Original Investigation

Neighborhood Perceptions Are Associated With Tobacco Dependence Among African American Smokers

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Abstract

Introduction: The animal and human research literatures suggest that deprived environmental conditions may be associated with drug dependence, but the relation of neighborhood perceptions with a multidimensional measure of tobacco dependence has not been previously studied. The purpose of this study was to examine the associations between neighborhood perceptions (neighborhood problems and neighborhood vigilance) and tobacco dependence among smokers as measured by the Wisconsin Inventory of Smoking Dependence Motives-68 (WISDM).

Methods: Participants were 384 African American smokers (49% men, 80% <\$30,000 annual household income) enrolled in a randomized clinical trial of a smoking cessation intervention. A series of regression models were conducted to examine the associations between neighborhood perceptions and tobacco dependence using a generalized estimating equation approach, which accounted for potential correlation in tobacco dependence between participants from the same neighborhood.

Results: Results indicated that more self-reported neighborhood problems and greater neighborhood vigilance were significantly associated with tobacco dependence as measured by the WISDM total score in analyses adjusted for age, gender, income, education, employment status, and partner status ($p \leq .002$). Neighborhood perceptions were related to both primary and secondary dependence motives ($p \leq .005$).

Conclusions: Results suggest that the neighborhood context is associated with dependence on tobacco among African American smokers but longitudinal studies are needed to assess causation. Future research should also explore the mechanisms that account for the associations between neighborhood perceptions and tobacco dependence to better inform intervention development.

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Introduction

Recently, there has been an increased focus in the literature on deciphering the social-contextual determinants of smoking behaviors, and a few emerging studies in this area have focused on smokers' subjective perceptions of their neighborhood environments. These studies have indicated that characteristics of the residential neighborhood are associated with smoking behaviors, over and above the influence of sociodemographic characteristics. For example, perceived neighborhood problems and low ratings of neighborhood safety have been associated with increased smoking prevalence (Ellaway & Macintyre, 2009; Miles, 2006); and trust among neighbors has been inversely associated with smoking prevalence (Patterson, Eberly, Ding, & Hargreaves, 2004) and the number of cigarettes smoked per day (Sapag et al., 2010). This social-contextual research is important inasmuch as significant findings may highlight novel determinants of smoking behaviors that can be targeted within multilevel interventions (cf. Echeverria, Diez-Roux, Shea, Borrell, & Jackson, 2008). The significant findings thus far citing relations between the neighborhood social context and smoking behaviors suggest that this is a promising avenue to pursue, but additional research is needed to better understand their basis, especially among underserved groups of smokers (e.g., African Americans) who bear a large burden of tobacco-related morbidity and mortality (Vidrine, Reitzel, & Wetter, 2009a, 2009b).

Empirical research and theoretical models suggest that relations between neighborhood characteristics and smoking might be explained by associations between certain environmental characteristics and vulnerability to drug dependence. For example, a number of animal-based laboratory studies have indicated that environmental enrichment is associated with decreased responsiveness to addictive drugs (Bezaud et al., 2003; El Rawas,

Thiriet, Lardeux, Jaber, & Solinas, 2009; Solinas, Thiriet, El Rawas, Lardeux, & Jaber, 2009), including nicotine (Green, Cain, Thompson, & Bardo, 2003), and decreased vulnerability to drug abuse (Laviola, Hannan, Macri, Solinas, & Jaber, 2008; Stairs & Bardo, 2009). Theoretical frameworks suggest that the mechanism of action by which environmental enrichment affects addiction lies in its antistress effects (Solinas, Thiriet, Chauvet, & Jaber, 2010). An extrapolation of this framework to human addiction suggests that environments (or neighborhoods) with numerous resources would be associated with less stress and thus less drug addiction, whereas deprived environments would be associated with greater stress and drug addiction. In fact, research among racially/ethnically diverse smokers has confirmed a significant prospective relationship between neighborhood problems and neighborhood vigilance and increased negative affect/stress (Businelle et al., 2010), and numerous human studies have linked negative affect and stress to smoking behaviors and smoking cessation (e.g., Kenford et al., 2002; Shiffman & Waters, 2004). Other potential mechanisms connecting neighborhood environments and smoking behaviors could include the increased presence of smoking cues in less desirable neighborhoods, such as a greater density of tobacco retail outlets and more tobacco advertising (cf. Schneider, Reid, Peterson, Lowe, & Hughey, 2005; Siahpush, Jones, Singh, Timsina, & Martin, 2010a, 2010b). Tobacco retail outlet density has been associated with the number of cigarettes consumed per day among smokers in at least one prior study (Chuang, Cubbin, Ahn, & Winkleby, 2005). Thus, subjective perceptions of problems or the need for increased vigilance in the neighborhood might affect tobacco dependence among smokers through motives such as the relief of negative affect/stress or by evoking greater physiological cravings to smoke in response to smoking cues. Increasing understanding of relations between neighborhood perceptions and tobacco dependence is an important first step in better understanding the influence of the neighborhood environment on smoking behaviors.

To our knowledge, only one study has examined the impact of neighborhood perceptions on nicotine dependence. Specifically, Sapag et al. (2010) found that trust among neighbors was inversely associated with the number of cigarettes smoked per day among Chilean smokers. However, no previous studies have examined the association between the neighborhood context and smoking dependence among vulnerable minority groups in the United States, such as African Americans (AAs). A better understanding of the relations between the neighborhood environment and tobacco dependence among this population is important, as AA smokers are more likely to incur tobacco-related diseases and die from these diseases than their Caucasian counterparts, despite the later initiation of smoking and lower smoking rates (i.e., cigarettes consumed per day) than Caucasian smokers (American Cancer Society, 2009; Vidrine et al., 2009a, 2009b). In addition, AA smokers may also be less likely to successfully quit smoking than Caucasians (Fu et al., 2008; Stahre, Okuyemi, Joseph, & Fu, 2010), and new information on potentially modifiable determinants of smoking behaviors among this group could contribute to improved cessation interventions.

The primary purpose of this study was to explore the associations between neighborhood perceptions (i.e., neighborhood

problems, neighborhood vigilance) and tobacco dependence among treatment-seeking AA smokers from Houston, TX. The associations of neighborhood perceptions with primary versus secondary tobacco dependence motives were also explored. This study builds on the work of Sapag and colleagues, which indicated that neighborhood factors were associated with tobacco dependence among low-income, Chilean smokers (Sapag et al., 2010) in several ways. First, it expands the investigation of neighborhood influences on tobacco dependence from perceived social trust among neighbors to perceptions of neighborhood problems and neighborhood vigilance. Secondly, it uses a comprehensive and multidimensional measure of tobacco dependence that taps not only the core (primary) features of tobacco dependence but also situational/instrumental (secondary) dependence motives. This may be particularly important because a multidimensional measure is a more reliable indicator of tobacco dependence than cigarettes smoked per day (Benowitz & Jacob, 2011), particularly among AA smokers (Barondess, Meyer, Boinapally, Fairman, & Anthony, 2010; Benowitz & Jacob, 2011). Third, it focuses on an underserved population of relevance to the United States: AA smokers. Thus, research on the association of neighborhood perceptions with multidimensional tobacco dependence among AAs represents a novel contribution to the extant literature. Based on both animal and human studies, greater neighborhood problems and neighborhood vigilance were hypothesized to be associated with greater tobacco dependence among AA smokers, with both primary dependence motives (PDM) and secondary dependence motives (SDM) significantly contributing to that association.

Methods

Participant Eligibility

Data were collected as part of a randomized clinical trial to determine the efficacy of a smoking cessation treatment designed for AA smokers that utilized palmtop computers. Individuals were eligible to participate if they were AA, smoked ≥ 5 cigarettes/day for ≥ 12 months, produced expired carbon monoxide levels of ≥ 8 parts per million, were willing to quit smoking within the next 2 weeks, possessed a functioning home telephone number, had a permanent home address, and were able to understand English at a sixth-grade literacy level. Individuals were excluded from the study if they reported regular use of tobacco products other than cigarettes, were using pharmacological smoking cessation treatments at the time of enrollment, reported medical contraindications to the nicotine patch, or were pregnant or lactating.

Procedure

Participants in the clinical trial were 399 self-identified AA smokers recruited from the Houston, TX, metropolitan area who were enrolled between 2005 and 2006. The data relevant to the current study were collected approximately two weeks prior to the participants' quit day (i.e., at baseline). All study procedures were approved by the Institutional Review Board of the University of Texas MD Anderson Cancer Center, and informed consent was obtained from all participants. Participant recruitment and flow through screening and enrollment are reported elsewhere (Kendzor et al., 2008).

Measures

Questionnaires were administered and completed via computer. All data were collected prior to participants quitting smoking and receiving cessation treatment.

Sociodemographics

Sociodemographics included age, gender, total annual household income, educational level, employment status, and partner status. These variables were treated as covariates in the analysis due to known associations with the variables of interest. There were no missing data for participant age, gender, or education. However, because participants could refuse to answer certain questions, there were missing data for income ($n = 84$), employment status ($n = 10$), and partner status ($n = 8$). All participants who failed to provide partner status data also failed to report income and employment data, and nine participants who failed to report employment status also failed to report income.

Neighborhood Perceptions

Neighborhood perceptions were conceptualized and measured as individual-level variables rather than aggregated constructs in order to account for differences in the ways in which individual smokers perceived their local environments. Neighborhood perceptions were assessed with two separate measures. *Neighborhood problems* is a 10-item self-report measure of problems in the neighborhood such as vandalism, litter, and traffic (Steptoe & Feldman, 2001). Scores range from 10 to 30, with higher scores indicating greater neighborhood problems. The coefficient alpha for this sample was .83. *Neighborhood vigilance* is a six-item self-report measure of vigilance for threat within the neighborhood (Feldman & Steptoe, 2004; Taylor & Seeman, 1999). Items are rated on a 5-point Likert-type scale, with total scores ranging from 6 to 30. Higher scores indicate greater vigilance for threat ($\alpha = .73$). The correlation between neighborhood problems and neighborhood vigilance in this sample was .45. There were two participants who refused to answer the neighborhood perception measures. These participants were among those who also failed to provide data on income, employment, and partner status.

Tobacco Dependence

Dependence on tobacco was assessed using the total score of the Wisconsin Inventory of Smoking Dependence Motives-68 (WISDM; Piper et al., 2004), as well as with the PDM and SDM WISDM scores (Piper et al., 2008). The WISDM PDM comprises four WISDM subscales (loss of control, craving, automaticity, and tolerance) and represents the core motivational features of tobacco dependence (Piasecki, Piper, & Baker, 2010; Piasecki, Piper, Baker, & Hunt-Carter, 2010; Piper et al., 2008). The WISDM SDM comprises the remaining nine WISDM subscales (affiliative attachment, behavioral choice/melioration, cognitive enhancement, cue exposure/associative processes, negative reinforcement, positive reinforcement, social/environmental goads, taste/sensory processes, and weight control), and represents more situational and instrumental motives for smoking (Piasecki, Piper, & Baker, 2010; Piasecki, Piper, Baker, et al., 2010; Piper et al., 2008). The coefficient alphas for the WISDM Total, WISDM PDM, and WISDM SDM were .94, .90, and .92, respectively, in this sample. The two participants who refused to answer the neighborhood perception measures also refused to answer the WISDM items.

Data Analysis

Participant's residential addresses were batch geocoded with Environmental Systems Research Institute's ArcGIS software (version 9.3.1; ESRI Developer Network, Redlands, CA) using address points from Centerpoint Energy's Houston metropolitan area address database. The majority of the participants' residential addresses were successfully geocoded, with the exception of 13 participants (P.O. Box, $n = 11$; address not found, $n = 2$). The 386 remaining participants resided within 176 Census tracts within the Houston metropolitan area (based on the 2000 U.S. Census). Clustering within tracts ranged from 1 to 10, with 79 tracts being home to two or more participants. Census tracts have been supported as suitable proxies for neighborhoods in previous research (Krieger, Chen, Waterman, Rehkopf, & Subramanian, 2003).

A series of regression models were conducted to examine the associations between neighborhood perceptions and nicotine dependence. A generalized estimating equation approach assuming a normal marginal distribution for each observation of the outcome variable was used for all analyses because of the potential for correlations in tobacco dependence outcomes between participants from the same neighborhood. As a result, the maximum sample size for each analysis was 384 (i.e., 386 [the number of participants who could be geocoded to a neighborhood] - 2 [participants with missing data for neighborhood perceptions and dependence]). Model 1 tested the unadjusted associations between neighborhood perceptions and dependence. Model 2 tested the associations between neighborhood perceptions and dependence while controlling for age, gender, total annual household income, educational level, employment status, and partner status.

Secondary analyses were conducted to ensure that any effects resulting from the primary analyses were resilient to the inclusion of the participants who declined to provide data on their income. This was accomplished by rerunning Model 2 including all previously specified covariates except income. In addition, as the unique contributions of neighborhood problems and neighborhood vigilance to tobacco dependence were of interest, a final analysis was conducted that included both predictors together in a fully adjusted model. All analyses were performed using SAS v. 9.1 (SAS Institute, Inc., Cary, NC).

Results

Participant Characteristics

A total of 384 AA participants provided data on residential neighborhood, neighborhood perceptions, and tobacco dependence and were available for inclusion in analyses. Participants were roughly equally divided between the genders (51.3% women) and were 42.2 years old on average (± 9.7). Most of the sample (61.1%) were unemployed, with almost half (47.9%) reporting an annual household income of <\$10,000. Participant characteristics are shown in Table 1.

Primary Analyses

The results from Models 1 and 2 indicated that more neighborhood problems and greater neighborhood vigilance were each significantly associated with greater dependence on tobacco as measured by the WISDM Total, the WISDM PDM, and the WISDM SDM in both unadjusted and adjusted analyses (Table 2).

Table 1. Participant Characteristics

Characteristic	Mean (SD)/%	<i>n</i>
Sociodemographics		
Age (years)	42.2 (±9.7)	384
Gender		
Female	51.3	197
Male	48.7	187
Total annual household income		
<\$10,000	47.9	146
\$10,000–\$29,999	31.8	97
≥\$30,000	20.3	62
Educational level		
<High school	18.0	69
High school degree/some college, no degree	60.9	234
≥College degree	21.1	81
Employment status		
Employed	38.9	147
Unemployed	61.1	231
Partner status		
Single/widowed/divorced	77.8	295
Married/living with partner	22.2	84
Neighborhood problems (range 10–30)	16.5 (±4.5)	384
Neighborhood vigilance (range 6–30)	17.6 (±4.3)	384
WISDM Total (range 13–91)	57.1 (±17.0)	384
WISDM PDM (range 1–7)	4.9 (±1.4)	384
WISDM SDM (range 1–7)	4.2 (±1.4)	384

Note. WISDM = Wisconsin Inventory of Smoking Dependence Motives; PDM = primary dependence motives; SDM = secondary dependence motives.

Secondary Analyses

The general pattern of results was unchanged when the 21% missingness on income data in this sample was handled by omitting this covariate from Model 2. Finally, when both neighborhood problems and neighborhood vigilance were included together in the fully adjusted models, results indicated that whereas neighborhood problems remained significantly associated with WISDM Total ($p = .0247$), WISDM PDM ($p = .0501$), and WISDM SDM ($p = .0240$), neighborhood vigilance did not maintain independent significance in these analyses ($p = .0880$, $.1003$, $.1038$, respectively). The details of these additional analyses are available from the corresponding author upon request.

Discussion

The current study was the first to examine the effects of neighborhood perceptions on tobacco dependence among AA adult daily smokers. Consistent with hypotheses, results indicated that the total score on a multidimensional measure of tobacco dependence was significantly associated with perceptions of neighborhood problems and neighborhood vigilance, even after controlling for the influence of various sociodemographic variables. Specifically, smokers living in neighborhoods with more perceived physical problems (e.g., vandalism, problems with dogs, litter in the streets) exhibited greater tobacco dependence than those living in neighborhoods with fewer perceived problems. Likewise, smokers living in neighborhoods engendering high levels of vigilance (e.g., feeling on guard, not relaxed, not safe in their neighborhood) exhibited greater tobacco dependence than those living in neighborhoods warranting less vigilance. This study adds to the literature on the multilevel sociocontextual effects of the neighborhood environment on smoking behaviors, and extends laboratory-based animal research linking environmental deprivation to drug dependence to the real-world human experience of tobacco dependence.

This study also examined associations between neighborhood perceptions and differing motives for tobacco dependence using the PDM and SDM factors of the WISDM scale (Piasecki, Piper, & Baker, 2010; Piper et al., 2008). Whereas PDM represent the core features of tobacco dependence, SDM are more situational and instrumental in nature (e.g., smoking in response to negative affect). Our results indicated that neighborhood perceptions were related to both primary and secondary motives for tobacco dependence. Adjusted post-hoc analyses of the relations between neighborhood perceptions and each of the individual subscales comprising the WISDM PDM and the WISDM SDM were conducted to identify whether certain subscales were driving these results. Neighborhood problems were significantly associated with each of the WISDM PDM subscales, and each of the WISDM SDM subscales except taste/sensory processes and affiliative attachment. Neighborhood vigilance was significantly associated with each of the WISDM PDM subscales except automaticity, and each of the WISDM SDM subscales except taste/sensory processes (results are available upon request). These results highlight the association of neighborhood perceptions with multiple primary and secondary motives for tobacco dependence.

Table 2. Associations of Neighborhood Perceptions With Tobacco Dependence

Independent Variable	Dependent Variable	Model 1			Model 2		
		<i>B</i> (SE)	<i>n</i>	<i>p</i>	<i>B</i> (SE)	<i>n</i>	<i>p</i>
Neighborhood problems	WISDM Total	1.0439 (0.2210)	384	<.0001	0.7737 (0.2366)	305	.0011
	WISDM PDM	0.0727 (0.0180)	384	.0001	0.0559 (0.0186)	305	.0027
	WISDM SDM	0.0837 (0.0173)	384	<.0001	0.0614 (0.0194)	305	.0015
Neighborhood vigilance	WISDM Total	0.8551 (0.2075)	384	<.0001	0.6790 (0.2203)	305	.0021
	WISDM PDM	0.0561 (0.0171)	384	.0010	0.0528 (0.0185)	305	.0044
	WISDM SDM	0.0698 (0.0165)	384	<.0001	0.0518 (0.0175)	305	.0031

Note. WISDM = Wisconsin Inventory of Smoking Dependence Motives; PDM = primary dependence motives; SDM = secondary dependence motives; Model 1 = unadjusted model; Model 2 = model adjusted for participant age, gender, education level, income, employment status, and partner status.

Results regarding PDM suggest that neighborhoods with more physical disorder and neighborhoods that engender more vigilance among residents may provoke greater physiological cravings to smoke or result in the perception of less personal control over their addiction. It is possible that other environmental characteristics, such as the availability of tobacco in the neighborhood (i.e., density of tobacco outlets), are related to neighborhood problems and vigilance and may at least partially account for these associations (cf. Chuang et al., 2005). Although we did not control for tobacco outlet density in these analyses, we conducted a post-hoc analysis controlling for neighborhood socioeconomic status (i.e., median income at the Census tract level as procured from U.S. Census data, which is a strong proxy for tobacco outlet density; Schneider et al., 2005; Siahpush et al., 2010a). However, results were unchanged in these additional analyses (available upon request). Thus, future studies might further explore the roles of environmental cues in explaining associations between neighborhood problems and vigilance and primary dependence on tobacco.

Results regarding SDM complement theoretical models and previous findings supporting a link between negative environmental conditions, the generation of negative affect, and resulting drug dependence. For example, the animal literature suggests that stress may be the mechanism by which deprived environments influence drug dependence (Solinas et al., 2010), and clinical research has supported positive associations between the experience of stressful events and nicotine dependence (cf. Hapke et al., 2005). Thus, it may be that neighborhoods with significant problems, and those warranting high levels of vigilance, exert their effects on tobacco dependence via an induction of stress among their residents. Other research has supported associations between neighborhood problems and negative affect (Businelle et al., 2010; Echeverria et al., 2008), and links between depression and enhanced sensitization to the effects of stressful circumstances, which can be neurochemically relieved by smoking (Balfour & Ridley, 2000). Thus, our results indicating an association between living in problematic neighborhoods and secondary motives for tobacco dependence suggests that stress and negative affect may be important underlying mechanisms of interest. Definitive information, however, awaits longitudinal studies with a focus on meditational linkages among neighborhood characteristics, stress and negative affect, and smoking.

Our results suggest that AA smokers from troubled neighborhoods experience greater tobacco dependence. Although the cross-sectional design of the current study precludes any conclusions about causal pathways between neighborhood perceptions and tobacco dependence, results suggest intervention pathways that can be explored among people endorsing greater neighborhood problems and vigilance, and places marked by these characteristics, in future research. For example, results suggest that individual as well as contextual or place-based interventions for tobacco dependence should focus on both primary and secondary motives for tobacco use. Supporting the potential for area-level interventions to affect tobacco dependence is laboratory-based animal research suggesting that enhancing environmental conditions can treat or even prevent drug addiction (Solinas, Chauvet, Thiriet, El Rawas, & Jaber, 2008; Solinas et al., 2010). Likewise, researchers who study humans have suggested that the modification of the neighborhood context may exert positive effects on residents' health and health-related behaviors, including smoking

rates (Echeverria et al., 2008; Ludwig et al., 2011). Such place-based interventions might entail policy- or community-level changes to address the mechanisms that contribute to the link between problematic neighborhoods and secondary tobacco dependence.

In this study, secondary analyses indicated that when both neighborhood predictors were considered jointly in a single model, only neighborhood problems maintained independent significance in its associations with tobacco dependence. This pattern of results may reflect the interdependence and shared variance between individual-level neighborhood problems and neighborhood vigilance (neighborhoods with more physical problems engender the need for greater vigilance among residents), despite the fact that correlations between these measures were moderate in this sample ($r = .45$). However, these results may suggest that place-based interventions targeted at reducing physical problems in neighborhoods may be particularly relevant and may themselves ultimately affect residents' perceptions for the need for vigilance in the environment. Future research should explore how best to alter the contextual environment to affect reductions in tobacco dependence among smokers living in less desirable neighborhoods.

Although we hypothesized that troubled neighborhoods affect tobacco dependence in this study, it is also important to acknowledge the potential for a reversed model whereby tobacco dependence contributed to residence in troubled neighborhoods. Tobacco dependence might affect neighborhood selection directly (more dependent people may choose to live in areas with greater access to tobacco, and these areas may be more likely to have problems or engender more vigilance). Or, alternatively, tobacco dependence might be a proxy for other factors that contributed to residence in troubled neighborhoods. These possibilities might limit the effects that environmental manipulations could have on tobacco dependence. Future studies should make use of longitudinal designs to enhance our understanding of the directionality of effects, which will also help to inform the utility of place-based interventions.

This study relied entirely on self-reported data. Therefore, the same-source reporting bias might have affected the significance of our results. To address this possibility, we conducted additional analyses that aggregated participant's neighborhood perceptions to the tract level (see Echeverria et al., 2008, for precedent). Both area-level neighborhood problems and area-level neighborhood vigilance remained significantly associated with tobacco dependence in these adjusted analyses, with relations driven by secondary dependence motives (results are available upon request). These results help to minimize concerns about the potential influence of same-source reporting bias in our data. However, although the aggregation of individual-level perceptions is helpful to address concerns about biases in self-reported data, the inclusion of mental health data (e.g., depression measures) in future research would also be helpful to rule out potential confounding.

Strengths of the current work include the use of a multidimensional measure of tobacco dependence, which has several advantages over traditional single-item tobacco dependence questions (e.g., cigarettes per day), especially among AA smokers (Barondess, Meyer, Boinapally, Fairman, & Anthony, 2010; Benowitz & Jacob, 2011). This work also has limitations. For

example, neighborhood characteristics were based on individual perceptions and may not reflect objective neighborhood conditions. To the extent to which the two diverge, place-based interventions may be ineffective for altering residents' tobacco dependence. Future studies in this area might include both self-reported and objective neighborhood data (e.g., crime statistics) to assess whether key findings replicate across data sources. Additional limitations of the current research include that participants were self-selected, treatment-seeking AA smokers. Such smokers may differ from smokers who are not interested in quitting, and the influence of neighborhood perceptions on dependence among the latter group remains unknown. Moreover, this study focused on AAs, and results may not generalize to smokers of other race/ethnicities, especially inasmuch as neighborhood characteristics may systematically differ between neighborhoods based on area-level racial/ethnic homogeneity and related factors. Likewise, our findings about neighborhood perceptions may not generalize to smokers living in rural areas or to metropolitan areas in other parts of the country.

In summary, the current study provides the first evidence that greater perceptions of neighborhood problems and neighborhood vigilance are associated with greater tobacco dependence among AA adult daily smokers, even after accounting for the effects of several covariates (including individual- and area-level socioeconomic status). Our results add to a growing literature highlighting the role of the social context in shaping behavior and extend those findings to tobacco dependence among AA adult daily smokers. Future research should explore mechanisms accounting for relations between neighborhood problems/vigilance and dependence on tobacco, and consider the application of this knowledge to multilevel interventions to affect smoking prevalence and cessation among underserved groups.

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Declaration of Interests

Authors have no competing interests pertaining to this research but would like to report that P.M.C. and J.S.A. have served on the scientific advisory board of Pfizer Pharmaceuticals and have conducted educational talks sponsored by Pfizer on smoking cessation for physicians within the past 3 years.

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References

- American Cancer Society. (2009). *Cancer facts and figures 2009*. Atlanta, GA: Author.
- Balfour, D. J., & Ridley, D. L. (2000). The effects of nicotine on neural pathways implicated in depression: A factor in nicotine addiction? *Pharmacology Biochemistry and Behavior*, 66, 79–85. doi:10.1016/S0091-3057(00)00205-7
- Barondess, D. A., Meyer, E. M., Boinapally, P. M., Fairman, B., & Anthony, J. C. (2010). Epidemiological evidence on count processes in the formation of tobacco dependence. *Nicotine & Tobacco Research*, 12, 734–741. doi:10.1093/ntnq073
- Benowitz, N., & Jacob, P. (2011). *Non-linear dose-response relationship between cigarettes per day and nicotine and carcinogen exposure*. Symposium presentation at the 17th annual meeting of the Society for Research on Nicotine and Tobacco, Toronto, Canada.
- Bezard, E., Dovero, S., Belin, D., Duconger, S., Jackson-Lewis, V., Przedborski, S., et al. (2003). Enriched environment confers resistance to 1-methyl-4-phenyl-1, 2, (3), 6-tetrahydropyridine and cocaine: Involvement of dopamine transporter and trophic factors. *Journal of Neuroscience*, 23, 10999–11007.
- Businelle, M. S., Kendzor, D. E., Reitzel, L. R., Costello, T. J., Cofta-Woerpel, L., Li, Y., et al. (2010). Mechanisms linking socioeconomic status to smoking cessation: A structural equation modeling approach. *Health Psychology*, 29, 262–273. doi:10.1037/a0019285
- Chuang, Y. C., Cubbin, C., Ahn, D., & Winkleby, M. A. (2005). Effects of neighbourhood socioeconomic status and convenience store concentration on individual level smoking. *Journal of Epidemiology and Community Health*, 59, 568–573. doi:10.1136/jech.2004.029041
- Echeverria, S., Diez-Roux, A. V., Shea, S., Borrell, L. N., & Jackson, S. (2008). Associations of neighborhood problems and neighborhood social cohesion with mental health and health behaviors: The Multi-Ethnic Study of Atherosclerosis. *Health & Place*, 14, 853–865. doi:10.1016/j.healthplace.2008.01.004
- El Rawas, R., Thiriet, N., Lardeux, V., Jaber, M., & Solinas, M. (2009). Environmental enrichment decreases the rewarding but not the activating effects of heroin. *Psychopharmacology (Berl)*, 203, 561–570. doi:10.1007/s00213-008-1402-6
- Ellaway, A., & Macintyre, S. (2009). Are perceived neighbourhood problems associated with the likelihood of smoking? *Journal of Epidemiology and Community Health*, 63, 78–80. doi:10.1136/jech.2007.068767
- Feldman, P. J., & Steptoe, A. (2004). How neighborhoods and physical functioning are related: The roles of neighborhood socioeconomic status, perceived neighborhood strain, and individual health risk factors. *Annals of Behavioral Medicine*, 27(2), 91–99. doi:10.1207/s15324796abm2702_3
- Fu, S. S., Kodl, M. M., Joseph, A. M., Hatsukami, D. K., Johnson, E. O., Breslau, N., et al. (2008). Racial/ethnic disparities in the use of nicotine replacement therapy and quit ratios in

- lifetime smokers ages 25 to 44 years. *Cancer Epidemiology, Biomarkers, and Prevention*, 17, 1640–1647. doi:10.1158/1055-9965.EPI-07-2726
- Green, T. A., Cain, M. E., Thompson, M., & Bardo, M. T. (2003). Environmental enrichment decreases nicotine-induced hyperactivity in rats. *Psychopharmacology (Berl)*, 170, 235–241. doi:10.1007/s00213-003-1538-3
- Hapke, U., Schumann, A., Rumpf, H. J., John, U., Konerding, U., & Meyer, C. (2005). Association of smoking and nicotine dependence with trauma and posttraumatic stress disorder in a general population sample. *Journal of Nervous and Mental Disorders*, 193, 843–846. doi:10.1097/01.nmd.0000188964.83476.e0
- Kendzor, D. E., Cofta-Woerpel, L. M., Mazas, C. A., Li, Y., Vidrine, J. I., Reitzel, L. R., et al. (2008). Socioeconomic status, negative affect, and modifiable cancer risk factors in African-American smokers. *Cancer Epidemiology, Biomarkers, and Prevention*, 17, 2546–2554. doi:10.1158/1055-9965.EPI-08-0291
- Kenford, S. L., Smith, S. S., Wetter, D. W., Jorenby, D. E., Fiore, M. C., & Baker, T. B. (2002). Predicting relapse back to smoking: Contrasting affective and physical models of dependence. *Journal of Consulting and Clinical Psychology*, 70(1), 216–227. doi:10.1037//0022-006X.70.1.216
- Krieger, N., Chen, J. T., Waterman, P. D., Rehkopf, D. H., & Subramanian, S. V. (2003). Race/ethnicity, gender, and monitoring socioeconomic gradients in health: A comparison of area-based socioeconomic measures—The public health disparities geocoding project. *American Journal of Public Health*, 93, 1655–1671. doi:10.2105/AJPH.93.10.1655
- Laviola, G., Hannan, A. J., Macri, S., Solinas, M., & Jaber, M. (2008). Effects of enriched environment on animal models of neurodegenerative diseases and psychiatric disorders. *Neurobiological Disorders*, 31(2), 159–168. doi:10.1016/j.nbd.2008.05.001
- Ludwig, J., Sanbonmatsu, L., Gennetian, L., Adam, E., Duncan, G. J., Katz, L. F., et al. (2011). Neighborhoods, obesity, and diabetes—A randomized social experiment. *New England Journal of Medicine*, 365, 1509–1519. doi:10.1056/NEJMsa1103216
- Miles, R. (2006). Neighborhood disorder and smoking: Findings of a European urban survey. *Social Science and Medicine*, 63, 2464–2475. doi:10.1016/j.socscimed.2006.06.011
- Patterson, J. M., Eberly, L. E., Ding, Y., & Hargreaves, M. (2004). Associations of smoking prevalence with individual and area level social cohesion. *Journal of Epidemiology and Community Health*, 58, 692–697. doi:10.1136/jech.2003.009167
- Piasecki, T. M., Piper, M. E., & Baker, T. B. (2010). Refining the tobacco dependence phenotype using the Wisconsin Inventory of Smoking Dependence Motives: II. Evidence from a laboratory self-administration assay. *Journal of Abnormal Psychology*, 119, 513–523. doi:10.1037/a0020235
- Piasecki, T. M., Piper, M. E., Baker, T. B., & Hunt-Carter, E. E. (2011). WISDM primary and secondary dependence motives: Associations with self-monitored motives for smoking in two college samples. *Drug and Alcohol Dependence*, 114, 207–216. doi:10.1016/j.drugalcdep.2010.10.005
- Piper, M. E., Bolt, D. M., Kim, S. Y., Japuntich, M. S., Smith, S. S., Niederdeppe, J., et al. (2008). Refining the tobacco dependence phenotype using the Wisconsin Inventory of Smoking Dependence Motives (WISDM). *Journal of Abnormal Psychology*, 117, 747–761. doi:10.1037/a0013298
- Piper, M. E., Piasecki, T. M., Federman, E. B., Bolt, D. M., Smith, S. S., Fiore, M. C., et al. (2004). A multiple motives approach to tobacco dependence: The Wisconsin Inventory of Smoking Dependence Motives (WISDM-68). *Journal of Consulting and Clinical Psychology*, 72(2), 139–154. doi:10.1037/0022-006X.72.2.139
- Sapag, J. C., Poblete, F. C., Eicher, C., Aracena, M., Caneo, C., Vera, G., et al. (2010). Tobacco smoking in urban neighborhoods: Exploring social capital as a protective factor in Santiago, Chile. *Nicotine & Tobacco Research*, 12, 927–936. doi:10.1093/ntr/ntq117
- Schneider, J. E., Reid, R. J., Peterson, N. A., Lowe, J. B., & Hughey, J. (2005). Tobacco outlet density and demographics at the tract level of analysis in Iowa: Implications for environmentally based prevention initiatives. *Prevention Science*, 6, 319–325. doi:10.1007/s11121-005-0016-z
- Shiffman, S., & Waters, A. J. (2004). Negative affect and smoking lapses: A prospective analysis. *Journal of Consulting and Clinical Psychology*, 72(2), 192–201. doi:10.1037/0022-006X.72.2.192
- Siahpush, M., Jones, P. R., Singh, G. K., Timsina, L. R., & Martin, J. (2010a). Association of availability of tobacco products with socio-economic and racial/ethnic characteristics of neighbourhoods. *Public Health*, 124, 525–529. doi:10.1016/j.puhe.2010.04.010
- Siahpush, M., Jones, P. R., Singh, G. K., Timsina, L. R., & Martin, J. (2010b). The association of tobacco marketing with median income and racial/ethnic characteristics of neighbourhoods in Omaha, Nebraska. *Tobacco Control*, 19, 256–258. doi:10.1136/tc.2009.032185
- Solinas, M., Chauvet, C., Thiriet, N., El Rawas, R., & Jaber, M. (2008). Reversal of cocaine addiction by environmental enrichment. *Proceeds of the National Academy of Sciences USA*, 105, 17145–17150. doi:10.1073/pnas.0806889105
- Solinas, M., Thiriet, N., Chauvet, C., & Jaber, M. (2010). Prevention and treatment of drug addiction by environmental enrichment. *Progress in Neurobiology*, 92, 572–592. doi:10.1016/j.pneurobio.2010.08.002
- Solinas, M., Thiriet, N., El Rawas, R., Lardeux, V., & Jaber, M. (2009). Environmental enrichment during early stages of life reduces the behavioral, neurochemical, and molecular effects of cocaine. *Neuropsychopharmacology*, 34, 1102–1111. doi:10.1038/npp.2008.51
- Stahre, M., Okuyemi, K. S., Joseph, A. M., & Fu, S. S. (2010). Racial/ethnic differences in menthol cigarette smoking, population quit ratios and utilization of evidence-based tobacco

cessation treatments. *Addiction*, 1(105 Suppl.), 75–83. doi:10.1111/j.1360-0443.2010.03200.x

Stairs, D. J., & Bardo, M. T. (2009). Neurobehavioral effects of environmental enrichment and drug abuse vulnerability. *Pharmacology Biochemistry and Behavior*, 92, 377–382. doi:10.1016/j.pbb.2009.01.016

Steptoe, A., & Feldman, P. J. (2001). Neighborhood problems as sources of chronic stress: Development of a measure of neighborhood problems, and associations with socioeconomic status and health. *Annals of Behavioral Medicine*, 23, 177–185. doi:10.1207/S15324796ABM2303_5

Taylor, S. E., & Seeman, T. E. (1999). Psychosocial resources and the SES-health relationship. *Annals of the New York Academy of Sciences*, 896, 210–225. doi:10.1111/j.1749-6632.1999.tb08117.x

Vidrine, J. I., Reitzel, L. R., & Wetter, D. W. (2009a). The role of tobacco in cancer health disparities. *Current Oncology Reports*, 11, 475–481. doi:10.1007/s11912-009-0064-9

Vidrine, J. I., Reitzel, L. R., & Wetter, D. W. (2009b). Smoking and health disparities. *Current Cardiovascular Risk Reports*, 3, 403–408. doi:10.1007/s12170-009-0060-5