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Race, regionality and pre-diabetes in the Reasons for Geographic and Racial Differences in Stroke (REGARDS) study

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ABSTRACT

Objective. To determine the association between race, region and pre-diabetes.

Method. The study used 2003–2007 United States baseline data from the Reasons for Geographic and Racial Differences in Stroke (REGARDS) study for this cross-sectional analysis. Participants in this study were 45 years or older at recruitment. Logistic regression was used to assess whether race and region are associated with pre-diabetes independent of demographics, socioeconomic factors and risk factors.

Results. Twenty-four percent of the study participants (n = 19,889) had pre-diabetes. The odds ratio (95% confidence interval) for having pre-diabetes was 1.28 (1.19–1.36) for blacks relative to whites and 1.18 (1.10–1.26) for people living in the Stroke Belt region relative to the other parts of the United States. The odds of having pre-diabetes for Stroke Belt participants changed minimally after additional adjustment for race (OR = 1.20; 1.13–1.28), age and sex (OR = 1.24; 1.16–1.32), socioeconomic status (OR = 1.22; 1.15–1.31) and risk factors (OR = 1.26; 1.17–1.35). In the adjusted model, being black was independently associated with pre-diabetes (OR = 1.19; 1.10–1.28).

Conclusion. The prevalence of pre-diabetes was higher for both blacks and whites living in the Stroke Belt relative to living outside the Stroke Belt, and the prevalence of pre-diabetes was higher for blacks independent of region.

Introduction

Pre-diabetes is a new diagnostic category established by the Expert Committee on Diagnosis and Classification of Diabetes Mellitus as impaired fasting glucose (IFG) and impaired glucose tolerance (IGT), defined as a fasting blood glucose level between 100 and 125 mg/dL (Anon, 2009). Individuals in a pre-diabetic state are at substantially higher risk for progression to type 2 diabetes (T2D), with up to 70% of individuals with pre-diabetes converting to a T2D diagnosis within ten years (Buysschaert and Bergman, 2011). Other major adverse effects of pre-diabetes include microvascular complications, and cardiovascular disease (Anon, 2007; Coutinho et al., 1999; Plantinga et al., 2010) highlighting the significant public health impact of this new disease category.

In the U.S. National Health and Nutrition Examination Survey (NHANES) III, 1988 to 1994 data revealed that among overweight adults aged 45 to 74 years, 23% of participants had pre-diabetes (Benjamin et al., 2003). Further, 12 million overweight adults, age 45 to 74 years were reported to have pre-diabetes in 2000 (Benjamin et al., 2003), with an upward trend to 57 million American adults in 2007 (Control and Prevention, 2011). Accordingly these statistics continued to worsen in 2010 with an estimated 79 million American adults having pre-diabetes as defined by fasting blood glucose or hemoglobin A1C (Control and Prevention, 2011).

A higher T2D prevalence has previously been reported in the Stroke Belt region of the southeastern US (Cushman et al., 2008; Howard, 1999) and the prevalence of T2D and cardiovascular disease have been shown to vary by race (Cowie et al., 2006; Cushman et al., 2008). The clustered high T2D prevalence area has been identified by the US Center for Disease Control and Prevention (CDC) as the Diabetes Belt and exists primarily in the Stroke Belt region (Barker et al., 2011). The prevalence of diabetes in the Diabetes Belt is 11% relative to 8.5% in

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the remaining US, with 24% of the population in the Diabetes Belt being black (Barker et al., 2011). Data from the Diabetes Belt reveal that the increased risk of T2D is attributable to known risk factors: 30% modifiable risks (i.e. lifestyle factors) and 37% non-modifiable risk factors (i.e. race) (Barker et al., 2011), yet few studies have investigated the association between biological, social, demographic, or geographic factors with a diagnosis of pre-diabetes. The identification of individuals who are at increased risk of pre-diabetes may provide a window of opportunity to improve the efficiency of screening for T2D. Subsequently progression to T2D from pre-diabetes can be prevented or delayed with early intervention (Rydén et al., 2007). Therefore, the authors sought to determine whether race and region are associated with pre-diabetes in the Reasons for Geographic and Racial Differences in Stroke (REGARDS) cohort.

Methods

Permission was obtained from the University of Alabama at Birmingham Institutional Review Board to conduct a cross-sectional study using data from the REGARDS study. Briefly, the REGARDS study is a prospective cohort study of 30,239 black and white community-dwelling residents aged 45 years and older. The overall goal of REGARDS is to better understand the contributors to the substantial racial and geographic disparities in stroke. By design the study included 56% of the cohort from residents of the Stroke Belt states (North Carolina, South Carolina, Georgia, Alabama, Mississippi, Tennessee, Louisiana, and Arkansas) and the remainder from the rest of the 40 contiguous US states. Also, the study oversampled blacks. Potential participants were sampled from a commercially available list, and recruited from 2003 to 2007 through a combination of mail and telephone. For those agreeing to participate (cooperation rate was 49%, participation rate 33%), using a computer-assisted telephone interview, trained interviewers obtained demographic information and medical history. A brief physical examination including blood pressure measurements, blood samples, and an electrocardiogram (ECG) was conducted in-person 3–4 weeks after the telephone interview. Consent was obtained verbally and later in writing. Follow-up for incident stroke events and cognitive assessment is ongoing. Details of the methods are available elsewhere (Howard et al., 2005).

Individuals who had not fasted (n = 4321; 14%) for 8–10 h at the time of blood collection were excluded from the analysis. Of those fasting, the diabetes status of the participants was trichotomized following the American Diabetes Association guidelines (Anon, 2009) as: normoglycemic with fasting glucose less than 100 mg/dL (n = 15,031, 72%); pre-diabetic with a fasting glucose between 100 and 125 mg/dL (n = 4858, 24%), or diabetic with a fasting glucose of 126 mg/dL or greater (n = 893, 4%). Since the focus of this study was on the differences between the normoglycemic and pre-diabetic strata, individuals with diabetes or a fasting glucose of 126 mg/dL or greater were also excluded from the analysis. Race was defined by self-report as black or white (with those reporting other race/ethnic membership excluded from REGARDS). Region was defined as Stroke Belt or non-Stroke Belt, with the Stroke Belt being defined as current residence in North Carolina, South Carolina, Georgia, Tennessee, Alabama, Mississippi, Arkansas or Louisiana. Socioeconomic status was defined according to annual household income and highest education level. Annual household income (<$20,000, $20,000–$34,000, $35,000–$74,000, and $75,000 and over) and education (less than high school, high school graduate, some college, or college graduate) were defined by self-report. Risk factors were defined as body mass index (BMI) (<18.5 kg/m^2, underweight; 18.5–25 kg/m^2, normal weight; 25–30 kg/m^2, overweight; and >30 kg/m^2, obese) and self-reported lifestyle characteristics (physical activity, smoking history, and alcohol use). Physical activity was defined by response to the computer assisted telephone interview question — "How many times per week do you engage in intense physical activity, enough to work up a sweat?", categorized as none, 1–3 times a week, or 4 or more times a week. Smoking was categorized into strata of never, past and current smoker. Alcohol use was defined according to the National Institute on Alcohol Abuse and Alcoholism (NIAAA) guidelines as none, moderate (1–7 drinks/week for women and 1–14 drinks/week for men), and heavy drinker (8+ drinks/week for women and 15+ drinks/week for men) (Gunzerath et al., 2004).

Statistical analysis

Among individuals with no history of diabetes, logistic regression was used to assess the relationship between race and region with the prevalence of pre-diabetes in incremental models, first assessing the crude association, then considering the joint effect of race and region, then adjusting for demographic factors (age and sex), socio-economic status, and finally after adjustment for risk factors. Data were analyzed with Statistical Analysis System (SAS) software, version 9.1.

Results

A total of 19,889 subjects met inclusion and exclusion criteria, of which 24% were pre-diabetic, 36% were black, 44% were male and 55% were from the Stroke Belt. The mean (±SD) age for the sample was 64 ± 10 years. Table 1 presents the demographic, socioeconomic, and risk factors of study subjects dichotomized by race and region.

Regardless of the region of residence, pre-diabetes was more common in blacks compared to whites; in the Stroke Belt the prevalence was 31% in blacks and 24% in whites, in the non-Stroke Belt it was 25% in blacks and 20% in whites. The unadjusted odds ratio of having pre-diabetes was 1.28 (95% CI: 1.19–1.36) for blacks compared to whites, and 1.18 (95% CI: 1.10–1.26) for people living in the Stroke Belt region compared to the non-Stroke Belt of the United States (Table 2). Interestingly, within Stroke Belt subjects, odds ratios changed minimally after additional adjustment for race (OR = 1.20; 95% CI: 1.13–1.28), age and sex (OR = 1.24; 95% CI: 1.16–1.32) and socioeconomic status (OR = 1.22; 95% CI: 1.15–1.31) (Table 2). After adjusting for region; age and sex; socioeconomic status; and risk factors, black race was independently associated with pre-diabetes (OR = 1.19; 95% CI: 1.10–1.28).

Discussion

In this large national cohort study, the prevalence of pre-diabetes was higher for both blacks and whites living in the Stroke Belt, and the prevalence of pre-diabetes was higher for blacks than whites independently of region. Until recently, few studies provided support for regionality as a risk factor for diabetes, but work by the REGARDS investigators has shown that diabetes in blacks and whites is significantly more prevalent in those living within the Stroke Belt (Barker et al., 2011; Voeks et al., 2008). Others have identified states within the Stroke Belt that have multiple counties in close proximity where rates of diabetes are greater than 10%, describing what has previously been referred to as the Diabetes Belt (Barker et al., 2011). The higher prevalence of pre-diabetes in the Stroke Belt and diabetes in the Diabetes Belt may be related to the increased prevalence of risk factors such as obesity, sedentary lifestyle and lifestyle choices that include smoking or alcohol use. Thirty-three percent of the people living in the Diabetes Belt are obese relative to 25% of the remaining US (Barker et al., 2011). Moreover 31% of the people living in the Diabetes Belt lead a sedentary lifestyle relative to 25% for the rest of the country (Barker et al., 2011). There are limited data on the effect of smoking on pre-diabetes, although there is an abundance of evidence related to the negative effects of smoking on diabetes (Willi et al., 2007; Xie et al., 2009). Further, the association between moderate or heavy alcohol consumption and pre-diabetes has not been studied but the most consistent finding is that no beneficial effect can be attributed to high alcohol consumption on diabetes (Carlsson et al., 2005). Pre-diabetes is an important risk factor for T2D and our findings suggested that pre-diabetes status may be a substantial contributor to racial and regional disparities that have been previously associated with a diagnosis of T2D. Because progression from pre-diabetes to T2D may be halted with appropriate treatment (Rydén et al., 2007), our findings highlight the need for early identification and treatment of pre-diabetes as a key target for future intervention to reduce racial and regional disparities related to diabetes.

Genetic variants associated with race may increase the risk of having pre-diabetes (Konen et al., 1999) and subsequently diabetes (Carnethon et al., 2002; Vassy et al., 2012). The *thrifty* gene hypothesis offers one explanation for the increased risk of pre-diabetes and T2D in blacks. Researchers continue to look for support or otherwise for the theory.