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Racial/ethnic residential segregation, neighborhood poverty and urinary biomarkers of diet in New York City adults

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ABSTRACT

Consuming less sodium and more potassium are components of a healthy diet and reduced cardiovascular disease risk. Racial/ethnic segregation and poverty are both associated with dietary habits, but data linking dietary intake to neighborhood characteristics are limited, particularly in Hispanic and Asian American ethnic enclaves. This study presents relationships between neighborhood-level segregation, poverty and biologic indicators of sodium and potassium consumption. Data were from the 2010 Heart Follow-Up Study, a cross-sectional health survey, which included 24-h urine collections and self-reported health status ($n = 1656$). Black, Hispanic, and Asian segregated areas and neighborhood poverty were defined for aggregated zip-code areas. Multivariable models assessed the association between neighborhood segregation and poverty and sodium and potassium intake, after adjustment for individual-level covariates. In unadjusted models, potassium intake (a marker of fruit and vegetable consumption) was lower in high-versus low-Hispanic segregated neighborhoods, and the sodium–potassium ratio was higher in high-versus low black and Hispanic segregated neighborhoods, and in high-versus low-poverty neighborhoods; the sodium–potassium ratio was lower in high-versus low Asian segregated neighborhoods. Segregation and poverty were not independently associated with nutrition biomarkers after adjustment for demographics and for each other; however, practical consideration of neighborhood race/ethnic composition may be useful to understand differences in consumption.

1. Introduction

Chronic diseases are the leading causes of death in both the U.S. overall and New York City (NYC) (Hoyert, 2012). Having a healthy diet, and in particular, consuming less sodium and more potassium through fewer packaged and processed foods and more fruits and vegetables, is an important component to reducing the risk of chronic disease, particularly for preventing hypertension and other cardiovascular-disease related morbidity and mortality (Aburto et al., 2013; Appel et al., 2006; Boeing et al., 2013; Yang et al., 2011). Previously published studies have documented disparities in access to healthy foods, with the lowest access being observed in neighborhoods of high deprivation or high minority composition (Franco et al., 2008; Kamphuis et al., 2006; Larson et al., 2009). Racial/ethnic segregation is a compelling area of interest with regard to dietary intake because of the dual influences of access to healthy food and cultural patterns of food shopping, preparation and consumption. Among blacks, segregation often has negative effects on diet due to limited access to healthy options such as fresh fruits and vegetables (Morland et al., 2002; Franco et al., 2008), and a high density of fast food establishments (which have high sodium and caloric content) in neighborhoods where many blacks reside (Kwate et al., 2009). Segregation in Hispanic and Asian American populations is more likely due to the formation of 'ethnic enclaves' or 'barrios' (Hispanic) rather than racial discrimination (Acevedo-Garcia et al., 2003). Living in a Hispanic or Asian American ethnic enclave, has been shown to be associated with healthier dietary patterns (Park et al., 2011), diets lower in fat and processed food, and better access to healthy foods (Osypuk et al., 2009). However, predominantly Hispanic neighborhoods have also been shown to have a higher proportion of fast food restaurants compared to mixed race neighborhoods (Galvez et al., 2008). Studies of ethnic enclaves and nutrition are few in number.

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Several studies have examined the relationship between neighborhood poverty and healthy dietary intake, and while some have found evidence for a positive association between these two factors (Dubowitz et al., 2008; Murakami et al., 2009; Shohaimi et al., 2004), others have not (Diez-Roux et al., 1999; Jack et al., 2013). Only one study has assessed dietary intake using measured biomarkers (Murakami et al., 2009); all other studies used self-reported diet, either through food frequency questionnaire (Diez-Roux et al., 1999; Shohaimi et al., 2004), 24-h dietary recall (Dubowitz et al., 2008), or a single-item question on fruit and vegetable intake (Jack et al., 2013). Further, the current literature examining the relationships among segregation, neighborhood poverty, and nutrition outcomes tends to focus on blacks and whites only. While recent data have been presented for Mexican–Americans, they are not the most populous Hispanic subgroup in NYC. To the authors' knowledge, only one other study has been presented on the association between living in an Asian American enclave and dietary habits (Chinese American population in California) (Osypuk et al., 2009).

Overall, there are few studies that have examined both racial/ethnic segregation and neighborhood-level poverty in one analysis, despite encouragement in the published literature to do so (Acevedo-Garcia et al., 2003). Using 24-h urine samples, we 1) compared sodium, potassium (as a marker of fruit and vegetable intake), and sodium–potassium ratio among high-versus low-segregated black, Hispanic and Asian American neighborhoods and neighborhood poverty level; and 2) assessed the independent association of segregation and poverty with nutrition biomarkers in multivariable models.

2. Materials & methods

2.1. Study design

The NYC Heart Follow-Up Study (HFUS) was a cross-sectional study conducted in 2010 to assess sodium intake in a population-based representative sample of non-institutionalized NYC adults, aged 18 years and older. Detailed study information has been published in a Methods Report (Sanderson et al., 2012). Study participants were recruited from the NYC Health Department's Community Health Survey (CHS), an annual telephone survey of 8,000 to 10,000 New Yorkers. To obtain a representative sample of non-institutionalized adult New Yorkers, the CHS uses a dual frame sample design consisting of random-digit-dial landline telephone exchanges and a second frame of cellular telephone exchanges that cover NYC. The CHS incorporates a disproportionate stratified random sample design to allow for analysis at the city, borough and neighborhood levels.

Following completion of the CHS, participants were invited to participate in the HFUS. Participants who were pregnant, breastfeeding or lactating, or on current or past dialysis were excluded. HFUS participants performed a 24-h urine collection; published protocols (Elliott and Stamler, 1988) were used as a basis for the design of the 24-h urine collection. Following the collection period, a home visit was scheduled with a medical technician. The home visit did not occur unless a signed informed consent was collected at the start of the visit. At the home visit, the technician collected an aliquot of the 24-h urine collection and took height and weight measurements. Urine samples were sent to a collaborating laboratory for the analysis of sodium and potassium. The Institutional Review Board of the NYC Health Department approved this study.

2.2. Study participation

The 2010 CHS response rates were 17% and 28% for landline and cellular telephone exchanges, respectively. Cooperation rates among those who were reached were 77% among landline contacts and 94% among cellular contacts. Of the 2010 CHS participants screened for HFUS participation, 5830 eligible adults were identified. A total of 2305 agreed to provide a 24-h urine sample, and of these, 1775 (30.4% of eligible adults) provided a sample that could be analyzed by the laboratory. Those who agreed to participate were slightly more likely than those who did not participate to be Hispanic, <65 years of age, lower income, and obese (Sanderson et al., 2012). Incomplete samples were defined as those provided by participants who reported missing a collection, samples with a total urine volume <500 ml, or urine creatinine <6.05 mmol in males and <3.78 mmol in females (both being biologically implausible; Paul Elliott, Imperial College London, personal communication, 2011). The final analytic sample size was 1656 (Fig. 1).

2.3. Individual-level covariates

Demographic (age, sex, race/ethnicity) and other data (household poverty, education) were collected as part of the CHS and were self-reported. Race/ethnicity was assessed using two questions on Hispanic origin and race group, and was categorized as non-Hispanic white, non-Hispanic black, Hispanic, non-Hispanic Asian and non-Hispanic other (hereafter referred to as 'white', 'black', 'Asian', or 'other'). Poverty status was assessed as combined household income, grouped according to the 2010 federal poverty guidelines determined by the U.S. Department of Health and Human Services (<200%, 200–400%, 400+% of federal poverty level). Education was categorized as less than high school, high school, some college, or college graduate. Body mass index (BMI) was calculated from measured height and weight. Sodium and potassium content of the 24-h urine samples were determined using the ion-selective electrode potentiometric method on the Roche DPP Modular analyzer (Hoffman-La Roche, Ltd.). The sodium–potassium ratio (mg/mg), a marker that is more predictive of cardiovascular morbidity and mortality than either sodium or potassium alone (Cook et al., 2009; Yang et al., 2011), was calculated by dividing sodium (mg/day) by potassium (mg/day).

2.4. Neighborhood-level covariates

Defined spatial areas for assessing neighborhood-level covariates (poverty classification and residential segregation) were United Hospital Fund (UHF) neighborhoods ($n = 42$), administrative units comprised of two to eight contiguous zip codes (mean and median = four zip codes) commonly used for health surveillance and resource planning. Neighborhood poverty was defined as the percent of the UHF's (per zip code) residents that lived below the federally defined poverty threshold (Toprani and Hadler, 2013) and was categorized as high (20%+ of neighborhood residents living in poverty) and low (<20% living in poverty). Limited sample size in the HFUS precluded use of a smaller geographic area (e.g., census tract). Segregation was determined using the isolation index, which was first described by Massey and Denton in 1989 (Massey and Denton, 1989) and reflects the population-weighted average proportion of minority residents for each defined spatial area. More generally, the isolation index represents the level of interaction between minority and non-minority groups. The isolation index per UHF may be calculated as follows:

$$\text{Isolation Index} = \sum_{i=1}^{n} \frac{x_i}{X} * \frac{x_i}{t_i}$$