# Social and Environmental Risk Factors for Hypertension in African Americans

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**ABSTRACT**

*This study tests the hypothesis that disparities of hypertension risk in African Americans is related to lead exposure, perceptions of racism, and stress, among urban (Roxbury, MA) and rural (Gadsden, FL) communities. Analysis of preliminary data from Phase I reveal 60% in Gadsden and 39% in Roxbury respondents self-reported having hypertension. In Gadsden 80% people did not know if their residence contained lead paint, compared to 45% in Roxbury. In Gadsden County, 58% of respondents reported experiencing racial discrimination in different settings compared with 72% in Roxbury. In regression analyses high cholesterol emerged as a significant predictors of hypertension in Gadsden County (OR=8.29, CI=1.4-49.3), whereas monthly household income (OR=0.15, CI=0.04-0.7) and diabetes (OR=6.06, CI=1.4-26.17) were significant predictors of hypertension in Roxbury after adjusting for other covariates. These preliminary findings set the stage for initiating Phase II (Phase I continues recruitment), that entail biological marker measurements to rigorously test main hypothesis.*

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## Introduction

Cardiovascular disease accounted for more than one-third of all deaths in 2004 (Wayne et al., 2007; Minino, Heron, & Smith, 2006). A continuous, strong, and graded relationship exists between blood pressure and cardiovascular disease (Padwal, Sharon, & Finlay, 2001) with hypertension being implicated in 35% of all atherosclerotic cardiovascular events (Kannel, 1996). Prevalence of hypertension, a major public health problem, is socially patterned (Burt et al., 1995). African Americans experience a disproportionate burden of hypertension (Jones et al. 2002), with an increase in prevalence from 35.8% to 41.4% compared to an increase from 24.3% to 28.1% among white adults, for the years 1988–1994 and 1999–2002 (Hertz, Unger, Cornell, & Saunders, 2005). In addition, hypertension in African Americans has an earlier age of onset, is more severe, and is associated with more pressure-related target organ damage such as left ventricular hypertrophy, coronary artery disease, and nephrosclerosis, compared to whites (Burt et al. 1995; Post et al. 2003; Flack & Wiist 1991; Gleiberman, Harburg, Frone, Russell, & Cooper, 1995; Kaplan, 1994). A higher prevalence of Stage 3 hypertension (>/=180/110 mm Hg) in all age categories of African Americans also exists, leading to more frequent and severe sequelae from this disease compared to non-blacks, even at similar levels of blood pressure (Burt et al., 1995).

These disparities in incidence, prevalence, and severity of hypertension in African Americans have been attributed usually to differential distribution of either genetic and/or environmental risks when compared with whites. However, recent research suggests that genetics is not sufficient to explain

much of the differential rates of high blood pressure seen among African American populations in the United States. For instance, an international study provided a different interpretation to the previous US data and suggested that high rates of hypertension may be associated more with socially-determined exposures, including socioeconomic resources, affecting ways of living (e.g., diet, physical activity), rather than racial origin (Cooper et al., 2005). Additionally, a growing body of literature suggests that racial inequality may be important as well (Krieger, 2000; Williams, Neighbors, & Jackson, 2003; Paradies, 2006) with pathways posited to harm health including:

- social trauma, e.g. chronic everyday awareness and experiences of racial discrimination;
- economic and social deprivation due to discrimination in education, employment, and housing;
- residential and occupational racial segregation, resulting in increased risk of exposure to toxic substances, hazardous conditions, and restricted educational and employment opportunities;
- racially targeted marketing of harmful commodities (e.g., alcohol, tobacco); and
- inadequate and degrading medical care (Krieger, 2000).

Exposure to lead and the impact of such exposure on health is still of high concern, because of the continued high level of exposure for specific socio-demographic populations, and because the toxic effects of blood lead that exist even at low levels. Several epidemiological studies have demonstrated a positive association between elevated blood lead and hypertension in the general population (Harlan, Landis, Schmouder, Goldstein, & Harlan, 1985; Pirkle, Schwartz, Landis, & Harlan, 1985; Kromhout et al., 1985; Orssaud et al., 1985; Pocock, Shaper, Ashby, Delves, & Clayton,1988; Neri, Hewitt, & Orser, 1988; Schwartz, 1988; Sharp et al., 1988; Weiss, Munoz, Stein, Sparrow, & Speizer,1988: Hense, Filipiak, & Keil 1993; Maheswaran, Gill, & Beevers 1993; Schwartz, 1995; Bener, Obineche, Gillett, Pasha, & Bishawi 2001) whereas others have not shown an association (Pocock, Shaper, Ashby, Delves, & Whitehead, 1984; Elwood et al., 1988; Grandjean, Hollnagel, Hedegaard, Christensen, & Larsen, 1989; Den Hond, Nawrot, & Staessen, 2002). Because most of these studies have been cross-sectional and some were unable to control for important confounding variables, this association has not been universally accepted (Moller & Kristensen, 1992); different patterns of environmental exposure and racial differences might also contribute to inconsistency in the findings of different studies (Vupputuri et al. 2003; Rothenberg et al. 1999).

Several studies that measured lead in bone discerned that the major lifestyle determinants of elevated bone lead levels were age, progressively lower levels of education, cumulative smoking, low dietary levels of calcium and Vitamin D, and both individual and geographic indicators of socioeconomic status (Hu et al. 1996; Cheng et al. 1998; Elreedy et al., 1999). Higher concentrations of blood lead among African Americans have been found compared to Whites and among people with low income compared to people with high income (Environmental Protection Agency 1992; Brody et al. 1994; Montgomery and Carter-Pokras, 1993). Recent studies using KXRF have also indicated that bone lead levels are substantially higher in minority cohorts, particularly at middle and higher ages (Lee et al. 2001), with an effect that is particularly pronounced in blue-collar workers (Elmarsafawy et al. 2002).

The present research explores the relationship of lead exposure with self-reported experiences of racial discrimination, stress and other socio-demographic factors in two populations: a rural cohort in Gadsden County, Florida and an urban cohort in Roxbury, (Boston) Massachusetts. The study aims to test the hypotheses that African Americans with higher levels of environmental lead exposure have an elevated risk of hypertension, even after adjusting for other potential risk factors; and that the risk of hypertension among low income African Americans is associated with experiences of racial discrimination and stress, even after adjusting for other potential risk factors. Phase I of this study involves soliciting participants in the community from a screening questionnaire assessment through a door-knocking campaign. Phase II involves detailed biological measurements including state-of-the-art KXRF measurements of bone lead. Herein are the results of our Phase I data.

## Methods

This was strictly an observational epidemiologic study using community based participatory research methods. Study participants were solicited through a door-to-door campaign targeting randomly selected households from each community.

### *Household Selection*

Gadsden households to be sampled were drawn from the Gadsden County Tax Collectors parcel database. This database contains location information on all land parcels in the county (n=12,423). Parcels were classified as commercial, agricultural,

industrial, or residential. The majority of parcels (n=11,319) were residential. These residential parcels were geocoded (longitude, latitude) using the Census Tiger files as a reference. A successful match was achieved for 10,301 residential parcels (90.0%).

Gadsden County contains 9 census tracts and 33 block groups. To maximize the probability of selecting a Black household, those census block groups with a Black population over 50% (from the 2000 census) comprised the sampling universe. Twenty-four block groups had an African American population of greater than 50%. There were 6,946 residential parcels in these block groups. A stratified proportionate random sample of parcels was drawn from these census block groups. The sample was weighted by the number of parcels in each block group. A total of 2,502 parcels were selected. These parcels were plotted on street maps of Gadsden County to facilitate the location of addresses.

Roxbury contains residents in 18 census tracts. In order to maximize the probability of selecting a Black household, sample was collected from the 11 census tracts with a Black population of over 50% (based on the 2000 census). These 11 tracts contained 16,514 residences. From these residences, 2,002 were selected using stratified proportionate random sampling weighted by the number of parcels in each census tract.

*Recruitment and Data Collection*

Participants were recruited for the community survey through a door-to-door campaign. A postcard announcing the project was first mailed to all target households. Trained Health Advisors (HAs) and Volunteer Research Assistants (VRAs) from the community carried out the door-to-door campaign. The HAs and VRAs knocked on the doors of each household up to three separate times to engage one of the residents and administer the survey. To protect the concerns of residents' confidentiality of the responses to the initial survey, interviewees were given several options for completing the survey:

- administration of the survey by a member of the research team at the time of the face-to-face encounter;
- self-administration and returning it directly to the research team in a postage-paid envelope; or
- self-administration and picking up of the survey at a later time by the research team.

A separate analysis is being conducted and will be published later on factors associated with our recruitment success.

*Survey Instrument*

The well-validated survey instrument had a total of 63 questions and required, on average, around 45 minutes to complete. The survey included demographics, self-reported experiences of racial discrimination (Krieger & Sidney 1996, 1370; Krieger et al. 2005, 1576), job strain and employment, socioeconomic status, hypertension, potential environmental lead exposure, and other potential biologic, social, and lifestyle risk factors for hypertension using well-validated instruments. Each survey was scanned, read and tabulated using the Cardiff-Teleform.

*Data Analysis*

Results were entered into the Channing Database and analyzed using the SAS 10.0. A descriptive analysis was done to explore the demographics, housing, lead exposure and other environmental determinants of self-reported hypertension; experiencing racial discrimination was also explored and all the variables representing discrimination in different settings were pooled to one variable to get a combined score on either 'ever' or 'never' experienced discrimination. Logistic regression analyses were done to determine whether lead exposure and other social and environmental factors can predict self reported hypertension in both cohorts from Roxbury and Gadsden County, using a backward elimination procedure.

**Results**

*Demographics and Social Determinants of Self Reported Hypertension*

Table 1 shows the demographics of the participants from Roxbury and Gadsden County. Mean age was 52 years (SD=13) in both communities, which were predominantly African American, 78% in Gadsden County and 75% in Roxbury respectively. More respondents in Gadsden County (60%) reported having HTN that in Roxbury (39%). Similar proportions reported having high cholesterol (Gadsden County 40% and Roxbury 38%) and obesity (Gadsden 45% and Roxbury 38%). Forty-eight percent of the respondents were unemployed in Gadsden County during the last three years compared to 58% in Roxbury.

*Housing, Lead and other Environmental Determinants of Self Reported Hypertension*

Table 2 describes housing, lead exposure and other environmental determinants of self-reported hypertension. In Gadsden County, 76% of respondents resided in a single-family house, defined as a house detached from any other house, comparing to 18% living in a single-family house in Roxbury. In Roxbury, 45% lived in a building with (2-9)

apartments, 7% in building with (10-19) apartments and 12% in building with 20 or more apartments. Eighty-three percent of the housing in Roxbury was built before 1980, compared to 65% in Gadsden County. Knowledge of exposure to lead paint and reports of having children tested for lead differed considerably in the two communities In Gadsden, 80% of respondents did not know if their residence contained lead paint, compared to 45% in Roxbury. In Roxbury, 11% reported having lead paint in residence compared to only 1.41% in Gadsden County. In Gadsden County, only 3% of respondents from homes with a child ≤ 6 years of age had their children's blood lead tested, and 25% did not have their children's blood tested for lead. In Roxbury, this percentage was 19% and 11% respectively. In contrast to knowledge and lead testing behaviors, similar proportions of respondents in the two communities reported knowing children in their neighborhood being followed up for or treated for lead poisoning: 3% in Gadsden County and 4% in Roxbury.

Forty-eight percent of Roxbury respondents were exposed to environmental smoking, a combined variable of smoking cigarettes, cigars, or other tobacco products by the respondent or anyone else in the home, compared to 40% respondents in Gadsden.

*Experiencing Racial Discrimination*

Fifty-eight percent of survey respondents in Gadsden and 72% in Roxbury reported having ever experienced racial discrimination at any time in different settings, such as, school, getting hired or getting a job, work, getting housing, getting medical care, getting service in a store or restaurants, getting credit, bank loans or mortgage, on the street or in a public setting, from the police or in the courts respectively. All the variables representing discrimination in different settings were combined to one variable and also converted to dichotomous as, 'ever experiencing discrimination' (whatever the number of experiencing discrimination, once, 2-3 times or 3-4 times) and 'never experiencing discrimination'. In Gadsden**,** most of the respondents reported experiencing discrimination in "getting housing" (90%), followed by "getting medical care" (87%). In Roxbury**,** most of the participants reported experiencing discrimination in "getting medical care" (79%), followed by "getting housing" (70%).

*Logistic Regression to Predict Self-reported Hypertension*

Logistic regression analyses were done to see whether lead exposure and other social and environmental factors could predict self-reported hypertension in both cohorts from Roxbury and Gadsden County. A backward elimination procedure was followed and logistic regression analyses showed self-reported high cholesterol as a significant predictor of self-reported hypertension in Gadsden County after adjusting for other covariates (crude OR=14.3, CI=3.0-68.0 and adjusted OR=8.29, CI=1.4-49.3). Logistic regression analyses of Roxbury data showed monthly household middle income (OR=0.15, CI=0.04-0.7) and self-reported diabetes (OR=6.06, CI=1.4-26.17) as significant predictors of self-reported hypertension in Roxbury after adjusting for other covariates. Income was categorized in three groups as less than $1000 monthly take-home household income (comparison group in logistic regression), $1000-$2999 monthly take home household income, and $3000 and above monthly take home household income. People who had monthly take home household income between $1000 and $2999) were 85% less likely to have self reported hypertension comparing to people who had monthly take-home household income less than $1000. People who reported having diabetes were six times more likely to have self-reported hypertension compared to people who did not report having diabetes. Odds ratios and 95% confidence intervals for other covariates are reported in table 3.

**Discussion**

The causes of minority health disparities are complex and only somewhat understood. The complex interactions of behavior, socio-economic status, culture, and ethnicity are important predictors of health outcomes and contributors to health disparities. According to BRFSS survey data (Mensah et al., 2005), a high proportion of the U.S. population had multiple risk factors for heart disease and stroke, particularly certain population subgroups defined by race/ethnicity and socioeconomic status; the prevalence of having two or more risk factors was highest among blacks (48.7%), which is much higher than overall population.

The prevalence of hypertension in African Americans in the United States is among the highest in the world. Compared with Whites, African Americans develop hypertension earlier in life and their average blood pressures are much higher and as a result, compared with Whites, Blacks have a 1.3 times greater rate of nonfatal stroke, a 1.8 times greater rate of fatal stroke, a 1.5 times greater rate of heart disease death and a 4.2 times greater rate of end-stage kidney disease (Thomas et al., 2006). Research to understand the reasons behind these racial differences better may guide more effective public health prevention programs.

This study provides descriptive statistics on self-reported hypertension, conventional risk factors such

as, obesity, age, smoking, socioeconomic status, diabetes, and high cholesterol, and proposed risk factors, such as self-reported indices of racial discrimination, lead exposure risk factors (age of housing, residence lead containment, childhood lead poisoning, etc.). Self-reported high cholesterol was a significant predictor of self-reported hypertension in

**Table 1: Demographic and Health Characteristics of the Participants, and Self-reported Experiences of Racial Discrimination.**

| | **Gadsden County (n=74)** | **Roxbury (n=101)** |
|---|---|---|
| **Demographics** | | |
| Gender | 64% female | 64% female |
| Race | 78% Black | 75% Black |
| Age (mean age) | 52 yrs (SD 13.8) | 50 yrs (SD 13.2) |
| Education | 58% < college | 51% < college |
| Relationship status | 46% married | 27% married |
| Income (monthly take-home household income) | Less than 1000=37%<br>$ (1000-2999)=24%<br>Above $3000 =39% | Less than $1000=36%<br>$ (1000-2999)=35%<br>Above $3000=29% |
| Unemployed during last 3yrs (age 30-60) | 48% | 58% |
| Hourly wage/wk | 38% (<$11/hr) | 24% (<$11/hr) |
| Health Insurance | 15% don't have health insurance | 17% don't have health insurance |
| **Existing Medical Condition (told subject by health provider)** | | |
| High blood pressure | 60% | 39% |
| Diabetes | 30% | 22% |
| High cholesterol | 40% | 38% |
| Overweight or obese | 45% | 38% |
| Depression or anxiety | 29% | 38% |
| Smoking: current smoker | 26% | 33% |
| | | |
| **Racial discrimination** | | |
| Ever experienced racial discrimination | 58% | 72% |

**Table 2: Housing, Lead Exposure and Other Environmental Determinants**

| | **Gadsden County (n=74)** | **Roxbury (n=101)** |
|---|---|---|
| **Housing** | | |
| Type residence<br>single house<br>trailer<br>Apartment Building | <br>76%<br>15%<br>3% | <br>18 %<br>0<br>64% |
| Age residence (before 1980) | 65% | 83% |
| Own v. rent | 86% (own) | 35% (own) |
| **Housing and Lead Exposure** | | |
| Lead paint present | 80% don't know whether housing contain lead<br>1.4% know that housing does contain lead | 45% don't know if housing contain lead<br>11% know that housing does contain lead |
| Lead paint tested | 4%=tested<br>79%=not tested<br>17%=don't know | 64%=tested<br>12%=not tested<br>24%=don't know |
| Child (≤ 6) in home w/blood lead tested | 25%=no<br>3%=yes | 11% =no<br>19% =yes |
| Know child in neighborhood lead poisoned | 3% know that children in neighborhood being followed or treated for lead poisoning | 4% know that children in neighborhood being followed or treated for lead poisoning |
| **Other Environmental Exposures** | | |
| Chemicals used for pests | 59% | 54% |
| Disturbed by noise from traffic in neighborhood | 75% sometimes or, always disturbed | 74% sometimes or, always disturbed |
| Environmental smoking (whether the subject or anyone at home smoke) | 40% exposed to environmental smoking | 48% exposed to environmental smoking |

**Table 3: Predictors of Self-reported Hypertension.**

| | Gadsden County (n=74) | | Roxbury (n=101) | |
|---|---|---|---|---|
| Variables | Point Estimate | 95% CI | Point Estimate | 95% CI |
| ***Age*** | | | | |
| <40 | 1.00 | | | |
| 40-60 | 5.91 | 0.97-35.95 | 1.36 | 0.39-4.74 |
| >60 | 4.61 | 0.61-35.13 | 1.85 | 0.34-10.0 |
| ***Gender*** | | | | |
| Male | 1.00 | | | |
| Female | 0.98 | 0.21-4.45 | 1.61 | 0.46-5.59 |
| ***Income*** | | | | |
| <$1000 | 1.00 | | | |
| $(1000-2999) | 0.92 | 0.11-7.70 | **0.15** | **0.04-0.72** |
| >$3000 | 0.31 | 0.04-2.31 | 0.29 | 0.07-1.11 |
| ***Insurance*** | | | | |
| No | 1.00 | | | |
| Yes | 0.77 | 0.11-5.45 | 0.81 | 0.16-4.24 |
| ***House built*** | | | | |
| After 1980 | 1.00 | | | |
| before 1980 | 1.42 | 0.31-6.47 | 0.67 | 0.18-2.52 |
| ***Noise*** | | | | |
| No | 1.00 | | | |
| Yes | 2.05 | 0.45-9.26 | 2.26 | 0.56-9.07 |
| ***Smoking*** | | | | |
| Yes | 1.00 | | | |
| No | 1.34 | 0.23-7.96 | 2.28 | 0.73-7.17 |
| ***Racial Discrimination*** | 1.00 | | | |
| Never | 2.40 | 0.42-13.90 | 0.33 | 0.08-1.33 |
| Ever | | | | |
| ***Diabetes*** | | | | |
| No | 1.00 | | | |
| Yes | 4.92 | 0.55-43.89 | **6.07** | **1.41-26.18** |
| ***High Cholesterol*** | | | | |
| No | 1.00 | **1.39-49.31** | | |
| Yes | **8.29** | | 3.35 | 0.86-13.09 |
| ***Obesity*** | | | | |
| No | 1.00 | | | |
| | 1.80 | 0.38-8.47 | 1.52 | 0.39-6.03 |
| ***Depression*** | | | | |
| No | 1.00 | | | |
| Yes | 0.21 | 0.03-1.61 | 0.57 | 0.17-1.89 |

Gadsden County respondents after adjusting for other covariates (crude OR=14.3, CI=3.0-68.0 and adjusted OR=8.29, CI=1.4-49.3), while 40% among that same cohort reported being told by their health care provider of having high cholesterol. Moreover, 45% also reported been told by their health care provider of being obese, a known risk factor for hypertension. Seventy-eight percent of the population in Gadsden County is African American, which further necessitates exploration of the social and environmental factors related to hypertension and obesity in this population. Data from Roxbury, on the other hand, revealed monthly household middle-income (OR=0.15, CI=0.04-0.7) and self-reported diabetes (OR=6.06, CI=1.4-26.17) as significant predictors of self-reported hypertension after adjusting for other covariates.

One of the most interesting findings of this small urban and rural community sample is the disparity between the residents' knowledge and behavior related to lead testing in the house and in the blood of children. Of note is that 80% of Gadsden County residents did not know whether lead paint was present in the house compared to 45% of Roxbury residents. Further, 96% of Gadsden residents either did not have their house tested for lead or did not know whether the house ever had been tested for lead, compared to 36% of Roxbury residents. Moreover, 3% of Gadsden residents with children less than six years of age have had their children tested for lead, compared to 19% in Roxbury.

Public health policies in each community vary dramatically in terms of mandatory screening for lead in children, guidelines for household testing, and abatement and monitoring of lead removal. The disparity in lead knowledge and practices underscores the importance of more aggressive public health rules, as in the case of the Roxbury sample. These results also necessitate more comprehensive interventions in the communities.

This study has several limitations. First, our response rate was low and may have contributed to selection bias. However, a strength is that the subjects were highly unlikely to know what their own lead burden is, making it unlikely that we would have selection bias in relation to known exposures. Second, those respondents who had not ever been screened for high cholesterol, diabetes, high blood pressure or any other risk factors or disease/condition might not have been aware of having these risk factors, an occurrence possibly attributable to unequal access to health-care services. Third, data are based on self-report information and are subject to recall, interpretation of information provided by a health provider, and social desirability biases. Finally, the small sample size may have limited our ability to detect statistically significant associations. Nevertheless, the magnitude and direction of the observed associations for some of the "non-significant" exposures (e.g., noise, racial discrimination, at least in Gadsden County, or the protective impact of higher income) are worthy of future consideration.

**Conclusion**

Hypertension is a modifiable risk factor for heart disease and stroke that can be addressed through prevention, early detection, and appropriate treatment. Environmental and psychosocial factors related to hypertension need to be explored further with biological validation. This study will continue Phase I while initiating Phase II, which entails measurement of bone lead levels, a biomarker of cumulative lead dose using K-x-ray fluorescence, and other risk factors using detailed methods.

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