PERGAMON

Social Science and Medicine 52 (2001) 571–583

SOCIAL SCIENCE & MEDICINE

www.elsevier.com/locate/socscimed

Substance use during pregnancy in the state of California, USA

Brian Karl Finch[a,*], William A. Vega[b], Bohdan Kolody[c]

[a] Population Research Center, Department of Sociology, The University of Texas at Austin, 1800 Main Building, Austin, TX 78712-1127, USA

[b] Robert Wood Johnson Medical School — UMDNJ, USA

[c] Department of Sociology, San Diego State University, USA

Abstract

Most analyses of prenatal substance use focus on individual level correlates and ignore community level variables and the effect of the dependency of respondents within communities. This analysis uses multilevel logistic regression models to more accurately assess the correlates of perinatal substance use in California. Statistical results indicate that a significant portion of substance use can be attributed to neighborhood heterogeneity, and that traditional models of substance use may inaccurately attribute this variation to individual level regression coefficients. Substantive results indicate that levels of neighborhood public assistance had an independent, significant effect on the prevalence of all substances tested for except alcohol. Black women had higher predicted prevalence risks for alcohol and cocaine while White women had higher predicted risks for tobacco, marijuana and amphetamines. Racial contrasts were non-significant for the overall illicit drug category and opiates, after controlling for neighborhood public assistance. Finally, individual level variables, with the exception of age, were not moderated by levels of neighborhood public assistance. © 2001 Elsevier Science Ltd. All rights reserved.

Keywords: Community effects; Perinatal substance use; Race

The effects of community conditions, common social environments and shared neighborhood morality should be seen as essential to understandings of social/epidemiological phenomenon. While most studies of substance use focus on the individual characteristics and correlates of substance use, the more detailed interactions of neighborhood conditions are often ignored or are left uncollected (Vega & Gil, 1998). While it might be difficult to directly interpret the effects of neighborhood conditions on political attitudes, for example, the effects of neighborhood should be seen as especially relevant as they relate to the use and abuse of substances. Specifically, not only do neighborhood conditions reflect the amount of poverty, joblessness, isolation, and hopelessness in a neighborhood (Wilson, 1987), they may also indicate common moral perceptions of substance use and provide an indication of the normality of use in a given community. Neighborhood conditions may also indicate the level of resources in a community — such as social services, crime, and housing states (Macintyre & Ellaway, 1998).

The use of appropriate statistical techniques for these analyses should also be seen as imperative. Since individual decisions to use drugs are nested within community-level contexts and the social milieu of the neighborhood, multilevel models which nest individuals within communities and control for the dependency of cases within these social areas are needed for investigations of the correlates of substance use and abuse (Bryk & Raudenbush, 1992).

Background

Studies of the actual effects on infants exposed to licit and illicit substances in the fetus are not univocal. A report by the *American Journal of Obstetrics and Gynecology* (Shiono et al., 1995) suggests that neither cocaine nor marijuana nor alcohol use during pregnancy

*Corresponding author. Fax: +1-512-471-4886.
E-mail address: bkfinch@prc.utexas.edu (B.K. Finch).

0277-9536/01/$ - see front matter © 2001 Elsevier Science Ltd. All rights reserved.
PII: S0277-9536(00)00161-1

has any effect on the probability of low-birth weight, nor is their use associated with pre-term births. This same study suggests that low-birth weights were largely the effect of widespread smoking during pregnancy.[1] However, several studies have linked perinatal substance use with decreased mental capacity and cognitive ability among children (Azuma & Chasnoff, 1993; Fried & Watkinson, 1990; Howard, Beckwith, Rodning & Kropenske, 1989). Other studies have found that smoking in pregnancy increases the risk of SIDS (Blair et al., 1996), that parental drug use is associated with an increased risk for infant mortality (Blair et al., 1996) although these effects may be mediated by birth-weight and gestational age (Brown, Bakeman, Coles, Sexson & Demi, 1998; Ostrea, Ostrea & Simpson, 1997), and that substance use in pregnancy may lead to physical dependence and withdrawal symptoms in infants (Finnegan, 1986; Fried, 1980).

Some research has indicated that there are no socio-demographic patterns of substance use by pregnant women (Gitler & McPherson, 1990; Goldberg, 1995; Gurnack & Paul, 1997). However, findings from the Perinatal Substance Exposure (PSE) study reported that the largest rates of substance exposure were among poor-White and Black women (both poor and non-poor) while the lowest rates were among Hispanic and Asian women (Vega, Kolody, Hwang & Noble, 1993a). Significant differences were also observed between native and foreign born women (the latter having much lower prevalences). This study elaborates models from the PSE study and investigates the effect of levels of neighborhood public assistance for pregnant, White and Black women. Specifically, this study: (a) investigates the culpability of neighborhood public assistance as a significant predictor of individual level drug use — above and beyond individual level public assistance; (b) tests Black-White substance prevalence rate differences as a function of neighborhood poverty; and (c) analyzes the moderating effects of neighborhood poverty on individual level characteristics.

Previous research

Risk profiles for substance abusing pregnant women have been based on fairly limited research designs. Most of the research has focused on samples of low-income women, women in drug treatment centers, women of color, and patients at inner-city or public hospitals rates (Frank et al., 1988; Gillogley, Evans, Hansen, Samuels & Batra, 1990; Khalsa & Gfroerer, 1991; Zuckerman et al., 1989). With these limitations in mind, previous studies have demonstrated that the prevalence of drug use generally decreases with age, with the highest prevalence observed among women aged 18–25 (Khalsa & Gfroerer, 1991). Black women are reported as having the highest levels of substance use (Berenson, Stiglich, Wilkinson & Anderson, 1991; Vega et al., 1993b). Pregnant, substance using women are generally reported to have poorer education and vocational skills (Abma & Mott, 1991), poor nutrition (Frank et al., 1988), higher rates of sexually transmitted diseases (Amaro, Zuckerman & Cabral, 1989; Frank et al., 1988; Hawthorne & Maier, 1993; Zuckerman et al., 1989), a greater likelihood of a history of physical and sexual abuse (Amaro et al., 1989; Berenson et al., 1991; Chavkin, Paone, Friedmann & Wilets, 1993; Hortensia, Fried, Cabral & Zuckerman, 1990; Klein & Zahnd, 1997; Ladwig & Anderson, 1989) and are unlikely to seek prenatal care (Hawthorne & Maier, 1993; McCalla et al., 1991; Noble et al., 1997; Ostrea, Brady, Gause, Raymundo & Stevens, 1992). Perinatal substance users are also likely to be smokers (Abma & Mott, 1991), unmarried (Gillogley et al., 1990), and either uninsured or a Medicaid recipient (Ostrea et al., 1992; Schutzman, Frankenfield-Chernicoff, Clatterbaugh & Singer, 1991).

Several studies of the prevalence of perinatal substance exposures have relied on self-reports (Abma & Mott, 1991; Graham & Koren, 1991; Zambrana, Hernandez, Dunkel-Schetter & Scrimshaw, 1991) which may inaccurately estimate prevalences, especially in states where evidence of perinatal substance use can lead to criminal prosecution. Studies that have utilized urine testing often employ convenience samples that do not address the more general problems and risk profiles of the larger population. There have been few studies on a state-wide basis that have tested the profiles and prevalence rates of perinatal substance abusers and abuse. Three of these studies are described as follows.

A study in South Carolina reported that 12.1% of delivering women tested positive for drugs or alcohol (Slutsker, 1992). This South Carolina study used several demographic variables (race, age, and hospital payment source), and found that Black women had higher prevalence rates for alcohol and cocaine use while White women were more likely to test positive for marijuana. Alcohol use increased with age while marijuana and cocaine use peaked in early adulthood. Additionally, alcohol and cocaine prevalence rates were higher for women whose childbirth payment source was Medicaid, suggesting relationships between perinatal substance exposure and socio-economic status. A Rhode Island study of 465 women indicated an overall prevalence rate of 7.5% with specific substance prevalence rates as follows: cocaine, 2.6%; marijuana, 3.0%; opiates, 1.7%; and amphetamines, 0.2% (Goodman, 1990). Risk factors for higher prevalence rates included: age less than 25, public insurance, poverty status, and regional hospital status. In Utah, 792 women were screened and

[1] About 15% of all low birth-weight cases could have been prevented if the women had not smoked during pregnancy, according to the study.

data were collected on age, ethnicity, number of children, and insurance (Buchi, Varner & Chase, 1993). The overall prevalence rate for illicit drugs and alcohol combined was 7.8%. Women with no insurance or receiving Medicaid were four times more likely to test positive for illicit substances while non-Whites were more likely to test positive for cocaine and marijuana. The sampling frame represented a largely White, middle class population, indicative of the state of Utah. Virtually all of these studies relied on individual level data, and ignored the social context of one's environment as a factor related to perinatal substance use, however.

Contextual effects and neighborhood analysis

Following the publication of Wilson's (1987) *The Truly Disadvantaged*, a burgeoning number of studies have investigated the impact of neighborhood context on individual and social outcomes. Testing the numerous hypotheses put forth by Wilson, these studies emphasize the spatial configuration of social and material resources and contend neighborhood context influences outcomes over and above individual characteristics. In a review of the literature, Jencks and Mayer (1990) argue that multi-level research prior to 1990 did not discover any significant contextual relationships. More recent empirical research on neighborhood effects has demonstrated deleterious relationships between the concentration of poverty on a wide range of social consequences, including: political efficacy (Cohen & Dawson, 1993), welfare participation (Osterman, 1991), adolescent development (Brooks-Gunn, Duncan, Lebanov & Seland, 1993; Brooks-Gunn, Duncan & Aber, 1997; Elliot, Wilson, Huzinga, Sampson, Elliot & Rankin, 1996), maternal warmth in mother's parenting (Klebanov, Brooks-Gunn & Duncan, 1994), occupational expectations (Quane & Rankin, 1995), various health outcomes (Krause, 1996; Robert, 1998), the likelihood of marriage (Massey & Shibuya, 1995), sexual activity (Brewster, 1994; Furstenburg, Morgan, Moore & Peterson, 1987; Ku, Sononstein & Pleck, 1993), and contraceptive use (Hogan, Astone & Kitagawa, 1985). Several studies have found that, net of individual socioeconomic status (SES), low levels of neighborhood SES increase the likelihood of individual deviancy and drug use (Bursik, 1988; Clapp, 1995; Ennett, Flewelling, Lindrooth & Norton, 1997; Peeples & Loeber, 1994; Simacha-Fagan & Schwartz, 1986). Chasnoff et al. (1990) and Finch, Kolody and Vega (1999) have both used community-level SES to predict perinatal substance exposure but found mixed results. Whereas Chasnoff, Landress and Barrett found no "neighborhood effects" on prevalence rates, Finch and colleagues found neighborhood SES to be a strong and significant predictor of perinatal substance exposure among pregnant women, net of individual-level SES.

The recent studies of neighborhood effects have made the general assertion that neighborhood affects individual level outcomes above and beyond individual level characteristics and mediates the effect of many individual level characteristics. Specific to drug use, geographic marginalization (operationalized as communities with low SES) may exert stress factors on individuals which lead to substance use. In a similar vein, these same neighborhood characteristics may play a role in increasing substance use in that 'substance using behavior' is reinforced and normalized. Neighborhood SES only serves as a proxy for the micro-level interactions and/or structural conditions of one's environment. In other words, neighborhood SES may represent the set of norms, behavioral expectations, stresses, and milieu of everyday living in a given community (compositional effects) and/or neighborhood SES may represent the structural aspects (contextual effects) of a community such as the availability of housing, health care, pollution, social services, and other infrastructure (Macintyre & Ellaway, 1998). Subjective interpretations aside, it is well known that individual level characteristics are directly related to geographic living circumstances (Jargowsky, 1997; Massey & Denton, 1993). Therefore, it seems crucial that studies of individual level-behavior should control for and incorporate the nesting of individuals within geographic locations, and the differential effect of geographic circumstances on individual level variables and outcomes.

Using crude, census level data to proxy for 'neighborhood' characteristics is useful in identifying the presence/absence of neighborhood effects, but these specifications have no way of determining whether or not the observed effects are due to compositional effects of the neighborhood, or contextual effects. The effects of neighborhood poverty (the variable chosen for these analyses) may represent the whole of the individuals who are living in this neighborhood and may be capturing compositional effects. That is, the overall social milieu, norms, and behaviors (e.g. drug markets, lack of police enforcement, normality of substance use and sales) at the micro-level, captured in a macro-level measurement of neighborhood characteristics, may simply indicate that the types of individuals living in the same community may be contributing to higher rates of substance use. On the other hand, true contextual effects may contribute to higher rates of substance use because a particular neighborhood is rife with poor infrastructure, has poor social services (including health care), and poor housing and living conditions (Macintyre & Ellaway, 1998). While the use of census data can indicate the absence/presence of these effects, there is no way to partial out compositional effects from contextual effects, without the use of more detailed data.

This study was undertaken in order to test the viability of the relationships between neighborhood poverty, individual level characteristics, and perinatal substance use. The first hypothesis to be tested is that there is a linear relationship between the proportion of households receiving public assistance in a zip code and individual perinatal substance use. That is, predicted substance prevalence rates will change as levels of neighborhood public assistance increase. Our second assertion relates to the previously outlined Black-White differences in substance exposure outcomes. When controlling for individual level variables, many racial differences may be reduced, but the addition of a neighborhood poverty variable will further reduce, if not eliminate, racial contrasts in prevalence estimates. Therefore, the second hypothesis to be tested is that there are no Black-White differences in substance prevalence estimates after controlling for neighborhood public assistance. [2] This hypothesis stems from research by Williams and Collins (1995) that suggests that varying living environments (exposure to stress, crime, and discrimination) may account for some of the observed racial differences in health outcomes and health behavior. For example, Lillie-Blanton, Anthony & Schuster (1993) found that previously observed racial differences in crack use were actually attributable to differences in neighborhood contexts. Our third hypothesis argues that neighborhood SES moderates the relationship between individual level variables and substance use. Two particular variables that may be moderated by neighborhood poverty are race and individual poverty. For example, researchers argue that poor individuals living in poor environments experience a "double jeopardy" effect on health and health behaviors (Robert, 1999). That is, although poor neighborhoods are detrimental to health, they are especially detrimental to poor people. In a similar vein, Wilson (1997) argues that poor neighborhoods differentially affect White and Black people such that the racism and discrimination experienced by nearly all Black people is exacerbated when they live in poor communities.

Perinatal substance exposure study (California, 1992)

The data chosen for this study come from the PSE Study done in California in 1992. The PSE is the largest, state-wide, population-based study done on the prevalence of drug exposed infants (for a full description, see Vega et al., 1993a; Vega et al., 1993b). Cross-sectional data were collected between the months of March and October during 1992. The sampling frame consisted of two-thirds of all California birthing hospitals, randomly selected, from which sampling fractions were established based on the 607,000 infants born in California between July 1, 1991 and June 30, 1992. A multi-stage, stratified, probability sample was collected which resulted in an unweighted sample size of 29,494 women.

When a pregnant woman (in our sampling frame) was admitted for delivery of her child, a portion of her urine sample was allocated for the PSE study and sent to a certified lab for analysis. This approach mitigates selection bias that generally occurs among studies of prenatal substance use that utilize convenience samples. In addition to the urine samples, simple demographics profiling these women were collected by a nurse from hospital admission records and appended to their respective urine test results. Data collection procedures did not include any personal identifiers, and the research design had been approved by human subjects review committees in every participating hospital, the state of California, and the University of California, Berkeley. The 29,494 women were tested for the following battery of drugs: alcohol, amphetamines, barbiturates, benzodiazepines, cannabinoid, cocaine metabolite, methadone, opiates and phencyclidine (PCP). There was no urine testing done for smoking, all tobacco prevalences were self-reported.

The testing limitations were such that exposure to any of these drugs had to have been very recent, especially alcohol which can only be detected if consumed less than a few hours prior to hospital admittance. Therefore, the PSE study was simply an indication of at least a fairly recent, and at least a single exposure to any number of substances. For this reason, and the reasons mentioned above, the findings of this study probably underestimate the actual exposure to substances throughout the course of a pregnancy.

The findings from the PSE study estimated that 6.72% of all infants are exposed to alcohol in the womb while 5.16% are exposed to any drug.[3] Overall prevalence rates for other substances are as follows: cannabinoid, 1.88%; cocaine, 1.11%; opiates, 1.47%; amphetamines, 0.66%; and tobacco, 8.82%. Prevalence rates varied widely by race, with Black women exhibiting the largest rates for every substance listed above, except for amphetamines for which whites had the highest prevalence (Vega et al., 1993a).

[2] It should be anticipated that controlling for individual level factors and neighborhood factors may not completely eliminate racial contrasts in substance use estimates since race may be an important antecedent to many of these controls (i.e. individual level characteristics and neighborhood location) (Beggs, Villemez & Arnold, 1997; Williams & Collins, 1995). Further, the effects of discrimination, social interaction, and historical experience may not be reflected in any of the control measures and may manifest themselves in significant racial contrasts.

[3] The category 'any drug' refers to: amphetamines, barbiturates, benzodiazepines, cannabinoid, methadone, opiates, or phencyclidine.

Sample

The subjects in this study ($n=13{,}280$) are the subset of women identified as White, non-Hispanic ($n=10{,}611$) and Black/African-American ($n=2669$) from the larger, multiethnic sample ($n=29{,}494$). These numbers do not match estimated population proportions in California as the sampling frame was based on births, rather than the current population. For example, Latina births made up nearly the same percentage of White births in this sample (37.3% and 39.3%, respectively), but relatively few of the substance positives. In fact, rates of Latina substance use were significantly lower than Black and White rates. In addition, there is ample evidence that both individual and contextual level variables have differential effects on the rates of perinatal substance use for Latinas, relative to White and Black women (Finch, Kolody & Vega, 1999; Finch, Boardman, Kolody & Vega, 2000). Issues of acculturation and nativity are especially relevant for the Latina population in the PSE sample, but have very little relevance for native born White and Black women. Therefore, in order to assess contrasts among women with relatively high rates of substance use, and in order to examine traditional contrasts between White and Black women, the use of a White-Black sub-sample is both purposive and desirable.

Multilevel (mixed effects) models

Multilevel logistic regression models (Wong & Mason, 1985) were built with all individual level effects (level 1) and the neighborhood indicator of public assistance (level 2). Random intercepts with fixed slopes were specified for each substance tested (DeLeeuw & Kreft, 1986), and cross-level interactions were specified between neighborhood level variables and race and poverty. The general equational form for these models can be seen as:

$$\ln[\pi_n/1-\pi_n] = \Sigma\beta_{k,zc}X_{k,g}$$

(where)

$$\beta_{k,zc} = \Sigma\gamma_{k,j}Z_{j,zc} + v_{k,zc}$$

where $\beta_{k,zc}$ is the kth first-level regression coefficient for zip code [4] zc, $Z_{j,zc}$ is the jth predictor score for zip code zc, and $\gamma_{k,j}$ is the jth second-level regression coefficient for the linear prediction of the kth first-level parameter (McArdle & Hamagami, 1994). In essence, the mixed effects model estimated for this study requires the estimation of one only extra parameter ($_{k,zc}$) which represents the variation between zip codes at the second level ($_k \sim N(0,\Omega_{k,k})$). Traditional chi-squared, likelihood ratio tests indicate that the multilevel/mixed effects models are better fits than traditional fixed effects models which were tested using Statistical Package for the Social Sciences (SPSS).

The multilevel modeling technique controls for dependency of cases within zip codes while traditional fixed effects models do not account for the nested structure of individual respondents within zip-codes. Since intra-cluster correlations within zip codes were non-zero (see Table 1), use of fixed effects logistic regression analyses may yield biased estimates and deflated standard errors of the regression coefficients (Barcikowski, 1981). Since the mixed effects models exhibited a better overall fit of the data, and since they account for the biases inherent in geographically nested data, they are used for the estimation of regression parameters in this study.[5]

Most contextual analyses utilize census tract as a neighborhood proxy since tracts are specified to achieve demographic and socioeconomic homogeneity (Census, 1992b). In contrast, zip codes are designed strictly for the efficient delivery of mail (Census, 1992b). Chasnoff et al. (1990), Datcher (1982), Finch, Vega, Kolody & Echevarria (1998) and Osterman (1991) have all used zip codes as a level of neighborhood, and the business and medical communities have demonstrated that zip codes are a cost-effective and robust level of measurement of social area (Cobrda, 1995; Pittman, Andrews & Struening, 1986; Weiss, 1988). Zip codes are, on average, five times larger than the average census tract in California, and contain five times as many people. The average zip code in California contains 36,866 people with a median of 35,528. Zip codes for this sample range in size from 1 to 101 people with the 13,280 subjects representing 1,186 zip code areas. The average number of women per zip code is 11.2, with a median of 7 women per zip code. While more precise census level data (e.g. census tract) does serve as a better measurement of 'neighborhood' than zip-code level data, a zip code can be seen as the general social circumstances of larger numbers of people, i.e. a community. Considering that these data are collected throughout the state of California, zip code level data will pick up more general variations in living circumstances that are indicative of this enormously populated state of 33,145,121 people (nearly 1 of 8 people in the US live in California).

[4] Only zip codes were recorded from hospital records (i.e. no census tracts, etc.) in order to protect the anonymity of the women involved. Therefore, analyses were restricted to this level of measurement at the contextual level.

[5] Analyses of these data were performed using mixed effect models for panel data in Stata v. 6 (xtlogit). Random intercept models were specified using the zip code identifier as the cluster level variable, and cross-level interactions were specified to examine the heterogeneity of several individual level effects (race, age, poverty) between zip codes/neighborhoods.

Utilizing data from the 1990 census, the percentage of zip code residents receiving public assistance was attached to each respondent's data in the PSE data file (Perinatal Substance Exposure Study, 1992). The mean percentage of zip code households receiving public assistance income for this sample was 10.02%, with a standard deviation of 7.11%. The percentage of publicly assisted households in all neighborhoods ranged from 0–59%. Other contextual census variables were considered for analyses, including median family income, percent high school dropouts, percent persons below poverty level, percent female-headed households, and percent unemployed. The use of US census data obviously limited the range and detail of variables available. [6] Percentage of zip-code households receiving public assistance income was chosen singularly as the contextual variable for several reasons. First, neighborhood public assistance most closely resembled the individual level variable of public assistance. Second, the census level variables were highly multi-collinear. Lastly, and most importantly, as research by Geronimus, Bound and Neidert (1996) has demonstrated, an appropriate assessment of contextual effects is carried out by using census variables which have individual-level counterparts in the same model. They suggest that interpretation of an aggregate level variable as a contextual effect is problematic because "in the absence of a micro-level measure, the aggregate measure picks up individual as well as contextual effects" (Geronimus et al., 1996, p. 536). The overwhelming majority of Medicaid recipients are already receiving public assistance.[7] Therefore, the most appropriate combination of individual level and aggregate measures is individual level public assistance and zip code public assistance. The absence of individual-level indicators of income, education, employment, and household headship preclude the use of their aggregate census-level corollaries.

A natural question emerges from the use of 'public assistance' measurements. That is, do the observed effects result from the special circumstances of 'welfare recipients', or are they generally indicative of impoverished individuals? There is no question that publicly assisted individuals are impoverished; but publicly assisted individuals may have characteristics dissimilar to those that are poor but not receiving public assistance. However, US census data show that chronic poverty (throughout an entire year) is much less common than entries into and exits from poverty and welfare (Naifeh, 1998). Also, new evidence indicates that there may be few, if any, personality differences between impoverished women on welfare and impoverished women in general (Plotnick, Klawitter & Edwards, 1998). Therefore, we argue that "public assistance" simply represents a more destitute state of poverty at both the individual and neighborhood level, but does not indicate anything peculiar to 'welfare' recipients themselves.

Measures

All independent, individual level variables were dummy-coded since they represent nominal level categories. Percentage of households receiving public assistance was treated as continuous. The independent variables included are as follows: age (10–17, 18–24, 25–34, 35+), race (White, Black), marital status (married, not married, divorced/separated/widowed), public assistance (no public assistance, Medi-Cal), antepartum care (prenatal care, no prenatal care),[8] nativity (foreign born, native born), and proportion of zip code households receiving public assistance (0.0–0.59). Dummy variables indicating missing values on each of the independent variables were added to the models (not reported here, as none were significant) in order to retain these cases for analysis. Only cases which had missing values on the dependent variables ($n = 545$ for tobacco only), and cases for which an invalid zip-code was recorded ($n = 1175$) were excluded from the analyses.

The dependent variables tested for this study, were: alcohol, tobacco, marijuana, cocaine, opiates, amphetamines, and a more general category of positive for any drug (review endnote 3). Prevalence rates for other individual substances were too low to estimate reliable parameters (e.g. barbiturates, benzodiazepines, methadone, and phencyclidine). The dependent variables were a binary indicator of a substance positive (coded as 100) or a negative (coded as 0). The raw number of positives for each substance are as follows: alcohol (954), tobacco (2207), marijuana (541), cocaine (288), amphetamines (161), opiates (246), and any drug (1196). Percent

[6] The use of aggregate US census data limited the choice of variables to general indicators of poverty, unemployment, education, income, household structure, linguistic isolation, etc. Indices of segregation, and other more detailed neighborhood variables were not available.

[7] Medi-Cal is a very good indicator of individual public assistance as over 76% of Medi-Cal recipients in 1992 qualified because they were already receiving general public assistance. More than 90% of Medi-Cal recipients in 1992 were classified as: receiving public assistance, medically needy or medically indigent.

[8] The question of whether or not prenatal care is an exogenous variable is important. It can be suggested that women who have not received prenatal care may not be as aware of the dangers of substance misuse and therefore are more likely to use a substance during the course of their pregnancy. Conversely, women may not seek prenatal care because they are substance abusers.

Table 1
Intra-cluster correlations and zip-code response variance (unconditional means models)

Substance	ICC/ρ (SE ρ)	% Zip Codes with Non-Varying Responses (zip code $n=1176$)
Alcohol	0.17 (0.04)	62.16%
Tobacco	0.23 (0.03)	46.43%
Marijuana	0.19 (0.06)	74.06%
Cocaine	0.66 (0.03)	88.27%
Opiates	0.19 (0.08)	84.86%
Amphetamines	0.43 (0.09)	91.16%
Any Drug	0.26 (0.03)	60.12%

positive for each substance, by all independent variables, is listed in Table 2.

Findings

The models for each substance and group of substances are presented as unstandardized logistic regression coefficients in Table 3. The standard errors are presented in parentheses directly after the logits (log odds) and an asterisk next to the standard errors indicates a two-tailed level of significance of $\alpha<0.05$. These effects, and all subsequent interpretation of effects, are net of all other independent variables (controls) in the model.

The addition of the contextual level variable, neighborhood poverty, had a relatively minor effect on most of the individual level variable estimates in the model. [9] However, the effect is empirically important for a number of the relationships between individual characteristics and substance prevalence, especially when controlling for levels of neighborhood public assistance changed the once statistically significant Black-White contrasts in estimated prevalence risk. More directly, the effect is important in that increasing levels of neighborhood public assistance also had an effect on the probability of several substance positives.

Alcohol, tobacco and marijuana

Neighborhood public assistance was not significantly related to alcohol use. Controlling for neighborhood public assistance reduced the effect of being Black on the probability of testing positive for alcohol by 3%. However, the race variable is still statistically significant and indicates that Black women have a 64% greater odds of testing positive for alcohol than White women. Traditionally, alcohol use is a difficult substance to profile since it is a legal and widely used substance. For these data, race provides the only statistically significant contrast for perinatal alcohol use. Levels of neighborhood public were related to tobacco (self-report) prevalence estimates in that each 1% increase in neighbors receiving public assistance yielded a 2.8% increase in the odds of testing positive. This effect, although somewhat smaller, was also significant for marijuana. White women were 92% more likely to report smoking during pregnancy than Black women, and 51% more likely to test positive for marijuana. Controlling for neighborhood public assistance greatly increased both of these contrasts.

Cocaine

Cocaine paints an extremely disturbing picture of prevalence in that Black women were at a much greater risk of testing positive than White women. Specifically, Black women were predicted to have 512% greater odds of testing positive than White women. Neighborhood poverty was also significantly and substantively related to cocaine prevalence.

Opiates and amphetamines

In the model of opiate prevalence, controlling for neighborhood poverty eliminated a once significant contrast between White and Black women. This estimate is in direct contrast with the raw data in Table 2, which showed that Black women have a 0.9% higher prevalence rate than White women. The effect of neighborhood public assistance is such that every 1% increase in neighborhood poverty yielded a 2.2% greater odds of testing positive for opiate use during pregnancy.

Amphetamine use accounted for only 161 total positives with White women responsible for 97.2% of the positive tests. The raw data in Table 2 also show that amphetamine prevalence was 1.0% higher for White women than for Black women. The estimate yielded an even greater contrast in that White women had an extraordinarily greater odds (1483%) of testing positive for amphetamines than Black women. This result should be viewed with caution however, since the total amphetamine positives were very low (the lowest of all substances tested) and the majority of these positives were among White women. Each 1% increase in neighborhood poverty yielded a 3.2% increase in the odds of testing positive for amphetamines for all women.

[9] Models were tested first with only individual level variables, then with the addition of neighborhood public assistance. Although not reported here, the results were used to determine the effect of controlling for neighborhood on the individual variables (especially race) in the discussion and conclusions.

Table 2
Percent positive by model covariates

Variable	Alcohol	Tobacco	Marijuana	Cocaine	Opiates	Amphetamines	Any Drug
Total ($n = 13{,}280$)	7.2%	17.3%	4.1%	2.2%	1.9%	1.2%	9.0%
Race							
White (10,611)	6.2%	16.2%	3.9%	0.6%	1.6%	1.4%	7.3%
Black (2669)	11.2%	21.8%	5.0%	8.2%	2.5%	0.4%	15.3%
Age							
10–17 (450)	9.9%	15.6%	2.2%	0.7%	1.7%	0.7%	5.0%
18–24 (4031)	7.7%	20.0%	4.9%	1.5%	1.6%	1.2%	8.8%
25–34 (6985)	6.9%	16.4%	4.2%	2.5%	1.8%	1.3%	9.3%
35+(1814)	6.2%	14.2%	2.3%	2.5%	2.2%	0.8%	8.3%
Nativity							
Native Born (12,231)	7.3%	17.8%	4.2%	2.2%	1.8%	1.2%	9.1%
Foreign Born (1049)	6.1%	11.4%	2.4%	0.9%	1.7%	0.6%	6.0%
Marital Status							
Not Married (4154)	9.3%	29.9%	6.8%	5.3%	2.1%	1.9%	15.1%
Married (8602)	6.2%	10.2%	2.6%	0.4%	1.6%	0.8%	5.5%
Divorced/separated/widowed (365)	6.7%	41.6%	8.4%	4.9%	2.0%	2.6%	18.0%
Prenatal Care							
No Care (295)	11.0%	65.3%	11.8%	32.2%	5.3%	10.2%	51.8%
1st–3rd Trimester (12,629)	7.1%	16.3%	3.9%	1.5%	1.8%	1.0%	8.1%
Public Assistance							
No (8165)	6.3%	8.4%	1.9%	0.4%	1.4%	0.4%	4.4%
Yes (5115)	8.6%	32.0%	7.6%	4.8%	2.3%	2.4%	16.1%
Zip Code Public Assistance							
0–3% (1071)	4.5%	6.8%	1.3%	0.3%	0.9%	0.3%	3.2%
4–18% (9944)	7.2%	16.6%	3.9%	1.5%	1.6%	1.2%	8.0%
19–59% (1721)	8.5%	28.3%	6.8%	6.4%	3.3%	1.8%	17.4%

Any illicit drug

The overall prevalence rates in Table 2 indicated that Black women tested positive for overall drug use at a rate of 15.3%, while White women exhibited lower levels of exposure at 7.3%. However, net of controls, our regression model yielded no statistically significant contrast between White and Black women. This effect was statistically and substantively significant in a model that did not control for neighborhood public assistance. Specifically, the effect in the individual-level model yielded a 24% greater odds (among Black women) of testing positive for any illicit drug (than White women); while the non-significant effect in the contextual model yielded a nominal 8.7% increase in odds. Additionally, the effect of neighborhood poverty was such that every 1% increase in publicly assisted households resulted in a 2.3% increase in the odds of testing positive for any drug.

Moderating effects of public assistance

Results from our interaction models (see Table 4) test the moderating effects of neighborhood poverty on the relationship(s) between race, age, poverty, and substance use. Model 1 in Table 4 shows that other than for tobacco, the relationship between individual poverty and substance use is not moderated by neighborhood poverty. For tobacco, the interaction effect indicates a slightly larger effect of neighborhood poverty among the non-publicly assisted; although the effect is the same for poor and non-poor.

In addition, there are no significant interaction effects between neighborhood poverty and race, suggesting that neighborhood poverty affects White and Black women similarly.

Exogenaity of neighborhood and selection bias

Cross-sectional studies of neighborhood effects on individual outcomes should all come with a warning. Unless an individual has been born into and spent her entire life in the same neighborhood, choice of neighborhood may be related to the outcomes the researcher is testing. As an example, let's say that living in an impoverished neighborhood has a statistical and substantive impact upon children's delinquency in school. In this instance, the effects of neighborhood may be mitigated by the (unmeasured) characteristics of the family such that the same characteristics that

Table 3
Unstandardized logistic regression coefficients (standard errors)[a] for mixed effects models of substance use

Variable	Alcohol	Tobacco	Marijuana	Cocaine	Opiates	Amphetamines	Any Drug
Age (0–17)							
18–24	−0.044 (0.17)	0.681 (0.15)*	1.047 (0.33)*	1.579 (0.61)*	0.235 (0.40)	0.563 (0.61)	0.999 (0.23)*
25–34	−0.068 (0.18)	1.230 (0.15)*	1.459 (0.33)*	3.055 (0.61)*	0.566 (0.40)	1.463 (0.61)*	1.749 (0.23)*
35+	−0.076 (0.20)	1.295 (0.16)*	1.048 (0.36)*	3.542 (0.63)*	0.978 (0.43)*	1.257 (0.66)	1.861 (0.25)*
Race (White)							
Black	0.492 (0.09)*	−0.654 (0.07)*	−0.409 (0.12)*	1.812 (0.18)*	0.204 (0.17)	−2.762 (0.39)*	0.083 (0.08)
Nativity (foreign born)							
native born	0.051 (0.13)	0.320 (0.11)*	0.446 (0.21)*	0.619 (0.36)	−0.082 (0.24)	0.387 (0.37)	0.281 (0.14)*
Prenatal care (yes)							
no care	0.192 (0.21)	1.616 (0.15)*	0.611 (0.21)*	2.652 (0.20)*	0.747 (0.31)*	2.295 (0.27)*	1.903 (0.14)*
Marital status (married)							
not married	0.169 (0.09)	0.805 (0.07)*	0.395 (0.12)*	1.209 (0.21)*	0.034 (0.18)	0.370 (0.21)	0.496 (0.08)*
Divorced/separated/widowed	−0.022 (0.22)	1.049 (0.13)*	0.471 (0.21)*	1.131 (0.32)*	0.007 (0.36)	0.225 (0.37)	0.510 (0.16)*
Public assistance (no)							
yes	0.089 (0.09)	1.370 (0.06)*	1.307 (0.12)*	1.302 (0.21)*	0.441 (0.170)*	1.823 (0.23)*	1.181 (0.08)*
Zip code public assistance							
0.458 (0.56)	2.845 (0.37)*	1.507 (0.65)*	2.353 (0.97)*	2.152 (0.93)*	3.192 (1.3)*	2.260 (0.48)*	
Constant	−2.888 (0.23)*	−4.176 (0.19)*	−5.846 (0.40)*	−10.252 (0.75)*	−5.003 (0.48)*	−7.640 (0.75)*	−5.318 (0.28)*
ρ	0.131	0.000	0.078	0.271	0.104	0.367	0.070
S.E. (ρ)	0.038	N/a	0.062	0.096	0.090	0.101	0.034
−2LL	6762.13	10,085.96	4511.46	1805.44	2401.46	1467.91	7085.63
(*N*)	(13,280)	(12,735)	(13,280)	(13,280)	(13,280)	(13,280)	(13,280)

[a] Two-tailed significance. * = $\alpha < 0.05$.

Table 4
Summary table for moderating effects of zip code public assistance (ZCPA) on substance use by race and individual-level public assistance (interactions reported[a] are net of full models in Table 3)

Model no./Variables	Alcohol	Tobacco	Marijuana	Cocaine	Opiates	Amphetamines	Any Drug
Model no. 1 (Public Ass. By ZCPA)							
Main Effects:							
3a. Constant	−2.865*	−4.271*	−5.855*	−10.376*	−5.029*	−8.024*	−5.384*
3b. Zip Code Public Assistance	0.199	3.910*	1.615	3.369	2.435	7.103*	2.987*
3c. Individual Public Assistance	0.039	1.530*	1.321*	1.470*	0.493	2.364*	1.292*
Interaction Effects:							
3b*3c	0.430	−1.482*	−0.1364	−1.185	−0.439	−5.037	−0.988
Model no. 2 (Race by ZCPA)							
Main Effects:							
2a. Constant	−2.818*	−4.196*	−5.838*	−10.361*	−4.987*	−7.686*	−5.311*
2b. Zip Code Public Assistance	−0.356	3.056*	1.427	3.436	1.984	3.610*	2.182*
2c. Black	0.279	−0.574*	−0.439	2.003*	0.152	−2.022*	0.058
Interaction Effects:							
2b*2c	1.622	−0.512	0.194	−1.431	0.352	−3.932	0.168

[a] Two-tailed significance. * = $\alpha < 0.05$.

influenced the family to move into this neighborhood may also be related to the parental influence on their child's behavior. Therefore, neighborhood may be picking up the effects of unobserved family characteristics (Plotnick & Hoffman, 1999). This criticism can be extended to virtually any social outcome, although its merits are more credible for some than for others. In the instance of health outcomes and especially non-abusive drug use, it would be hard to imagine that anyone moved into a neighborhood in order to facilitate their poorer health or use of substances. This same argument can be made that drug addicts would definitely seek networks (both geographically and socially) which facilitate their drug use. At the same time, neighborhood choice does not exist in a vacuum. Socio-historical and contemporary forces are also to blame for the distribution of persons into specific neighborhoods. Persons of lower income can only afford to live in a limited number of neighborhoods and Black people in the US, regardless of SES, are forced into segregated and limited housing opportunities (Massey & Denton, 1993). In addition, if the effects of neighborhood can more accurately be described as contextual effects rather than compositional effects then the conditions of neighborhood infrastructure and social services are largely exogenous to the individuals living in them. Lacking longitudinal or historical data from these women, we are forced to assume that the effects of neighborhood choice are either minimal or non-existent on PSE, and the models specified do not suffer from omitted variable bias. Although not expressly stated in all research of neighborhood effects, this assumption is implicitly made as conclusions are drawn.

Conclusions

The raw number of positives for amphetamines (161), opiates (246), and cocaine (288) were small relative to the number of positives for alcohol (954), marijuana (541), tobacco (2207), and any drug (1196). Therefore, these small prevalences should be considered when drawing conclusions about effect contrasts. At the same time, these prevalences (due to the large initial sample) may represent the largest sample of positive substance use among pregnant women. Surely, these samples represent the largest number of randomly selected, urine tested results of pregnant women.

The testing technique that the PSE utilized is somewhat limited in that substance use can be detected only within a few days to a couple of months away from the actual use. Substance use in the first few months of pregnancy (even up until the final month) may not have been detected by the urine samples. This relatively short window of detection suggests that substance positive women were using drugs right up until the time of the childbirth. It can be hypothesized that these women had probably been using drugs throughout the pregnancy, rather than at a single time, directly before the childbirth (alcohol, notwithstanding).

The three major hypotheses tested in this study yielded varying results. First, the estimated effect of neighborhood had a (statistically significant) predictive effect for all substances except alcohol. These effects were also substantively significant as they increased the likelihood of a substance positive by 2.6–3.5% for each 1% increase in levels of neighborhood poverty. Considering that levels of public assistance ranged from

0–59%; the effect of neighborhood public assistance may be as great as 206% greater odds for a woman living in a predominantly publicly assisted neighborhood (contrasted with a woman living in a neighborhood with no public assistance).

The second hypothesis relates to the originally observed Black-White contrasts for all substances tested (without controlling for neighborhood poverty). While Black women had higher estimated prevalences for alcohol and cocaine, White women had higher estimated rates for tobacco, marijuana and amphetamines. There were not significant racial contrasts for opiates or for the more general category of any drug positive. Controlling for neighborhood public assistance eliminated the once significant racial contrasts for opiates and overall illicit drug use. These results suggest that some, and in two cases all, observed racial differences in substance use may be due to differential social environments.

Thirdly, our interaction models lend very little support to the contentions that neighborhood poverty moderates the relationships between individual level variables and perinatal substance use. Specifically, neighborhood poverty similarly affects women of different race and poverty status.

Why does neighborhood poverty differentially affect the use of substances? Alcohol is the only substance that was not significantly related to neighborhood poverty, more than likely because it is a widely used, legal, and readily available substance. The individual and contextual reasons for access to-, stressors leading to the use of-, and the normative use of- drugs in varying communities is too complex to outline within the confines of this paper. However, neighborhood poverty significantly affected the use of all substances, other than alcohol, although to varying extents. How does neighborhood poverty lead to increased substance use? If we assume that the observed neighborhood poverty effects are attributable to compositional effects, then neighborhood poverty may reflect the overall social environment of a community that is conducive of substance use. That is, the presence of greater numbers of substance users, access to substances, greater overall deviance, the social acceptability of substance use, and the added stresses of a neighborhood full of poverty may be the key to the relationship between individual substance use and neighborhood contest. However, if contextual effects are involved, then substance use in poorer neighborhoods may be due to the increased stresses of poor housing conditions, a lack of health care and substance use services, and a general lack of social services within the community. Future analyses should consider the nuances of the community in greater detail, and should utilize both detailed levels of measurement as well as detailed measurements of neighborhood characteristics.

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