer substance use (OR 0.94; 95% CI 0.89, 1.01), or adolescents' perceived harm of substance use (OR 1.03; 95% CI 0.94, 1.14) on respondent substance use. Supplemental analyses examining the moderating effects of other neighborhood-level variables were largely inconsequential.

Third, to address the potential bias produced from the multiple imputation procedures, we estimated all models without imputed data on the dependent variable, thereby effectively excluding individuals lost to attrition between waves 1 and 3 of the study. The results were substantively unchanged from those presented in the manuscript. We also found that the imputed data had no detectable relationship with the outcome, as noted at the bottom of Table 1.

Fourth, as discussed in the Measures section above, because more than one-third of respondents (37.6%) moved between study waves, we included a dummy variable representing respondent transiency in our models to examine whether (and to control for the possibility that) the results differed for respondents living in the same residence throughout the study and for those who have moved between waves of the study. This variable had no detectable relationship with the outcome, as noted at the bottom of Table 1. We further investigated whether the key findings in the manuscript were moderated by this variable, which would have indicated that the results were different for stable and transient youth. Again, the results were inconsequential, suggesting that respondent transiency, while prevalent, did not impact the results of the study.

Finally, although our sampling strategy restricted the sample primarily to youth under age 18 at wave 3, 11 youth in our sample were over 18. Because cigarette use was not illegal for these youth at the time the outcome variable was measured, we excluded these youth from the analysis with no change in the substantive pattern of results.

Discussion

Given the high prevalence of adolescent substance use (Miech et al. 2015) and its associated consequences, it is critical that research examine the multiple ecological domains that contribute to the initiation and continuation of youth substance use. But, high-quality, multi-level studies on adolescent substance use—which are necessary to place proximal individual factors relevant to substance use within family, peer, and neighborhood contexts—are sparse (see Jackson et al. 2014). In addition, despite the recognition that the “inclusion of moderation and mediation analyses would greatly contribute towards the understanding of causal pathways of neighborhood effects” (Jackson et al. 2014: 10), many studies continue to focus on the direct impact of neighborhood characteristics rather than on the indirect mechanisms through which the neighborhood context operates. Furthermore, many of these studies limit focus on structural neighborhood characteristics rather than on community norms relevant to substance use.

To address these issues, we used longitudinal, hierarchical data from the PHDCN to examine the direct and indirect (i.e., mediating and moderating) mechanisms through which neighborhood opportunities for substance use impact youth substance in a multilevel framework. We explored three sets of hypotheses: (1) opportunities for substance use in the neighborhood should have a direct effect on youth substance use; (2) the effect of neighborhood opportunities for substance use on adolescent substance use should be mediated by parental substance use (2a), peer substance use (2b), and respondents’ perceived harm of substance use (2c); and (3) neighborhood opportunities for substance use should amplify the detrimental effects of parental substance use (3a) and peer substance use (3b) on youth substance use, and attenuate the protective effect of respondents’ perceived harm of substance use on youth substance use (3c).

Contrary to our first hypothesis and our second set of hypotheses (2a–2c), we did not detect direct or mediated effects of neighborhood opportunities for substance use on adolescent substance use. Overall, the lack of support for the first two sets of hypotheses is not surprising given inconsistencies in the existing literature pertaining to the direct and indirect effects of neighborhood characteristics on youth substance use.

However, in line with previous research documenting the importance of familial and peer contexts for youth substance use (see Allison et al. 1999), we detected strong effects of parental and peer substance use on youth substance use. We also detected a strong effect of adolescents’ perceptions of the dangerousness of substance use on youth
substance use, consistent with prior research (see Wright et al. 2014). Moreover, and consistent with our third set of hypotheses, the effects on parental substance use, peer substance use, and the perceived harm of substance use were moderated by neighborhood opportunities for substance use. Specifically, living in a neighborhood with more opportunities for substance use: amplified the detrimental effects of parental substance use (3a) and peer substance use (3b) on youth substance use, and attenuated the protective effect of adolescents’ perceived harm of substance use on substance use (3c).

Implications for Research and Practice

The findings reaffirm the key insight from the social development model (see Hawkins and Weis 1985) and (bio)ecological systems theory (see Bronfenbrenner 1979) that understanding social behavior necessitates the study of relevant risk and protective factors across multiple units of socialization, including microsystems (families, peers) and developmental contexts (schools, communities). A summary of the neighborhood effects literature (see Sampson et al. 2002) reiterates this perspective, arguing that deviant behavior (in general) is not dependent on characteristics of either microsystems or macrosystems, but is rather a function of “kinds of individuals in kinds of settings” (Wikstrom 2004: 19).

The findings also reiterate a fundamental premise of the neighborhood effects literature that characteristics of the broader developmental context tend to operate indirectly, rather than directly (see Leventhal and Brooks-Gunn 2000). More specifically, neighborhood characteristics may impact individual behavior by moderating the effects of more proximal (e.g., individual) risk and protective factors. This view is consistent with Bronfenbrenner’s (1979) ecological model, which emphasizes the importance of considering interactions between complex layers of the environment. It is therefore possible that research neglecting the various mechanisms through which neighborhood factors operate (e.g., mediating and moderating effects) may be unintentionally discounting their overall impact. Moreover, as Jackson et al. (2014: 19) state: “Studies which only seek to examine the direct impact of neighborhoods will… hinder the development of understanding neighborhood effects on adolescents.”

Given this knowledge, we encourage future research to continue to investigate potential interactions between other salient neighborhood characteristics (e.g., disorder, collective efficacy, tolerance of deviance, and social capital) and more proximal factors (e.g., sociodemographic, family, peer, personality, and behavior) for substance use. Such research is likely to uncover additional causal pathways through which the environment is relevant to substance use (Donovan 2004).

Future research might also benefit from exploring different aspects of the neighborhood context. For example, recent literature suggests that neighborhoods outside of, but spatially proximate to an adolescent’s residential neighborhood are relevant in shaping adolescent behavior, suggesting a need to examine where youth act as well as live (see Jackson et al. 2016). Exploring neighborhood types based on the intersection of race/ethnicity, class, and geography may also be informative, given that these dimensions appear to be meaningful for adolescent substance use (Warner 2016).

Furthermore, the findings suggest that place-based interventions for reducing adolescent substance use are critical. These upstream interventions target neighborhood factors that contribute to maladaptive adolescent outcomes directly as well as indirectly by triggering existing vulnerabilities (Amaro 2014). Although moderation analysis can be particularly informative in identifying such neighborhood stimuli, prior research to inform this approach has been sparse (Jackson et al. 2014). Our study provides one avenue to address individual substance use from a community-based perspective: by reducing neighborhood opportunities for substance use, which can exacerbate pre-existing risk factors and weaken protective factors for substance use.

Limitations

The longitudinal, hierarchical nature of the PHDCN was well-suited to examine the study hypotheses. However, care must be taken in generalizing the results, given the place (Chicago) and time (1994–2002) of data collection. We also note that our measure of neighborhood opportunities for substance use was based on adult residents’ perceptions of the problematic nature of drinking and drug use in the neighborhood rather than on objective measures of substance use in the neighborhood. Nonetheless, official records would undoubtedly undercount such deviant behavior.

We also note that our measure of parental substance use was constructed at wave 1 of the study, in contrast to the time of measurement of our other focal independent variables, which were measured at wave 2. Measuring parental substance use at wave 1 could have had two effects on the study findings. First, it could have increased the observed relationship between parental substance and neighborhood substance use, both of which were measured contemporaneously. But, we note that the mediation analysis did not detect a relationship between parental substance and neighborhood substance use. Second, it could have tempered the relationship between parental substance use,
measured at wave 1, and respondent substance use, measured at wave 3, on average 4.5 years after wave 1. Indeed, the effects of peer substance use and perceived harm of substance use, both measured at wave 2, were more strongly associated with the outcome than was parental substance use, which was measured at wave 1. We therefore argue that our findings with respect to parental substance use were conservative.

Finally, our dependent variable was comprised of alcohol, tobacco, marijuana, and illicit drug use, and one could argue that there are inherent differences between the normative climates of these substances. We believe that our sensitivity analysis with respect to this issue demonstrates the robustness of the study findings.

Conclusion

This study addressed two critiques of prior research on adolescent substance use: (1) there is a dearth of research that has simultaneously examined the multiple ecological domains (e.g., families, peers, and neighborhoods) relevant to youth substance use in multilevel frameworks; and (2) our understanding of the mediating and moderating mechanisms through which neighborhood norms conducive to substance use operate is limited (see Jackson et al. 2014). Multilevel item response models that maximized the longitudinal, hierarchical nature of the PHDCN data failed to detect direct or mediated effects of neighborhood opportunities for substance use on adolescent substance use. But, consistent with expectations, the results indicated that living in a neighborhood with more opportunities for substance use amplified the detrimental impact of parental substance use and peer substance use on youth substance use, and weakened the protective effect of adolescents’ perceived harm of substance use on youth substance use. The results reiterate the key observation that neighborhoods matter in the etiology of adolescent substance use, but the ways in which neighborhoods matter is nuanced. Specifically, the more distal neighborhood context may be particularly relevant to youth substance use by moderating the effects of more proximal individual-level risk and protective factors for youth substance use (Leventhal and Brooks-Gunn 2000). Illuminating the indirect mechanisms through which the neighborhood context operates may hold key insights for place-based interventions addressing criminogenic neighborhood factors that trigger existing individual vulnerabilities for substance use (Amaro 2014).

Acknowledgments

This research uses data from the Project on Human Development in Chicago Neighborhoods, obtained from the Inter-University Consortium for Political and Social Research.

Author contributions

GMZ conceived of the study, participated in its design, conducted all statistical analyses, constructed the methods and results sections, and edited the introduction and discussion sections. CF participated in the design of the manuscript, drafted the introduction and discussion sections, and edited the methods and results sections. All authors read and approved the final manuscript.

Conflicts of interest

The authors report no conflict of interests.

Ethical approval

The use of PHDCN data for this study was approved by the Institutional Review Board at Northeastern University.

Informed consent

No data identifiable to a person were collected by the researchers. Gregory M. Zimmerman is an Associate Professor of Criminology and Criminal Justice at Northeastern University. He received his doctorate in Criminal Justice from the University at Albany, SUNY. His research focuses on the interrelationships among individual and contextual causes of criminal offending. Chelsea Farrell is a Doctoral student in the School of Criminology and Criminal Justice at Northeastern University. Her research focuses on neighborhood effects, victimization, and gendered relationships in the etiology of offending.

Appendix 1

Variable descriptions and summary statistics

Outcome measure (Wave 3)

Substance use

In the past 12 months, have you...

… had a drink of beer, wine, wine coolers, or liquor? (n = 505; 30.8 %)
… smoked cigarettes? (n = 321; 19.6 %)
… used marijuana? (n = 261; 15.9 %)
… used cocaine, crack, inhalants, psychedelics, heroin, amphetamines, barbiturates, or tranquilizers? (n = 38; 2.3 %)

Note The items were taken from the Substance Use questionnaire at wave 3 of the study. The dichotomous items, which conformed to a unidimensional scale (α = .67), were incorporated into a scale of substance use, a latent variable representing each person’s propensity for substance use, in the first level of a multilevel item response model.

Focal independent variables

Neighborhood opportunities for substance use (1994–1995 CS)
How much of a problem is…
…drinking in public [in your neighborhood]?
… people selling or using drugs [in your neighborhood]?
Mean = 3.7  SD = 0.9  Range 2.1–5.4  r = .90

Note: Responses ranged from 1 (“Not a problem”) to 3 (“A big problem”). The measure is the sum of the highly correlated items. Higher values on the scale represent higher levels of substance use in the neighborhood. The standardized scale ranges from −1.87 to 1.99

Parental substance use (Wave 1) (n = 243; 14.8 %)
Note: Youths’ primary caregivers were asked two filter questions in the wave 1 Family Mental Health and Legal History protocol: (1) Has drinking ever caused any of the people in your family to have problems with health, family, job, or police? (2) Has drug use ever caused any of the people in your family to have problems with health, family, job, or police? The measure of parental substance use was coded in the affirmative if the primary caregiver answered yes to at least one of these questions and indicated that the family member was the youth’s mother and/or father

Peer substance use (Wave 2)
In the previous 12 months, have any of your friends…
… had a drink of beer, wine, wine coolers, or liquor?
… smoked cigarettes?
… used marijuana?
Mean = 4.2  SD = 1.8  Range 3–12  Reliability = .80

Note: In the wave 2 deviance of peers questionnaire, respondents reported their friends’ substance-using behaviors on a scale from 1 (“None of them”) to 4 (“All of them”). Higher values represent higher levels of peer substance use. The standardized scale ranges from −.65 to 4.24

Perceived harm of substance use (Wave 2)
Do you think a person would hurt themselves if they…
… smoked one or more pack of cigarettes a day?
… smoked marijuana regularly?
… smoked marijuana now and then?
… tried marijuana once or twice?
… used inhalants regularly?
… tried inhalants once or twice?
… used heroin regularly?
… tried heroin once or twice?
… used cocaine regularly?
… used cocaine now and then?
… tried cocaine once or twice?
… had one or two drinks of alcohol (i.e., beer, wine, or liquor) nearly every day?
… had four or five drinks of alcohol nearly every day?
… had five or more drinks of alcohol twice a week?
Mean = 42.7  SD = 6.9  Range 14–56  Reliability = .88

Note: In the wave 2 Perceptions of Drug Risk instrument, respondents reported their perceptions of the harm of substance use on a scale from 1 (“Definitely no”) to 4 (“Definitely yes”). Higher values represent higher levels of perceived harm of substance use. The standardized scale ranges from −4.27 to 1.89

Control variables—demographic characteristics (Wave 1)
Male (n = 836; 51.0 %)
Age (Mean = 10.6; SD 1.5; Range 7.8–13.2)
Race/ethnicity
Hispanic (n = 755; 46.1 %)
Black (n = 587; 35.8 %)
White (reference) (n = 227; 13.9 %)
Other (n = 70; 4.2 %)
Immigrant generational status
First (n = 195; 11.9 %)
Second (n = 532; 32.5 %)
Third or higher (reference) (n = 912; 55.6 %)
Note: These variables were taken from the wave 1 Master File, except for Immigrant Generational Status, which was constructed primarily from information in the wave 1 Demographic File.

Control variables—family background factors (Wave 1)

Years at residence (Mean = 6.0; SD 6.7; Range .1–59)
Household socioeconomic status (SES) (Mean = -.1; SD 1.4; Range –3.6–3.7)

Note: Household SES was constructed as the first principal component of (1) the maximum of the PC’s total annual personal income and the subject’s total annual household income; (2) the maximum of the PC’s education level and the PC’s partner’s education level; and (3) the maximum of the PC’s occupational status and the PC’s partner’s occupational status.

Number of siblings (Mean = 2.3; SD 1.7; Range 0–10)
Family size (Mean = 5.4; SD 2.0; Range 2–14)
Primary caregiver employed (n = 967; 59.0 %)

Family structure
Two parents, both biological (reference) (n = 780; 47.6 %)
Two parents, one or both non-biological (n = 340; 20.7 %)
One parent, biological (n = 462; 28.2 %)
One parent, non-biological (n = 58; 3.5 %)

Note: The family-level variables were taken from the wave 1 Master File.

Control variables—behavioral and cognitive factors

Low self-control (Wave 1)
Lack of inhibitory control
Has trouble controlling impulses
Usually cannot stand waiting
Can tolerate frustration better than most (reverse-coded)
Has trouble resisting temptation
Finds self-control easy to learn (reverse-coded)

Present-orientation
Often says the first thing that comes into head
Likes to plan things way ahead of time (reverse-coded)
Often acts on the spur of the moment
Always likes to make detailed plans before doing something (reverse-coded)
Often has trouble making up mind (reverse-coded)

Sensation seeking
Feels happiest in familiar surroundings (reverse-coded)
Generally seeks new and exciting experiences and sensations
Will try anything once
Sometimes does “crazy” things just to be different
Tends to get bored easily

Lack of Persistence
Generally likes to see things through to the end (reverse-coded)
Tends to give up easily
Unfinished tasks really bother (reverse-coded)
Once gets going on something hates to stop (reverse-coded)
Tends to hop from one interest to another

Mean = 2.7 SD = .6 Range 1.0–4.6 Reliability = .75

Note: These items were in the emotionality, activity, sociability, and impulsivity temperament survey, administered to respondents’ primary caregivers during the wave 1 interview. Item responses ranged from 1 (“Uncharacteristic”) to 5 (“Characteristic”). The measure is the average of the items.

Prior substance use (Wave 2)
Have you ever…
… had a drink of beer, wine, wine coolers, or liquor?
… smoked cigarettes?
… used marijuana?
… used cocaine, crack, inhalants, psychedelics, heroin, methamphetamine, amphetamine, barbiturates, or tranquilizers?

Mean = .4  SD = .8  Range 0–4  Reliability = .65

Note These items were asked during the Substance Use questionnaire at wave 2 of the study. The measure is the count of the items

Control variables—additional person-level covariates

Age 17 at wave 3 (n = 175; 10.7 %)
Moved between study waves (n = 617; 37.6 %)
Unit-level missing data due to attrition across study waves (n = 474; 28.9 %)
Item-level missing due to non-response (n = 227; 13.8 %)

Control variables—1990 census neighborhood variables

Concentrated disadvantage
Percentage of families below the poverty line
Percentage of households receiving public assistance
Percentage of female-headed families with children
Percentage of population unemployed
Median household income in 1989

Mean = 0.0  SD = 1.0  Range –1.7 to 2.2

Note The variables were combined using a weighted factor regression score (all loadings ≥ 0.83 using principal components analysis with oblique rotation) such that high levels reflect high levels of disadvantage

Ethnic heterogeneity (Mean = 0.0; SD 1.0; Range –3.1 to 1.9)

Note The standardized scale was constructed using Blau’s equation: \( 1 – \sum p_i^2 \), where \( p_i \) is the proportion of the population in each racial/ethnic group (White, Black, Native American, Asian, Hispanic, Other). The resulting variable takes into account both the relative sizes of the groups and the number of groups in the population. Higher values reflect greater levels of heterogeneity

Residential stability
Percentage of residents living in the same house as 5 years earlier
Percentage of owner-occupied homes

Mean = 0.0  SD = 1.0  Range –1.7 to 2.2

Note The items were summed and then standardized. The items were highly correlated across neighborhood clusters (\( r = .89, p < .001 \)). Higher levels on the scale represent higher levels of residential stability in the neighborhood

Control variables—1994/1995 community survey neighborhood variables

Tolerance of substance use
How wrong is it for teenagers around 13 years of age to…
… smoke cigarettes?
… use marijuana?
… drink alcohol?

How wrong is it for teenagers around 19 years of age to…
… use marijuana?
… drink alcohol?

Mean = 0.0  SD = 1.0  Range –2.0 to 2.8  Reliability = .89

Note Responses ranged from 1 (“Extremely wrong”) to 5 (“Not wrong at all”). The measure is the standardized sum of the items. Higher values on the scale represent higher levels of tolerance of substance use in the neighborhood

Collective efficacy
Shared expectations for social control
How likely is it that people in your neighborhood would…
… do something about kids skipping school?
… do something about kids defacing a building?
… scold a child for not showing respect?
… break up a fight in front of their house?
… organize to keep a local fire station?

Social cohesion/trust
This is a close-knit neighborhood
People are willing to help their neighbors
People in the neighborhood can be trusted
Appendix 2

Sensitivity analysis regressing the disaggregated outcomes on cross-level interactions between neighborhood opportunities for substance use and parental substance use, peer substance use, and the perceived harm of substance use

| Independent variables                                      | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
|------------------------------------------------------------|---------|---------|---------|---------|---------|
| Parental substance use                                      | Alcohol, tobacco, and marijuana | Alcohol | Tobacco | Marijuana | Illicit drug use |
| × Neighborhood opportunities for substance use              | 1.36*   | 1.29    | 1.46*   | 1.27    | 1.00    |
| Peer substance use                                          | 1.47*** | 1.60**  | 1.46*** | 1.40*** | 1.42*   |
| × Neighborhood opportunities for substance use              | 1.12**  | 1.14*   | 1.12†   | 1.08    | 1.00    |
| Perceived harm of substance use                             | .74*    | .85*    | .68**   | .67***  | .77**   |
| × Neighborhood opportunities for substance use              | 1.07†   | 1.03†   | 1.10†   | 1.14†   | 1.14†   |

The models control for all item-, individual-, and neighborhood-level variables as in Table

Model 1 is a multilevel Rasch model (N = 4,917 item responses, 1,639 persons, 80 neighborhoods). Models 2–5 are hierarchical logistic regression models (N = 1,639 persons, 80 neighborhoods)

† p < .10; * p < .05; ** p < .01; *** p < .001. p values were determined by two-tailed test

References

Akers, R. L. (1977). *Deviant behavior: A social learning approach*. Belmont, CA: Wadsworth.

Akers, R. L. (2009). *Social learning and social structure: A general theory of crime and deviance*. New Brunswick, NJ: Transaction.

Allison, K. W., Crawford, I., Leone, P. E., Trickett, E., Perez-Febles, A., Burton, L. M., & Le Blanc, R. (1999). Adolescent substance use: Preliminary examinations of school and neighborhood context. *American Journal of Community Psychology, 27*, 111–141.

Amaro, H. (2014). The action is upstream: Place-based approaches for achieving population health and health equity. *American Journal of Public Health, 104*(6), 964.

Anderson, E. (1999). *Code of the street: Decency, violence, and the moral life of the inner city*. New York: Norton.

Bachman, J. G., Johnston, L. D., & O’Malley, P. M. (1998). Explaining recent increases in students’ marijuana use: Impacts of perceived risks and disapproval, 1976 through 1996. *American Journal of Public Health, 88*(6), 887–892.

Barkin, S. L., Smith, K. S., & DuRant, R. H. (2002). Social skills and attitudes associated with substance use behaviors among young adolescents. *Journal of Adolescent Health, 30*(6), 448–454.

Bauer, D. J., Preacher, K. J., & Gil, K. M. (2006). Conceptualizing and testing random indirect effects and moderated mediation in multilevel models: New procedures and recommendations. *Psychological Methods, 11*, 142–163.

Bronfenbrenner, U. (1979). *The ecology of human development: Experiments by nature and design*. Cambridge, MA: Harvard University Press.

Brown, Q. L., Milam, A. J., Smart, M. J., Johnson, R. M., Linton, S. L., Furr-Holden, C. D., & Ialongo, N. S. (2014). Objective and perceived neighborhood characteristics and tobacco use among young adults. *Drug and Alcohol Dependence, 134*, 370–375.

Cleveland, M. J., Feinberg, M. E., Bontempo, D. E., & Greenberg, M. T. (2008). The role of risk and protective factors in substance use across adolescence. *Journal of Adolescent Health, 43*, 157–164.

Donovan, J. E. (2004). Adolescent alcohol initiation: A review of psychosocial risk factors. *The Journal of Adolescent Health, 35*(6), 529.e7–529.e18.

Duncan, D. T., Palamar, J. I., & Williams, J. H. (2014). Perceived neighborhood illicit drug selling, peer illicit drug disapproval and illicit drug use among U.S. high school seniors. *Substance Abuse Treatment, Prevention, and Policy, 9*, doi:10.1186/1747-597x-9-35.

Efron, B., & Tibshirani, R. (1986). *Bootstrap methods for standard errors, confidence intervals, and other measures of statistical accuracy (with discussion)*. *Statistical Science, 1*, 54–75.

Fagan, A. A., Lee, M., Horn, V., Hawkins, D., & Jaki, T. (2013). Differential effects of parental controls on adolescent substance use: For whom is the family most important? *Journal of Quantitative Criminology, 29*(3), 347–368.
Fagan, A. A., Wright, E., & Pinchevsky, G. M. (2015a). A multi-level analysis of the impact of neighborhood structural and social factors on adolescent substance use. *Drug and Alcohol Dependence, 153*(1), 180–186.

Fagan, A. A., Wright, E. M., & Pinchevsky, G. M. (2015b). Exposure to violence, substance use, and neighborhood context. *Social Science Research, 49*, 314–326.

Gibson, C. L., Sullivan, C. J., Jones, S., & Piquero, A. R. (2010). Does it take a village? Assessing neighborhood influences on children’s self-control. *Journal of Research in Crime and Delinquency, 47*, 31–62.

Hansell, S., & White, H. R. (1991). Adolescent drug use, psychological distress, and physical symptoms. *Journal of Health and Social Behavior, 32*, 288–301.

Hawkins, J. D., & Weis, J. G. (1985). The social development model: An integrated approach to delinquency prevention. *Journal of Primary Prevention, 6*, 73–97.

Hirschi, T. (1969). *Causes of delinquency*. Piscataway, NJ: Transaction Publishers.

Hoffmann, J. P. (2002). The community context of family structure and adolescent drug use. *Journal of Marriage and Family, 64*(2), 314–330.

Hussong, A. M. (2002). Differentiating peer contexts and risk for adolescent substance use. *Journal of Youth and Adolescence, 31*, 207–220.

Jackson, A., Browning, C., Krivo, L., Kwan, M.-P., & Washington, H. (2016). The role of immigrant concentration within and beyond residential neighborhoods in adolescent alcohol use. *Journal of Youth and Adolescence, 45*(1), 17–34.

Jackson, N., Denny, S., & Ameratunga, S. (2014). Social and sociodemographic neighborhood effects on adolescent alcohol use: A systematic review of multi-level studies. *Social Science and Medicine, 115*, 10–20.

Jayasekara, H., English, D. R., Room, R., & MacNnis, R. J. (2014). Alcohol consumption over time and risk of death: A systematic review and meta-analysis. *American Journal of Epidemiology, 179*, 1049–1059.

Jencks, C., & Mayer, S. (1990). The social consequences of growing up in a poor neighborhood. In L. E. Lynn & M. F. H. McGeary (Eds.), *Inner-city poverty in the United States* (pp. 111–186). Washington, DC: National Academy Press.

Jennings, W. G., Piquero, A. R., Farrington, D. P., Tofei, M. M., Crago, R. V., & Theobald, D. (2014). The intersections of drug use continuity with nonviolent offending and involvement in violence over the life course: Findings from the Cambridge Study in Delinquent Development. *Youth Violence and Juvenile Justice*, doi: 10.1177/1541204014559524.

Leffheit, K. M., Parekh, J., Matson, P. A., Moulton, L. H., Ellen, J. M., & Jennings, J. M. (2015). Is the association between neighborhood drug prevalence and marijuana use independent of peer drug and alcohol norms? Results from a household survey of urban youth. *Journal of Urban Health, 92*(4), 773–783.

Leventhal, T., & Brooks-Gunn, J. (2000). The neighborhoods they live in: The effects of neighborhood residence on child and adolescent outcomes. *Psychological Bulletin, 126*(2), 309–337.

Little, R., & Schenker, N. (1995). Missing data. In G. Arminger, C. Clogg, & M. E. Sobel (Eds.), *Handbook of statistical modeling for the social and behavioral sciences* (pp. 39–76). New York: Plenum Press.

Lynskey, M., & Hall, W. (2000). The effects of adolescent cannabis use on educational attainment: A review. *Addiction, 95*, 1621–1630.

MacKinnon, D. P., Lockwood, C. M., & Williams, J. (2004). Confidence limits for the indirect effect: Distribution of the product and resampling methods. *Multivariate Behavioral Research, 39*, 99–128.

Mayhew, M. L., Espelage, D. L., & Koenig, B. (2009). Multilevel modeling of direct effects and interactions of peers, parents, school, and community influences on adolescent substance use. *Journal of Youth and Adolescence, 38*, 1038–1049.

Miech, R. A., Johnston, L. D., O’Malley, P. M., Bachman, J. G., & Schulenberg, J. E. (2015). Monitoring the future national survey results on drug use, 1975–2014: Volume I, secondary school students. Ann Arbor: Institute for Social Research, The University of Michigan. http://monitoringthefuture.org/pubs.html#monographs.

Mischel, W. (2004). Toward an integrative science of the person. *Annual Review of Psychology, 55*, 1–22.

Morgan, S. L., & Winship, C. (2007). *Counterfactuals and causal inference*. Cambridge: Cambridge University Press.

Musick, K., Selzer, J. A., & Schwartz, C. R. (2008). Neighborhood norms and substance use among teens. *Social Science Research, 37*(1), 138–155.

Ohannessian, C. M. (2012). Parental problem drinking and adolescent psychosocial adjustment: The mediating role of adolescent-parent communication. *Journal of Research on Adolescence, 22*, 498–511.

Osgood, D. W., McMorris, B. J., & Potenza, M. T. (2002). Analyzing multiple-item measures of crime and deviance I: Item response theory scaling. *Journal of Quantitative Criminology, 18*, 267–296.

Poooralal, J., Haighalab, T., Farhadi, M., & Darvishi, N. (2015). Substance use disorder and risk of suicidal ideation, suicide attempt and suicide death: a meta-analysis. *Journal of Public Health*, doi: 10.1093/pubmed/fdv148.

Preacher, K. J., & Selig, J. P. (2012). Advantages of Monte Carlo confidence intervals for indirect effects. *Communication Methods and Measures, 6*, 77–98.

Preacher, K. J., Zyphur, M. J., & Zhang, Z. (2010). A general multilevel SEM framework for assessing multilevel mediation. *Psychological Methods, 15*, 209–233.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*. London: Sage.

Raudenbush, S. W., Johnson, C., & Sampson, R. J. (2003). A multivariate, multilevel Rasch model with application to self-reported criminal behavior. *Sociological Methodology, 33*, 169–211.

Raudenbush, S. W., & Sampson, R. J. (1999). Ecometrics: Toward a science of assessing ecological settings, with application to the systematic social observation of neighborhoods. *Sociological Methodology, 29*, 1–41.

Richwood, T. D., Ford, H., DeCoster, J., Sutton, M., & Lochman, J. E. (2015). Risky sexual behavior and substance use among adolescents: A meta-analysis. *Children and Youth Services Review, 52*, 74–88.

Royston, P. (2005). Multiple imputation of missing values: update. *Stata Journal, 5*(2), 188–201.

Sampson, R. J., & Bartusch, D. J. (1998). Legal cynicism and (subcultural?) tolerance of deviance: The neighborhood context of racial differences. *Law and Society Review, 32*, 777–804.

Sampson, R. J., Morenoff, J. D., & Gannon-Rowley, T. (2002). Assessing “neighborhood effects”: Social processes and new directions in research. *Annual Review of Sociology, 28*, 443–478.

Sampson, R. J., Morenoff, J. D., & Raudenbush, S. (2005). Social anatomy of racial and ethnic disparities in violence. *American Journal of Public Health, 95*(2), 224–232.

Sampson, R. J., Raudenbush, S. W., & Earls, F. (1995). *Does it take a village? Assessing neighborhood influences on child and adolescent outcomes*. New York: Plenum Press.
in rural, suburban, and urban settings. *Journal of Child and Family Studies*, 9, 105–115.

Selig, J. P., & Preacher, K. J. (2008, June). Monte Carlo method for assessing mediation: An interactive tool for creating confidence intervals for indirect effects [Computer software]. http://quantpsy.org/.

Shoptaw, S., Montgomery, B., Williams, C. T., El-Bassel, N., Aramattana, A., Metsch, L., et al. (2013). Not just the needle: The state of HIV-prevention science among substance users and future directions. *Journal of Acquired Immune Deficiency Syndromes*, 63, S178–S184.

Snedker, K. A., Herting, J. R., & Walton, E. (2009). Contextual effects and adolescent substance use: Exploring the role of neighborhoods. *Social Science Quarterly*, 90, 1272–1297.

Sunder, P. K., Grady, J. J., & Wu, Z. H. (2007). Neighborhood and individual factors in marijuana and other illicit drug use in a sample of low-income women. *American Journal of Community Psychology*, 40, 167–180.

Tapert, S. F., Granholm, E., Leedy, N. G., & Brown, S. A. (2002). Substance use and withdrawal: Neuropsychological functioning over 8 years in youth. *Journal of the International Neuropsychological Society*, 8, 873–883.

Thrash, C. R., & Warner, T. D. (2016). The geography of normative climates: An application to adolescent substance use. *Journal of Youth and Adolescence*. doi:10.1007/s10964-016-0444-z.

Urberg, K. A. (1992). Locus of peer influence: Social crowd and best friend. *Journal of Youth and Adolescence*, 21, 439–450.

Van Horn, M. L., Hawkins, J. D., Arthur, M. W., & Catalano, R. F. (2007). Assessing community effects on adolescent substance use and delinquency. *Journal of Community Psychology*, 35(8), 925–946.

Warner, T. (2016). Up in smoke: Neighborhood contexts of marijuana use from adolescence through young adulthood. *Journal of Youth and Adolescence*, 45(1), 35–53.

Warr, M. (2002). *Companions in crime: The social aspects of criminal conduct*. Cambridge: Cambridge University Press.

Wikstrom, P.-O. H. (2004). Crime as alternative: Towards a cross-level situational action theory of crime causation. In J. McCord (Ed.), *Beyond Empiricism* (pp. 1–38). New Brunswick, NJ: Transaction Publishers.

Wright, E. M., Fagan, A. A., & Pinchevsky, G. M. (2014). Penny for your thoughts? The protective effect of youth’ attitudes against drug use in high-risk communities. *Youth Violence and Juvenile Justice*, doi:10.1177/1541204014562074.

Zimmerman, G. M., & Vasquez, B. E. (2011). Decomposing the peer effect on adolescent substance use: Mediation, nonlinearity, and differential nonlinearity. *Criminology*, 49(4), 1235–1273.