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The Urban Built Environment and Associations with Women's Psychosocial Health

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ABSTRACT *The determinants that underlie a healthy or unhealthy pregnancy are complex and not well understood. We assess the relationship between the built environment and maternal psychosocial status using directly observed residential neighborhood characteristics (housing damage, property disorder, tenure status, vacancy, security measures, violent crime, and nuisances) and a wide range of psychosocial attributes (interpersonal support evaluation list, self-efficacy, John Henryism active coping, negative partner support, Perceived Stress Scale, perceived racism, Center for Epidemiologic Studies—Depression) on a pregnant cohort of women living in the urban core of Durham, NC, USA. We found some associations between built environment characteristic and psychosocial health varied by exposure categorization approach, while others (residence in environments with more rental property is associated with higher reported active coping and negative partner support) were consistent across exposure categorizations. This study outlines specific neighborhood characteristics that are modifiable risk markers and therefore important targets for increased research and public health intervention.*

KEYWORDS *Pregnancy outcomes, Built environment, Psychosocial health, Urban health*

BACKGROUND

The perinatal period is important for both maternal and infant health. Preterm birth and low birth weight are leading causes of neonatal and infant mortality, as well as short- and long-term morbidity,[1,13] and the economic costs associated with these events are substantial. In 2006, the Institute of Medicine estimated that the annual cost of preterm birth in the USA was approximately $26 billion, or roughly $51,600 per preterm infant, with two thirds of the costs related to medical care.[1] In addition to effects on children, the prenatal period is influential for women's health and may establish future health-related trajectories for women of child-bearing age. For instance, women who gain excessive weight during pregnancy may have difficulty losing this weight during the postpartum period and struggle with overweight for years following the pregnancy[14] or may struggle with depression.[6] While critical for

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public health, the determinants that underlie a healthy or unhealthy perinatal period are poorly understood and not solely attributable to individual-level factors.[1]

The built environment, defined here to include the external physical conditions of the home, infrastructures, and resources that are created or modified by people, including schools, workplaces, parks/recreations areas, business areas, and roads,[28] is an important component of the total environment to which women are exposed during pregnancy and has been previously associated with adverse maternal and reproductive health outcomes (Messer et al., manuscript submitted for publication; Miranda et al., manuscript submitted for publication[31];). The residential environment is a critical component of the built environment (Miranda et al., manuscript submitted for publication).

Maternal psychosocial status is hypothesized to be one of the mechanisms through which the built environment influences human health, but limited research has considered the built environment and none has explicitly explored its relationship with maternal mental health. Some literature exploring the relationship between the built environment do exist and found that residence in a built environment of poor quality is associated with a greater incidence of depression.[32,33] Matheson and colleagues[23] also found residential mobility and material deprivation associated with depression. Poorer neighborhood conditions have also been related to higher stress levels.[3,7,29] But none of the work has been conducted among a pregnant population.

While prior work is suggestive, most has estimated the built environment using census data,[23] has not focused on psychosocial status,[3,7,17,22] and has considered a limited range of psychosocial attributes. In an effort to address these limitations, this paper will assess the relationship between the urban built environment and maternal psychosocial status using directly observed neighborhood characteristics and a wide range of psychosocial attributes. We hypothesize that women who reside in urban neighborhoods with more negative features will have poorer psychosocial health than women residing in more positive neighborhoods. The external built environment represents a modifiable feature to which women are exposed and is therefore important for public health research.

DESIGN AND METHODS

To address the study objectives, we draw upon data from two studies conducted as part of the United States Environmental Protection Agency-funded Southern Center on Environmentally Driven Disparities in Birth Outcomes (SCEDDBO). The Healthy Pregnancy, Healthy Baby (HPHB) study is a prospective cohort study examining the effects of environmental, social, and host factors on disparities in pregnancy outcomes. SCEDDBO investigators also assessed built environment features through a community assessment project (CAP). The Duke University Institutional Review Board approved the research described here.

Setting

The study area is contained within Durham, NC, USA, and includes the 29 neighborhoods that surround and include downtown Durham. The neighborhoods included in the project area were selected to ensure a socially and economically diverse study area and focus on the Durham urban core. The Durham County percent of non-Hispanic black residents ranges from 4 to 98 %, while the unemployment rate ranges from 1 to 45 %; in the CAP study area, approximately

36.5 % of the population is Black non-Hispanic, 11.3 % of the population is Hispanic, and 11.7 % of families are below the federal poverty level.

CAP Built Environment Data

The built environment data were collected by a six-member trained field team. Data collection occurred on foot, lasted approximately 10 weeks, and occurred from 7:00 am to 1:30 pm, Monday through Friday from late May to early August in 2008. Teams rated 17,239 residential parcels within 873 census blocks based on what was visible from the sidewalk or street. Field team members carried letters explaining the CAP, and contact information was provided to community members who approached the team.

Each parcel was assessed for 57 variables that categorized its land use, occupancy status, the physical condition of any buildings, yard or property, the presence of nuisances, and evidence of territoriality. Details of the CAP data collection process and results are available elsewhere (Miranda et al., manuscript submitted for publication).

Secondary Data Sources

Durham County Tax Parcel Data. The Durham County tax parcel-level data, which provided the sampling frame for the CAP data collection, were spatially linked to census blocks. Tenure (owner- or renter-occupied status) was abstracted for parcels in the CAP study area (n=17,239 parcels) by comparing the geographic address of the parcel to the owner's address with an algorithm that allowed for minor data entry and spelling errors. Addresses that matched were coded as owner-occupied residences, while those that did not match were coded as renter-occupied. Post office boxes were excluded from analyses as they are not geocodable addresses.

Crime data. We acquired crime data from the Crime Analysis Lab of the Durham Police Department. Data are all reported crime incidents for 2006–2007 and include the charge description and the physical address at which the incident occurred. These data were subsequently geocoded at the street level so these could be aggregated to the census block level. Once the crime data were geocoded, incidents were categorized according to crime type such that, upon aggregation, each block was assigned a count for each crime type that occurred within that block. Violent crime data were used for these analyses.

Community Definition

For this research, we constructed a new neighborhood unit, primary adjacency communities (PACs), to approximate each woman's proximate community. A PAC includes the index block, plus all adjacent blocks that share any portion of a line segment (block boundary) or vertex (Figure 1). We view the PAC as representing the immediate residential environment to which a woman is exposed from her home and in her trips around her residence.

Built Environment Index Development

We grouped the built environment variables into five domains: housing damage, property disorder, nuisances (which was restricted to public spaces only), territoriality, and vacancy. Domains were identified by examining the variables for shared built environmental features, determining if they contributed to the same

FIGURE 1. Primary adjacency community description.

latent construct and grouping them accordingly. For instance, the variables that represented residential property condition but were not part of the residence itself were grouped in the property disorder domain. The domains were constructed to enable investigators to describe the built environment in terms of "who" (vacant property containing no one, renter-occupied property, etc.) and "what" (damaged, disordered, and "claimed" territoriality) parcel conditions. The parcel domains directly observed by CAP included varying numbers of variables (Table 1): housing damage ($n=12$ variables), property disorder ($n=11$ variables), security measures (as markers of territoriality (six variables)), vacancy (three variables), and nuisances ($n=25$ variables).

Parcel-level data were summed to the block level, resulting in block-level counts of each variable for each domain. Block-level counts of each variable for each domain were divided by the total number of parcels in a given block, which resulted in the block-level proportion of each variable. The block-level proportions were standardized (mean of 0, standard deviation of 1), summed to the PAC level, which resulted in the PAC-level proportion of a given variable. Proportions for each of the variables comprising a domain were then added together, divided by the number of blocks contributing to that PAC, to result in PAC-level domain-specific indices. For instance, the PAC-level security measures index = (standardized block-level proportion of security bars) + (standardized block-level proportion of barbed wire) + (standardized block-level no trespassing signs) + (standardized block-level beware of dog signs) + (standardized block-level security sign) + (standardized block-level fencing). For each index, the more of an attribute, the higher its value (e.g., a PAC with a value of "5" for crime has more crime than a PAC with a value of "2"). For tenure, higher index values represent more rental properties. Principal components analysis indicated that each variable weight was similar, so a simple summation of each variable produces comparable—and more easily interpretable—results. In the

TABLE 1 Variables comprising each built environment index

Housing damage	Security measures	Nuisances	Crime count	Property disorders	Tenure status	Vacancy
Boarded door	Security bars	Shopping carts	Violent	Cars on lawn	Renter occupied parcels	Vacant parcels
Holes in walls	Barbed wire	Total drug paraphernalia	Vice	No grass		
Roof damage	No trespassing sign	Inoperable car	Vehicle	Standing water		
Chimney damage	Beware of dog sign	Food garbage	Theft	Litter		
Foundation damage	Security sign	Dog waste	Property	Garbage		
Entry damage	Presence of fencing	Tree debris		Broken glass		
Door damage		Discarded furniture		Discarded furniture		
Peeling paint		Discarded appliances		Discarded appliances		
Fire damage		Large trash		Discarded tires		
Condemned		Batteries		Inoperable vehicle		
Boarded windows		Condoms		High weeds		
Broken windows		Fallen wire				
		Broken manhole cover				
		Uncovered drain				
		Cigarette butts				
		Alcohol container				
		Clothes				
		Baby diapers				
		Construction debris				
		Deep holes				
		Standing water				
		Litter				
		Broken glass				
		High weeks				
		Graffiti				

absence of established cutpoints for the built environment indices, or any reason to prefer one outcome measure categorization over another, we constructed four dichotomous forms of the built environment indices for each of the seven domains: <25th percentile versus ≥25th percentile, a median split, <75th percentile versus ≥75th percentile, and ≤25th percentile versus ≥75th percentile. We modeled the relationship between each of these exposure measures and each of the psychosocial measures to assess robustness of the observed associations. Because some inconsistency was observed across the various exposure categorizations, and to facilitate the presentation of the material, two different categorizations are presented in "Results": the median split and the lower versus upper quartile split ($\leq 25^{th}$ percentile versus $\geq 75^{th}$ percentile).

HPHB Cohort

Study enrollment began in June 2005; pregnant women were approached to participate in the study when they were between 18 and 28 weeks' gestation at Duke University Obstetrics and the Durham County Health Department Prenatal Clinics. Women were excluded from participation if they were less than 18 years of age, were not English-literate, were greater than 28 weeks' gestation at enrollment, lived outside of Durham County, had a multiple gestation, known fetal genetic or congenital abnormality, or were not planning to deliver at Duke University Medical Center. As of December 2010, we had approximately 90 % consent rate and 92 % retention rate (with 104 women lost to follow-up, 25 withdrawn due to screening failure, and 18 voluntarily withdrawn).

Direct patient interview at the time of enrollment and electronic medical record review were used to collect demographic information, health behavior, and medical data. Psychosocial characteristics were assessed through a variety of survey instruments including the paternal support measures from Fragile Families and Child Well-Being Survey[25]; the Perceived Stress Scale,[4] the Interpersonal Support Evaluation List (ISEL),[5] the Centers for Epidemiologic Studies Depression Scale (CES—D),[27] the Jerusalem and Schwarzer instrument for assessing self-efficacy,[16] the John Henryism Active Coping (JHAC) scale,[15] and a perceived racism scale.[20]

As of December 2010, the cohort enrolled 1,743 women in the HPHB Study. We restricted our study sample to White non-Hispanic (92), Black non-Hispanic (554), and Hispanic (76) residents of the CAP study area. This resulted in 723 women residence-eligible for inclusion in these analyses. The racial/ethnic distribution of the study sample was comparable to the overall clinical distribution (oversampling of Blacks was an intentional design component).

Outcome Measures

Responses to each of the psychosocial measures were summed as instructed in the literature to produce continuous scales. The CES—D is the one measure for which established cutpoints for a pregnant population exist; therefore, the CES—D was dichotomized as described elsewhere.[26] No literature describing the relationship between psychosocial measures and the built environment exists. In addition, some of these relationships were non-linear. To improve comparability across indices, tertiles of the remaining psychosocial indices were constructed and used in the analyses. The racism score demonstrated insufficient variability for tertile construction; therefore, it was dichotomized at the mean for use in analyses. In all cases, higher values on a scale (or the higher the tertile) represent more of an attribute.

Covariates. The adjusted models control for possible confounders to the built environment–psychosocial status relationship. They include: categorical maternal age (18–20, 21–34, 35+), categorical maternal education (<12, = 12, > 12 years), dichotomous marital status (married, not married), dichotomous insurance status (private, not private), and dichotomous birth order (first birth, ≥ first birth). Because the risk profiles of White and Hispanic are somewhat similar to each other and differ from the profiles of black non-Hispanic women, dichotomous race (Black non-Hispanic and White non-Hispanic + Hispanic) is also adjusted for.

Statistical Analysis

Counts (and percentages) of the categorical variables and means (and standard deviations) of the continuous variables were calculated. Multinomial logistic regression for complete cases resulted in odds ratios and 95 % confidence intervals for the three-level psychosocial status outcomes. To account for the multinomial multilevel nature of the research questions and data structure, generalized linear latent and mixed models were run with a binomial family and multinomial logit link. Coefficients and confidence intervals were exponentiated, which resulted in the odds ratios reported in Table 3 and Figure 2. All analyses were conducted in Stata 11.0 (College Station, TX, USA).

RESULTS

Seven hundred twenty-three participants in the HPHB cohort lived in the CAP audit area (Table 2); of these, about 77 % were NHB and 23 % were W+H. Most women were between 21 and 34 years old (74 %); 46 % completed high school (but not further) but had no additional education beyond high school. The majority of women were not married (83 %), did not have private insurance (78 %), and had at least one prior live birth (61 %).

In the unadjusted models, we found some evidence for an association between residential environments, as defined using the upper versus lower quartile splits, and women's psychosocial status (Table 3). More *housing damage* was associated with perceived stress score while residence in PACs with higher amounts of *property disorder* was associated with negative psychosocial status (as indicated by multiple measures, including negative paternal support, perceived stress score, and depression). Residence in PACs with more *renters* was associated with higher John Henryism, negative paternal support, and more perceived racism, and women who lived in PACs with more *vacant* properties were less likely to report interpersonal support. *Security measures* was largely not associated with maternal psychosocial health, while *violent crime* was associated only with reduced social support and *nuisances* was associated with perceived racism. Following adjustment for individual-level covariates, many of the observed associations between the built environment indices and psychosocial status were attenuated. Only *tenure* remained statistically significantly associated with John Henryism and negative paternal support.

The graphical representation of the associations between residential environments, as defined using median splits, and women's psychosocial status showed similar patterns to that observed with the upper versus lower quartile split categorization (Figure 2). Some suggestion of reduced *interpersonal support evaluation list—total* was apparent for women who resided in PACs with lower

TABLE 2 Sample description—Healthy Pregnancy–Healthy Baby cohort (June 2005–December 2010)

	Number of cases, *N*	Percent (%)	Mean (SD)	Range
Maternal sociodemographic characteristics (*n* = 723)				
Race				
Black non-Hispanic	554	76.7		
White non-Hispanic	92	12.7		
Hispanic + other	76	10.5		
Age				
18–20 years	130	18.0		
21–34 years	533	73.8		
35+ years	59	8.2		
Education				
< High school	142	19.6		
= High school	330	45.6		
> High school	251	34.7		
Marital status				
Married	126	17.5		
Not married	596	82.6		
Insurance status				
Private	99	13.7		
Not private	561	77.6		
Missing	63	8.7		
Parity				
No prior live births	283	39.3		
1+ prior live birth	438	60.6		
Maternal psychosocial characteristics				
ISEL—total (ISEL—T)	687		37.1 (8.1)	7 to 48
Self-efficacy score (SE)	674		3.3 (0.5)	1 to 4
John Henry active coping score (JHAC)	671		51.2 (6.1)	24 to 60
Positive support score (PosSup)	690		2.5 (0.6)	1 to 10.2
Negative support score (NegSup)	692		1.2 (0.3)	0.8 to 3.0
Racism score (Race)	690		0.6 (1.1)	0 to 6
CES—Depression score (CES—D)	621		15.6 (10.7)	0 to 58
Perceived stress score (PSS)	678		2.6 (0.7)	1 to 4.6
Maternal residential characteristics				
Housing damage			0.2 (0.6)	−0.5 to 3.4
Property disorder			0.3 (0.7)	−1.1 to 2.0
Tenure status			0.2 (0.6)	−1.9 to 1.4
Vacancy status			−0.02 (0.6)	−0.8 to 4.0
Security measures			0.03 (0.6)	−1.7 to 3.2
Violent crime count			1.0 (2.4)	−0.6 to 11.5
Nuisances count			0.5 (0.9)	−0.9 to 6.5

more housing damage, vacancy, violent crime, and nuisances, while residence in PACs with more housing damage, property disorder, vacancy, violent crime, and vacancy seemed associated with low amounts of *self-efficacy*. *John Henryism active coping* was reported more by women resident in PACs with more property disorder

TABLE 3 Unadjusted and adjusted associations of BE indices and psychosocial measures among HPHB cohort in Durham, NC, USA (2005–2010)

Odds ratios (95 % CI)	ISEL—T		SE		JHAC		NegSupport		PSS		RACISM	CES—D
	Tert 2	Tert 3	Tert 2	Tert 3	Tert 2	Tert 3	Tert 2	Tert 3	Tert 2	Tert 3	Dichot	Dichot
Housing												
Unadjusted	0.60	0.64	0.77	0.63	0.96	1.13	1.11	1.49	2.06	1.20	1.14	1.31
≤25th vs ≥75th percentile	0.35, 1.05	0.36, 1.14	0.43, 1.37	0.34, 1.13	0.56, 1.67	0.62, 2.06	0.65, 1.87	0.75, 2.97	1.02, 4.15	0.58, 2.49	0.70, 1.87	0.79, 2.17
Adjusted	0.58	0.73	0.67	0.69	0.98	1.00	1.21	1.40	1.30	0.69	0.92	1.28
≤25th vs ≥75th percentile	0.30, 1.09	0.37, 1.43	0.34, 1.33	0.34, 1.39	0.52, 1.86	0.50, 1.99	0.65, 2.22	0.64, 3.03	0.67, 2.55	0.34, 1.40	0.52, 1.63	0.72, 2.29
Property												
Unadjusted	0.57	0.69	0.80	0.71	1.20	1.87	0.84	3.58	2.32	1.93	1.69	2.04
≤25th vs ≥75th percentile	0.31, 1.02	0.37, 1.29	0.44, 1.45	0.39, 1.31	0.68, 2.12	0.96, 3.62	0.50, 1.42	1.35, 9.47	1.29, 4.17	1.03, 3.62	0.99, 2.88	1.12, 3.70
Adjusted	0.72	1.16	0.68	0.90	0.84	1.19	0.83	1.58	1.39	0.92	1.53	1.61
≤25th vs ≥75th percentile	0.34, 1.54	0.51, 2.64	0.32, 1.48	0.40, 2.00	0.38, 1.85	0.51, 2.81	0.41, 1.68	0.53, 4.70	0.63, 3.08	0.39, 2.14	0.75, 3.10	0.74, 3.51
Tenure												
Unadjusted	0.81	0.58	0.87	0.72	0.96	2.16	2.06	2.23	1.54	1.86	1.80	1.23
≤25th vs ≥75th percentile	0.44, 1.50	0.31, 1.08	0.47, 1.60	0.39, 1.31	0.54, 1.70	1.13, 4.15	1.14, 3.71	1.01, 4.92	0.88, 2.72	0.99, 3.50	1.07, 3.04	0.60, 2.54
Adjusted	1.18	0.81	0.87	1.06	1.06	2.26	2.20	1.49	1.23	1.12	1.83	0.90
≤25th vs ≥75th percentile	0.59, 2.38	0.43, 1.63	0.43, 1.75	0.53, 2.12	0.55, 2.08	1.09, 4.67	1.13, 4.29	0.63, 3.52	0.64, 2.37	0.54, 2.31	0.99, 3.38	0.43, 1.88
Vacancy												
Unadjusted	0.81	0.56	0.86	0.79	0.85	0.77	1.22	1.23	1.60	0.97	1.50	1.61
≤25th vs ≥75th percentile	0.47, 1.42	0.32, 0.99	0.49, 1.51	0.44, 1.39	0.49, 1.46	0.43, 1.40	0.70, 2.14	0.64, 2.35	0.84, 3.07	0.48, 1.92	0.93, 2.40	0.96, 2.69
Adjusted	1.04	0.80	0.71	1.05	0.92	0.91	1.32	0.86	1.12	0.52	1.17	1.32
≤25th vs	0.56, 1.96	0.42, 1.53	0.38, 1.33	0.55, 2.01	0.49, 1.72	0.46, 1.78	0.70, 2.49	0.42, 1.77	0.57, 2.20	0.25, 1.07	0.66, 2.07	0.72, 2.41

TABLE 3 ***Continued***

Odds ratios (95 % CI)	ISEL—T		SE		JHAC		NegSupport		PSS		RACISM	CES—D
	Tert 2	Tert 3	Tert 2	Tert 3	Tert 2	Tert 3	Tert 2	Tert 3	Tert 2	Tert 3	Dichot	Dichot
≥75th percentile												
Security												
Unadjusted	0.82	1.18	1.09	1.19	1.37	1.24	0.76	0.93	1.14	1.05	0.87	1.30
≤25th vs ≥75th percentile	0.51, 1.32	0.72, 1.93	0.68, 1.76	0.74, 1.91	0.86, 2.20	0.75, 2.05	0.47, 1.23	0.56, 1.63	0.91, 1.83	0.64, 1.73	0.58, 1.29	0.86, 1.95
Adjusted	0.89	1.16	1.07	1.06	1.28	1.14	0.71	0.92	1.07	0.90	0.83	1.34
≤25th vs ≥75th percentile	0.54, 1.48	0.68, 2.00	0.64, 1.84	0.64, 1.78	0.77, 2.14	0.67, 1.96	0.42, 1.19	0.52, 1.66	0.64, 1.80	0.52, 1.55	0.54, 1.30	0.85, 2.11
Violent												
Unadjusted	0.50	0.58	0.78	0.63	1.03	1.45	1.56	2.07	1.33	2.15	1.49	1.21
≤25th vs ≥75th percentile	0.25, 1.00	0.28, 1.20	0.39, 1.55	0.32, 1.26	0.54, 1.97	0.66, 3.17	0.80, 3.05	0.84, 5.11	0.70, 2.56	0.98, 4.69	0.82, 2.71	0.62, 2.36
Adjusted	0.72	0.84	0.59	0.63	0.82	0.75	1.48	0.93	0.71	0.94	1.64	1.01
≤25th vs ≥75th percentile	0.32, 1.65	0.35, 2.02	0.26, 1.36	0.27, 1.44	0.36, 1.87	0.30, 1.88	0.65, 3.35	0.34, 2.53	0.32, 1.62	0.37, 2.38	0.77, 3.48	0.46, 2.21
Nuisances												
Unadjusted	0.59	0.82	1.39	0.56	1.29	1.10	0.66	1.97	0.94	1.52	1.78	1.91
≤25th vs ≥75th percentile	0.32, 1.09	0.43, 1.58	0.71, 2.71	0.30, 1.02	0.70, 2.37	0.56, 2.17	0.37, 1.17	0.83, 4.67	0.52, 1.69	0.75, 3.06	1.00, 3.15	0.96, 3.82
Adjusted	0.65	0.80	1.18	0.64	1.00	0.86	0.62	1.72	0.53	0.81	1.66	1.96
≤25th vs ≥75th percentile	0.32, 1.32	0.38, 1.68	0.53, 2.60	0.30, 1.33	0.49, 2.03	0.39, 1.88	0.32, 1.19	0.61, 4.87	0.26, 1.11	0.35, 1.89	0.83, 3.29	0.85, 4.50

Models were adjusted for dichotomous race (Black non-Hispanic, White non-Hispanic + Hispanic), categorical maternal age (18–20, 21–34, 35+), categorical maternal education (<12, = 12, > 12 years), dichotomous marital status (married, not married), dichotomous insurance status (private, not private), and dichotomous birth order (first birth, > first birth). For each tertile comparison, tertile 1 serves as the reference (1.0)

Tert tertile, *ISEL—T* interpersonal support evaluation list—total score, *SE* self-efficacy, *JHAC* John Henryism Active Coping, *NegSupport* negative partner support, *PSS* Perceived Stress Scale, *Racism* perceived racism, *CES—D* Center for Epidemiologic Studies—Depression

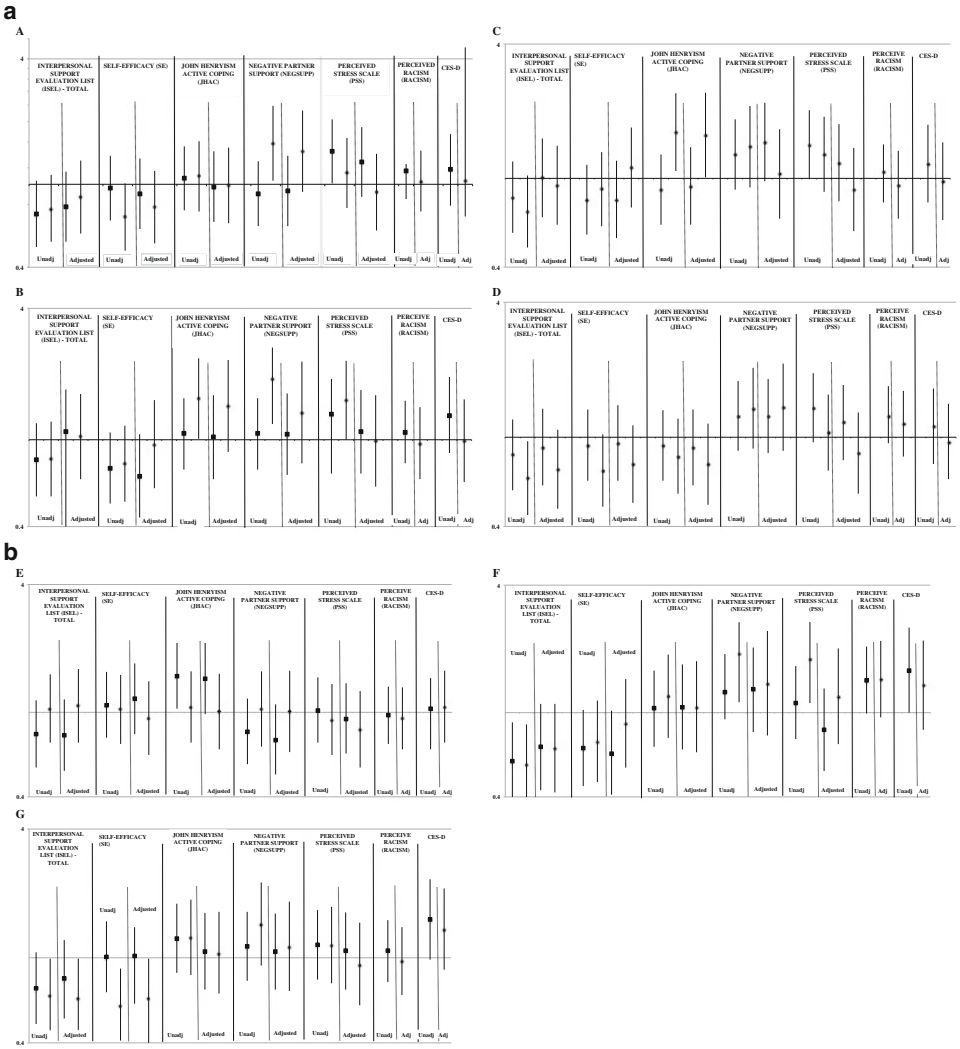

FIGURE 2. Unadjusted and adjusted associations (the same covariates as those of prior models) of BE indices (dichotomized at median value) and categorized psychosocial measures (tertiles or dichotomous) among HPHB cohort in Durham, NC, USA (2005–2010).

and more renters, while *negative partner support* was reported more by women who lived with higher amounts of housing damage, property disorder, renters, vacancy, and violent crime. *Perceived Stress Scale* showed little consistency in association with residential environments, while *perceived racism* was mostly not associated with these exposures. While the *Center for Epidemiologic Studies—Depression* measure did not appear associated with most built environmental measures, some suggestion of increased *racism* and *depression* was noted for women living in PACs with violent crime; higher *depression* scores were also observed for women who live with nuisances.

DISCUSSION

In this paper, we assessed the association between seven dimensions of the urban built neighborhood environment and multiple psychosocial measures

collected on a pregnant cohort of women living in the urban core of Durham, NC, USA. We found that some of the psychosocial attributes were associated with aspects of the built environment. In particular, we saw that *social support* was inversely associated with more property damage, vacant housing, violent crime, and nuisances in the PAC residential environment. More *active coping* (JHAC) was reported among residents in PACs with more property damage, security measures, and rental property. *Negative partner support* was also associated with more rental housing and property damage, along with more housing disorder and violent crime. *Perceived stress* was reported more frequently among residents with a less hospitable residential environment, characterized by more housing damage, property disorder, vacancy, and violent crime. *Perceived racism* was associated with more renters, vacancies, and nuisances, while *depression* was reported among women who resided in PACs with property damage, violent crime, and nuisances. Even after adjustment for individual-level covariates, more rental housing remained influential for psychosocial health (John Henryism, negative partner support, and perceived racism). Vacancy and nuisances also remained associated with psychosocial status following adjustment, but less consistently so.

While we used only a limited number of covariates in our adjusted models, our covariate adjustment may have actually explained away a portion of the neighborhood effect that we were attempting to estimate. For instance, urban neighborhoods may affect individual-level educational attainment, particularly if neighborhood schools vary in quality or student retention efforts. In addition, the neighborhoods that are affordable to lower-educational-attainment women may be systematically characterized by more depauperate built environments. While the correlation between high-poverty and low-education environments is rarely explicitly explored, experimental data from the Moving to Opportunity Study found that moving to low-poverty neighborhoods improved the achievement scores among 11–18 year olds.[21] Further, differences in age at childbearing can be influenced by neighborhood norms and practices.[11,12] By controlling for these individual-level factors, as well as marital and insurance status, we may have adjusted for causal intermediates on the pathway between built environments and psychosocial health. The unadjusted models may be closer to the actual "built environment effects" than the adjusted ones.

Even in the presence of possible over-adjustment, however, we observed important associations between adverse residential characteristics and psychosocial status. Many urban built environmental stressors, such as long-term exposure to poverty, crime, and inadequate or crowded housing, are present over a significant portion of the women's life.[18,19] These environmental conditions represent uncontrollable stressors, which have been hypothesized to undermine health more than controllable stressors.[8] If, as other work suggests, study respondents lived in their general neighborhoods for most of their pregnancy,[2] they may have become inured to the adverse environmental conditions to which they were regularly exposed. Therefore, finding even modest associations between neighborhood conditions and psychosocial health is meaningful.

Place attachment, which can be defined as the emotional or affective ties to a place that result from long-term connections with specific environments, has been associated with collective efficacy and social support, while its absence may be associated with social disorder and fear of crime.[30] It may be challenging for residents of high-rental neighborhoods to grow place attachment, which may help

explain why more rental housing remained associated with active coping, negative partner support, and perceived racism, even after adjustment. Further, considerable research shows that residential characteristics, like vacancy and incivilities (nuisances), are associated with unhealthy behaviors even after adjustment for individual-level confounders[9,24,31]; similar mechanisms likely contribute to an unhealthy psychosocial profile as well.

Finding only modest associations between the urban built environment and depression was not expected and inconsistent with prior published work. Previous work found that residents of poorer built environments are more likely to report both past 6-month and lifetime depression than residents of neighborhoods with better built environments,[10] even after adjustment for individual-level confounders.[32] In the HPHB cohort, approximately 90 % of the participants reported no prior depression or anxiety at the time of assessment. If the cohort was largely non-depressed, then little variability across neighborhood conditions would have been observable. In addition, it may be problematic to use the CES—D in a pregnant population given the physical effects of pregnancy (more fatigue, more difficulty in "getting going", and getting things done) and the nature of the CES—D questions.

While unique, our study is not without limitations. Self-reported psychosocial state has inherent issues and the acceptability of talking about psychosocial constructs may vary with age, race, and upbringing. We are limited in our ability to address this since our sample is predominantly NHB, of young age, and unmarried. Our largely NHB sample also restricted our ability to assess possible race-stratified relationships between neighborhood characteristics and psychosocial status.[18] We are extending the coverage of the CAP area in a reassessment to address some of these issues. Further, the lack of prior conceptual and empirical work assessing how external residential built environments may be associated with women's psychosocial health required us to explore multiple contrasts in our analyses; in light of multiple testing concerns, our results should be interpreted with caution.

Despite the limitations, this research is important to understanding how urban built environment features are related to women's psychosocial health. We used a unique approach to define the neighborhoods through which women work and travel. We also employed extensive measures of both psychosocial health and the built environment, allowing a multidimensional approach. These urban neighborhood indices can be used to evaluate new areas for public health interventions for pregnancy-related behaviors and outcomes. For example, instead of focusing more generally on impoverished neighborhoods, this study has outlined specific neighborhood characteristics that can be focused on for interventions, such as cleaning up disorder or attending to vacant properties.

CONCLUSION

The built environment is an important aspect of a woman's mental and physical health. A poorer built environment may lead to increased stress levels, which in turn may lead to harmful coping behaviors. Built environments are modifiable, unlike other risk markers (race, ethnicity) and are therefore important targets for interventions designed to improve public health. Future research exploring the

pathways between neighborhood characteristics and pregnancy outcomes as affected by maternal health behaviors is warranted.

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