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Racial differences in heritability of cigarette smoking in adolescents and young adults

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ABSTRACT

Introduction: Although epidemiologic studies suggest low levels of cigarette use among African American adolescents relative to White U.S. adolescents, it is not known whether this may be due to racial differences in the relative contribution of genes and environment to cigarette use initiation and progression to regular use.

Methods: Using data from White ($n = 2665$) and African American ($n = 809$) twins and full siblings sampled in the National Longitudinal Study of Adolescents, we fitted age-, sex- and race-specific variance decomposition models to estimate the magnitude of genetic and environmental effects on cigarette use initiation and cigarette use quantity in Whites and African Americans across adolescence and adulthood. We employ a causal-contingent-common pathway model to estimate the amount of variance explained in quantity of cigarettes smoked contingent on cigarette use initiation.

Results: African Americans had lower cigarette use prevalence from adolescence through adulthood, and used cigarettes less heavily than Whites. Race-specific causal-contingent-common pathway models indicate that racial differences in genetic and environmental contributions to cigarette use initiation and cigarette use quantities are not present in adolescence but appear in young adulthood. Additive genetic factors were an important risk factor for cigarette use initiation for White but not African American young adults and adults.

Conclusions: Genetic and environmental contributions for cigarette use are similar by race in adolescence. In adulthood, genes have a stronger influence for cigarette use among White adolescents while the influence of the environment is minimal. For African Americans, both genetic and environmental influences are important in young adulthood and adulthood.

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1. Introduction

Many epidemiologic and community-based studies have consistently reported relatively low levels of cigarette use among African American U.S. adolescents compared to White U.S. adolescents (Bachman et al., 1991; CDC, 2004; Griesler and Kandel, 1998). Between the ages of 12 and 17, White males and females initiate cigarette use at higher rates than African American males and females (Anderson and Burns, 2000). In fact, twice as many Whites are regular smokers compared to African Americans. National estimates suggest that in adolescence, 4.2% of African American 10th

graders (and 9.0% of 12th graders) report being a regular smoker compared to 9.5% of White 10th grade adolescents (17.5% of 12th graders) (Bachman et al., 2011, 1991).

During adolescence, African Americans initiate smoking during young adulthood (Taylor et al., 1997; Trinidad et al., 2004) rather than during adolescence, as has been found for White adults (White et al., 2004). When African American adolescents do initiate cigarette use fewer youth transition into regular cigarette use than White or Hispanic youth (Griesler and Kandel, 1998; Kandel et al., 2004). Similar risk factors predispose to cigarette use during adolescence and influence the cigarette use trajectories that African American and White adolescents follow (Fergus et al., 2005). Racial/ethnic differences in smoking prevalence exist even after controlling for the influence of socio-economic status (Blum et al., 2000). Despite lower levels of cigarette use among

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African Americans in adolescence, racial differences in cigarette use behaviors and smoking-related diseases emerge during adulthood and contribute to health disparities in lung cancer.

When African American adults smoke, they tend to be light smokers (smoke less than 10 cigarettes per day; Kandel and Chen, 2000) and show signs of nicotine dependence when smoking 6–10 cigarettes per day (Okuyemi et al., 2007). In a smoking cessation trial African Americans were found to smoke on average three fewer cigarettes per day than Whites (Branstetter et al., 2015). Previous studies also suggest that when smoking two packs per day, a greater proportion of Whites meet criteria for nicotine dependence than African Americans (Kandel and Chen, 2000). Although African American adults report smoking fewer cigarettes per day (Benowitz et al., 1999; Perez-Stable et al., 1998; Wagenknecht et al., 1990) the metabolism of nicotine into its metabolite cotinine is slower for African Americans than White adults and, as a result, African Americans have higher concentrations of cotinine (Benowitz et al., 2009). Lastly, rates of smoking-related cancers, such as lung (Haiman et al., 2006) and head and neck cancers (Molina et al., 2008; Sankaranarayanan et al., 1998) are higher among African Americans adults (Haiman et al., 2006). Lastly, data from the National Cancer Institute's SEER program indicates that African American men have the highest incidence of lung and bronchial cancer than other racial/ethnic groups and have lower survival rates when lung cancer is diagnosed (Ward et al., 2004).

Given the health disparities in lung cancer, studies have examined mechanisms that may give rise to racial disparities in cigarette use. Together these studies indicate that biological predispositions as well as social determinants are associated with cigarette use among African Americans in adulthood. The preference among African Americans to smoke mentholated cigarettes may contribute to the racial disparities in smoking-related cancers (Apelberg et al., 2012; Clark et al., 1996; Jones et al., 2013). To date, few studies have found support for the hypothesis that individuals who use mentholated cigarettes have higher rates of lung cancer (Mustonen et al., 2005). Other studies examining the link between the use of mentholated cigarettes and lung cancer have found no such support (Brooks et al., 2003; Carpenter et al., 1999; Stellman et al., 2003). Additional mechanisms to explain the health disparities in lung cancer among African Americans despite later onset and lower levels of use might be the experience of financial strain and stress (Advani et al., 2014), emotional distress (Bares and Andrade, 2012), and the exposure to everyday discrimination (Kendzor et al., 2014; Landrine and Klonoff, 2000). In their sample, Kendzor and colleagues found that White participants had been smoking for more years and smoked more cigarettes per day than African Americans, but greater proportions of African Americans smoked within 5 min of waking up and reported the highest scores on the Heaviness of Smoking Index. African Americans who report high rates of discrimination have 34% to 51% higher odds of being current smokers (Borrell et al., 2010). In addition, inequalities in health care access may be an additional contributing factor to higher rates of lung cancer and poorer prognosis among African Americans (Ward et al., 2004).

Previous studies examining racial differences in the influence of social determinants of cigarette use have found that African American adolescents may experience a different set of protective factors for cigarette use than Whites. African Americans adolescents who attend majority African American schools have one of the lowest rates of substance use compared to schools with a more mixed racial composition (O'Malley et al., 2006). In addition, having a positive relationship with one's mother (Mahabee-Gittens et al., 2011) is a stronger protective effect against cigarette use initiation in African Americans than in Whites.

Family, twin and adoption studies are used to estimate the proportion of variance in a trait or behavior that is accounted for

by genetic factors, or heritability. Ample evidence exists for the contribution of both genetic and shared environmental factors to cigarette initiation, with shared environmental factors being more important in adolescence with an increase in the role of genetic factors towards young adulthood (Hopfer et al., 2003; Maes and Neale, 2009; Maes et al., submitted). Furthermore, studies examining the heritability of cigarette use among adolescents and adults have uncovered that the genetic factors that influence cigarette initiation are shared with those influencing regular tobacco use as well as nicotine dependence (Bares et al., 2015; Do et al., 2015; Maes et al., 2004; Morley et al., 2007; Oncel et al., 2014). These results, however, are based on samples of twins who are predominantly White. Twin studies focused on differences in heritability by race have examined body mass index or hypertension (Jacobson and Rowe, 1998; Snieder et al., 2003). Using the first wave of the National Longitudinal Study of Adolescent Health (Harris et al., 2009), Jacobson and Rowe found that the genetic and environmental influences on BMI differ by race (1998). A recent study of female twins in Missouri has found no racial differences in the additive genetic contribution to the liability of cigarette use initiation but significant racial differences in the shared environment (Sartor et al., 2015).

Few adolescent twin studies have a sizeable number of non-White participants to determine whether heterogeneity exists in the heritability of cigarette use initiation and progression. For example, the Virginia Twin Study of Adolescent Behavioral Development contains primarily White twins (Simonoff et al., 1997), the Minnesota Twin and Family Study (Iacono et al., 2006), and the Colorado Longitudinal and Community Twin Studies (Rhea et al., 2006) each contain less than 2% African American twin pairs in each of their sample. To date, the study that includes the largest proportion of African American twin pairs is the National Longitudinal Study of Adolescent to Adult Health (Harris et al., 2013).

The question of whether racial differences exist in the degree of influence of genes and environment on adolescent cigarette use is best addressed by a classic twin study that includes both racial groups from a nationally representative U.S. sample. The goal of the present study was to examine the presence of racial differences in the contribution of genes, or environment, or both, to the initiation of cigarette use and quantity of cigarettes smoked in White and African American U.S. adolescents. Given the evidence on how aspects of the environment influence the cigarette use of African American and White adolescents differently we expected that there would be heterogeneity in the genetic and familial influences on the initiation and continued use of cigarettes by race.

2. Method

2.1. Sample

Data from twin and sibling pairs available in the National Longitudinal Study of Adolescent to Adult Health (Add Health; Harris et al., 2006; Harris and Udry, 2013) was used for the present analyses. Adolescent participants were recruited¹ into the nationally representative study when they were enrolled in high school and subsequently assessed at various points as they transitioned into adulthood. At the time of the initial assessment (Wave 1) participants were asked to list individuals who lived in their household. From this list, participants were identified who belonged to the

¹ Add Health participants provided written informed consent for participation in all aspects of Add Health in accordance with the University of North Carolina School of Public Health Institutional Review Board guidelines that are based on the Code of Federal Regulations on the Protection of Human Subjects 45CFR46: <http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.html>

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