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Associations of Self-Reported Sleep Duration and Sleep Difficulties with Cardiometabolic Risk Factors among U.S.-born and Foreign-born Black Adults in the United States: NHANES 2005-2016

By

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Master of Public Health

Epidemiology

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Abstract

Self-reported sleep duration and poor sleep quality are understudied determinants of cardiometabolic (CMB) health, particularly among Black populations, who are most-at-risk. We conducted a cross-sectional analysis among 5,589 Non-Hispanic Black adults (U.S.-born: N = 4974, Foreign-born: N = 615) using National Health and Nutritional Examination Survey data from 2005 to 2016. Poisson regression models with robust variance estimators were fit to estimate the association between self-reported sleep duration and sleep difficulties with CMB risk factors (overweight, obesity, hypertension, diabetes) with adjustment for sociodemographic and health behaviors. Adjusted ordinal logistic regression models were fit to estimate the associations between sleep measures and CMB comorbidity. Effect modification by nativity and length of U.S. residence (Foreign-born adults only) was assessed. Participants' mean age was 44.1 years, 45.7% were males, 49% were short sleepers, 8.8% were long sleepers, 28.6% were overweight, 46.6% were obese, 55.3% were hypertensive, and 15.7% were diabetic. Longer sleep and long sleep were associated with lower prevalence of obesity, PR: 0.97, 95% CI: 0.96, 0.99 and PR: 0.87, 95% CI: 0.80, 0.95, respectively. Short sleepers were more likely to be overweight (PR: 1.09, 95% CI: 1.03, 1.16) and obese (PR: 1.06, 95% CI: 1.01, 1.10). Among U.S.-born adults, long sleep was associated with lower prevalence of obesity (PR: 0.88, 95% CI: 0.80, 0.97); sleep difficulties were associated with a higher prevalence of hypertension (PR: 1.07, 95% CI: 1.01, 1.14) and CMB comorbidity (PR: 1.17, 95% CI: 1.02, 1.35). Among Foreign-born adults, longer sleep was associated with a lower prevalence of hypertension (PR: 0.94, 95% CI: 0.89, 0.99) and CMB comorbidity (PR: 0.87, 95% CI: 0.78, 0.97); short sleep was associated with a higher prevalence of obesity (PR: 1.30, 95% CI: 1.04, 1.63). Among recent Black immigrants (<10 years in the U.S.), short sleepers were more likely to be hypertensive (PR: 1.75, 95% CI: 1.13, 2.72). Short sleep was associated with being overweight and obese among Black adults. Associations between sleep duration or difficulties and CMB risk factors varied by nativity. As a heterogenous group, examining within race differences allows for development of specific sleep health interventions to address these disparities.

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Introduction

Despite the mortality rate decline, cardiovascular disease (CVD) continues to be the leading cause of death in the United States (U.S.), where approximately one in three adults have CVD.[1,2] The widespread increase of cardiometabolic (CMB) risk factors, a construct comprised of a cluster of risk factors such as body mass index (BMI), blood pressure, and insulin resistance, that increase the likelihood of experiencing a cardiovascular event,[3,4] have been identified as main contributors of CVD.[4,5] The prevalence of CMB risk factors and CVD increase with age and vary by race/ethnicity, geography, and socioeconomic factors such as income, education, and healthcare access.[1,4] In terms of racial disparities, Black Americans have the highest prevalence of CVD and CVD-related mortality rates compared to all other racial/ethnic groups.[6,7] This can be attributed to the disproportionate burden of elevated blood pressure, obesity, and diabetes within the community.[6] This disparity is likely the result of structural factors such as racism that is rooted in racial/ethnic discrimination, which can hinder access to care and decrease employment and education opportunities, subsequently limiting quality of healthcare and resources for CVD management.[8] In addition, acute and chronic experiences of discrimination exacerbate stress responses, which can increase vulnerability to cardiovascular events among Black adults.[9] As CVD morbidity and mortality continues to increase among Black adults, increased research towards prevention to identify modifiable CMB risk factors such as sleep is essential.

Sleep is a reoccurring neurophysiological state involving reduced body movement and electromyographic activity, reduced responsiveness to external stimuli, closed eyes, reduced breathing rates, and altered body position and brain wave architecture.[10] The sleep wake cycle is a neurobehavioral process involving intervals of activity alternating with restfulness in a 24-hour

cycle and is composed of approximately 16 waking hours and 8 sleep hours.[11] The sleep wake cycle is controlled by 2 modeled processes, homeostatic regulation and the circadian rhythm.[12] A highly characteristic feature of sleep is the cyclic sequence of non-rapid eye movement (NREM) and rapid eye movement (REM) sleep, known as the ultradian rhythm.[13] Once in a rested state, sleep relies on activity and metabolism in relation to the electrical brain signals obtained in the electroencephalogram (EEG) and is classified with three stages of NREM, N1, N2, and N3.[10,14] N1, the shortest stage, lasts less than 10 minutes and serves a transitional role in sleep-stage cycling.[14] N2, characterized as light sleep, lasts between 10 and 25 minutes. It involves muscle relaxation, reduced body temperature and heart rate, and relatively low-voltage, mixed-frequency brain wave activity.[14] N3, lasts between 20 to 40 minutes and is the deepest sleep period of NREM.[14] N3 is characterized by increased amounts of high-voltage, slow-wave activity on the EEG.[14] REM occurs approximately 90 minutes after sleep onset with muscle atonia, increased brain activity, and bursts of rapid eye movement. Dreaming is most often associated with REM sleep.[14] As sleep persists, REM encompasses a greater proportion of the sleep cycle.[10,14] The processes of sleep is integral for biological function and repair including physiological development, energy conservation, brain waste clearance, and modulation of disease, immune responses, and cognition.[10] Healthy sleep consists of multiple characteristics that optimize physical, mental, and neurobehavioral well-being such as obtaining the appropriate amount of sleep hours, subjective satisfaction, appropriate timing, high efficiency, and sustained alertness during waking hours.[15] The American Academy of Sleep Medicine and Sleep Research Society recommend that adults should obtain between 7 and 8 hours of sleep for optimal health.[16] Inadequate sleep duration, obtaining more or less than the recommended sleep hours,[17] or sleep difficulties, problems falling asleep, maintaining sleep during the night, waking up too early in

the morning, and nonrestorative sleep,[18] are a public health burden. Approximately 30% of American adults suffer from chronic sleep disorders or sleep deprivation.[19] Inadequate sleep duration or sleep difficulties are associated with increased risk for accidents and injury, impaired performance of daily function, and numerous diseases including CVD.[16,20,21] Poor sleep disrupts the circadian rhythm which is subsequently linked to hormonal imbalance, altered sympathetic-parasympathetic balance, decreased brain glucose utilization, increased pro-inflammatory cytokines, reduced energy use, and increased appetite.[22-24] The results of these effects include insulin resistance and impaired glucose intolerance, increased blood pressure, and unhealthy weight gain, increasing risk for CVD.[25] Emerging evidence suggests that sleep, and the high burden of inadequate sleep may drive the CMB burden among Black adults.[26]

Mirroring the disparities that exist within CMB health, there are disparities in sleep. Racial minority groups, and Black adults in particular sleep less and have increased sleep difficulties compared to Non-Hispanic White adults.[27] Nationally representative data showed that over nearly 36% of Black adults regularly have short sleep duration (< 7h) compared to about 28% of White adults.[28] In the Multi-Ethnic Study of Atherosclerosis (MESA) study, Black adults had approximately 5 times higher odds of actigraphy-measured short sleep duration (<6h) compared to White adults.[29] A cross sectional nationally representative study of 29,000 adults indicated that not only were Black adults more likely to self-report very short (≤ 5h) sleep duration compared to White adults but also long sleep (≥ 9h).[30] A cross sectional study among approximately 2,200 adults which consisted of polysomnography and actigraphy as well as sleep questionnaires, demonstrated that compared to White participants, Black participants had higher odds of sleep apnea, short sleep, poor sleep quality, and daytime sleepiness.[29] Disparities in sleep may explain the disproportionate prevalence of poor cardiovascular health among Black adults in

the US,[31,32] however, few studies have examined the association of sleep and CMB within a Black sample.

Although studies are limited within Black populations, epidemiologic studies have demonstrated adverse cardiometabolic health outcomes are more prevalent among individuals with unhealthy sleep durations (e.g., <7 hours or >9 hours) and presence of sleep difficulties. A cross sectional analysis of over 1,000 Black and White middle-aged adults observed 45% higher odds of metabolic syndrome (MetS) among participants who self-reported short sleep (<7h) and long sleep (≥ 9h).[33] Similarly, a cross sectional study of nearly 8,000 adults using data from 2013-2016 from the National Health and Nutritional Examination Survey (NHANES) found that short (<6h) and long (≥ 9h) sleep durations were associated with lower odds of ideal cardiovascular health and lower mean cardiovascular health scores.[34] An additional NHANES study of nearly 9,000 adults assessed self-reported sleep duration and CMB risk scores based on high-density lipoprotein (HDL) cholesterol, waist circumference, fasting insulin, fasting plasma glucose, BMI, and systolic and diastolic blood pressure.[35] After adjusting for demographic, socioeconomic, and health factors, individuals with a self-reported sleep duration of 7h had the lowest cardiometabolic risk scores compared to those who reported more or less than the recommended sleep duration.[35] While the effects of sleep duration are more commonly presented in the literature, studies assessing sleep difficulties and CMB health demonstrate similar trends. Cross sectional data from a sample of 38,000 White, Black, and Latina pre- and post-menopausal women revealed that along self-reported short sleep, self-reported insomnia symptoms were positively associated with MetS.[36] A large nationally representative cross sectional study using data from the Behavioral Risk Factor Surveillance System (BRFSS) consisting of 138,000 adults found that self-reported sleep disturbance was associated with increased odds of obesity,

diabetes, myocardial infarction, stroke and coronary artery disease.[37] Studies within Black adults, such as the Jackson Heart Study Cohort, have shown associations between objectively measured sleep difficulties and disorders with increased blood glucose levels,[38] high nighttime blood pressure,[39] and resistant hypertension.[40] The prior evidence suggests that sleep duration and difficulties are plausible risk factors for CMB disease, and based on the disproportionate burden of inadequate sleep duration and CMB disease among Black adults, it is likely sleep may be the driver of CMB disease in this population.

While Black Americans have a high prevalence of poor sleep and CMB risk factors, the racial group Black is heterogeneous with many within group differeces.[32,41] For example, this group consists of both U.S. and Foreign-born Black individuals. Foreign-born individuals are generally healthier than their U.S.-born counterparts, an advantage that reflects a combination of healthier lifestyles in the countries of origin, the selective migration of healthy immigrants, and cultural buffering that reduces risky behavior and strengthens support networks.[42] As immigrants assimilate to the American lifestyle, which is associated with an uptake of negative CMB risk factors such as poor diet, decreased physical activity, and increased stress, this advantage diminishes.[28] The relationship between the accumulation of substandard nutrition and exercise habits along with stress leading to worsened CMB health have been proposed to be mediated by sleep,[20] however, there is a lack of studies examining the sleep of Black immigrants.

Notwithstanding the few studies that have examined the sleep of Black immigrants, data suggests mixed findings regarding the immigrant advantage regarding sleep. An analysis of actigraphy-measured sleep duration revealed that Non-Hispanic African/Caribbean adults slept 64 minutes fewer a night compared to U.S. White adults.[43] Controlling for socioeconomic factors reduced this gap to 50 minutes fewer, and controlling for occupational characteristics such as

night shift and work hours resulted in 37 minutes fewer.[43] Although Foreign-born Black adults are known to partake in healthier behaviors than their U.S.-born counterparts,[44,45] data on differences in sleep between these groups have been less consistent. National Health Interview Survey (NHIS) data among 175,000 employed adults from 2004-2011 found that Black immigrant laborers had a higher prevalence of self-reported short sleep duration (<7h) compared to U.S.-born Black laborers.[46] However, another a study using 2012 NHIS data among 17,000 adults reported no significant differences in sleep duration between Black adults based on nativity.[28] Although the majority of sleep studies examine sleep duration, studies using other sleep measures were also conducted for differences based on nativity. Additional sleep-related factors such as sleepiness, which can result from short sleep duration and sleep difficulties, vary by country of origin. A cross sectional study which utilized Epworth Sleepiness Scale to measure excessive daytime sleepiness among approximately 1,050 hypertensive Black adults found that excessive daytime sleepiness was 69% more prevalent among U.S.-born Black adults compared to Foreign-born.[47] While Black immigrants appear to be selected in good health (the healthy migrant effect), with a lower prevalence of obesity, hypertension, and diabetes compared to their U.S.-born counterparts,[46] previous epidemiologic research present indications of negative health assimilation, which may include sleep.

Due to lifestyle changes resulting from transitioning to living in the U.S., acculturation may contribute towards the decline in sleep and CMB health among Foreign-born Black adults. Acculturation involves numerous factors such as language adaptation, adjusting for value and traditional differences, and a rebuilding of social networks and support systems.[4,48] Moreover, most Black immigrants originate from countries where Black race is the majority demographic, and when migrating to the U.S. they are suddenly considered part of a racial minority group.[42]

This cultural change combined with racism, xenophobia, and acculturation may be an extreme and new experience for Foreign-born Black adults which may induce stress and anxiety, thus leading to inadequate sleep duration and increased sleep difficulties.[28,46] Despite the initial health advantage which may mitigate the impact of poor sleep on CMB health, years of acculturation combined with chronic experiences of psychological stressors and racial discrimination may increases vulnerability to poor health, and sleep in particular.[49]

Given the heterogeneity of Black adults, there may be risk differences for CMB health, particularly for Foreign-born individuals. Due to an uptake of negative health behaviors attributable to assimilation and acculturation which may induce stress and interfere with sleep, country of origin or nativity is important to consider. Immigrants constitute a prominent and growing group of Black people in the U.S., yet Black immigrant representation in the literature regarding sleep is scarce. Identifying risk factors in order to improve Black health should involve recognizing shared and unique experiences within the racial group, which is necessary for the implementation of more specific interventions. Currently there are no studies that have explored the association of sleep and CMB risk factors among a group of U.S.-born and Foreign-born Black adults in the U.S., that considered country of origin. To address this gap, the current study will expand the current literature to explore sleep duration and sleep difficulties with CMB risk factors among both U.S. born and Foreign-born Black adults. There is a clear need to examine sleep and CMB risk factors within Black Americans to identify targets and those that are most-at-risk.

The aim of the study is to examine the associations between self-reported measures of sleep and CMB risk factors among Black adults in the U.S.; and test whether these associations vary by nativity. To address this research question, we tested associations of self-reported sleep

duration and sleep difficulties with obesity, hypertension, and diabetes among U.S. and Foreign-born Black adults. We hypothesized that individuals with shorter sleep duration and more sleep difficulties with have a higher prevalence of obesity, hypertension and diabetes; and the association between sleep duration and sleep difficulties and CMB risk factors will be more pronounced among U.S.-born Black adults compared to Foreign-born adults, due to a generally higher prevalence of CMB risk factors and poor health behaviors within this group. We also expect to observe a higher prevalence of CMB comorbidity among U.S.-born individuals. However, among Foreign-born adults, we hypothesized the difference of the magnitude of the effect of the associations will decrease with years lived in the U.S.

Methods

Data and Study Population

Cross sectional data was analyzed from the National Health and Nutrition Examination Survey (NHANES), a research program carried out as a series of surveys consisting of interviews and physical examinations designed to assess the health and nutritional status of adults and children in the U.S. The survey examined a nationally representative sample of about 5,000 persons per year, approximately 10,000 in each 2-year cycle, located in various counties across the country. Each year, fifteen different counties were randomly selected and visited for the interview and examination. The interview included demographic, socioeconomic, dietary, and health-related questions and were conducted by trained interviewers. The clinical examination component consisted of medical, dental, and physiological measurements collected in the Mobile Examination Center (MEC) by trained health technicians.[50] This study pooled data from 2005-2016 made publicly available from the Centers of Disease and Control and Prevention webpage, and included participants (N=7,302) who self-identified as Non-Hispanic

Black who were at least 20 years old. Participants were excluded (N=1,713) if they had missing data on sleep duration, sleep difficulties, CMB risk factors (obesity, hypertension, diabetes), and nativity. We also excluded pregnant women and participants with previous self-reported heart disease (congestive heart failure, coronary heart disease, angina, and heart attack). This study used publicly available deidentified data and was exempt from human subjects review by Emory University Institutional Review Board.

Measures

Outcome

The outcome of interest is CMB risk factors including obesity, hypertension and diabetes. Weight and height were collected in the MEC by trained health technicians and used to determine BMI for classification of obesity. Obesity was defined as a BMI of ≥30 kg/m^2, overweight as 25.0–29.9 kg/m^2, Under/Normal weight as 18.5–24.9 kg/m^2 and underweight as less than 18.5 kg/$m^{2.}$ Our analysis included a 3-level variable for obesity, obese and overweight compared to under/normal weight individuals.

To measure hypertension, participants had blood pressure measurements taken by certified examiners in the MEC. Three systolic and diastolic readings were obtained after participants were seated in a rested position for 5 minutes. For interrupted or incomplete readings, a fourth attempt was made. To determine hypertension status, the first reading was discarded, and the remaining systolic and diastolic blood pressure readings were averaged, unless only one reading was available.[51,52] For systolic averages, 93% of participants had 3 readings, 1% had 2 readings, and 2% had 1 reading. For diastolic averages 92% of participants had 3 readings, 2% had 2 readings, and 2% had 1 reading. Hypertension was defined as having an average systolic blood pressure ≥ 130 mmHg, an average diastolic blood pressure ≥ 80 mmHg,

reported current use of antihypertensive medication, or self-reported physician diagnosis of hypertension.[53]

Diabetes was defined by self-report and blood sample. Participants were asked "Other than during pregnancy, have you ever been told by a doctor or another health professional that you have diabetes or sugar diabetes?". Responses were recorded as yes, or no. Diabetes was also determined through MEC laboratory testing for HbA1c and fasting plasma glucose. Participants with HbA1c ≥ 6.5% ,fasting glucose ≥ 126 mg/dL, or self-reported diagnosis were considered diabetic.

We created a composite measure of CMB risk factors to assess the burden. CMB comorbidity was assessed as an ordered 4 level variable based on the number of CMB factors present ranging from 0-3. Participants with no CMB risk factors were categorized as having no conditions and used as the referent group. Participants with 1 CMB risk factor were categorized as having 1 condition. Participants with 2 CMB risk factors were categorized as having 2 conditions. Participants with all 3 CMB risk factors were categorized as having 3 conditions.

Sleep Duration

Sleep duration was measured by asking participants the amount of sleep they usually get on weekdays or workdays. Short sleep duration was defined as a usual sleep duration of < 7 hours; recommended sleep was defined as 7 to 8 hours; and long sleep was defined as ≥ 9 hours. Sleep duration of 7 to 8 hours was used as the reference group because of the documented associations with optimal health outcomes and lowest level of morbidity.[16,54]

Sleep Difficulties

Sleep difficulties were ascertained from the 9-item depression screening instrument. Sleep difficulties were defined by asking participants "Over the last 2 weeks, how often have you

been bothered by the following problems: trouble falling or staying asleep or sleeping too much." Response categories were "Not at all," "Several days," "More than half the days," or "Nearly every day." No self-reported sleep difficulty was the reference.

Immigration Status and Citizenship

To determine nativity, participants were asked "In what country were you born." Responses of "born in the 50 U.S. states or Washington, DC" classified U.S. born. Foreign-born was defined as reporting "Other," "Born in Mexico," "Born in Other Spanish Speaking Country," or "Born in Other Non-Spanish Speaking Country."

Among Foreign-born participants only, citizenship was determined by asking participants, "Are you a citizen of the United States?" Responses included "Citizen by birth or naturalization" or, "Not a citizen." Length of U.S. residence (<10, or ≥10 years) was also considered.

Covariates

Demographic and Socioeconomic Factors

Participants were asked to report their gender (male or female) and age in years at the time of screening. Marital status was classified as married or living with a partner, widowed, divorced or separated, never married. Educational attainment was classified as less than high school (no high school diploma), high school graduate (high school or general equivalent diploma), some college, or at least a college-level education or greater. Annual household income was dichotomized as less or more than the U.S. median income of $35,000.[55] We used the poverty income ratio (PIR) to define poverty status. The PIR is the ratio of total family income to the poverty threshold values. Persons with PIR values less than one were classified as living below the official poverty line. Employment status was categorized as being employed

(full or part-time) or unemployed. Health insurance was dichotomized as having coverage (through employment, purchased directly, or government programs) or no coverage.

Health Factors

Participants self-reported minutes of moderate or vigorous-intensity physical activity per week, which was further categorized as active (≥150 minutes of moderate, ≥75 minutes of vigorous) or inactive (<150 minutes of moderate and <75 minutes vigorous physical activity). Self-reported health status was categorized as "excellent/very good", "good/fair", and "poor." Cigarette smoking was classified into never smoker, former smoker, and current smoker. Participants were asked, "Have you smoked at least 100 cigarettes in your entire life?" Participants who answered "no" were classified as never smokers. Participants who answered "yes," but also answered, "Not at all" when asked, "Do you now smoke cigarettes?" were classified as former smokers. Participants who responded, "yes," when asked if they smoked at least 100 cigarettes in their entire life and reported smoking "every day" or "some days," were classified as current smokers. Alcohol intake was categorized as never, former, or current based off the following questions: "In your entire lifetime, have you had at least 12 drinks of any alcoholic beverage." "In any one year, have you had at least 12 drinks of any type of alcoholic beverage" "In the past 12 months, on those days that you drank alcoholic beverages, on the average, how many drinks did you have?" Participants who reported consuming < 12 alcohol drinks in their entire lifetime or in any one year were classified as never-drinkers. Participants who reported consuming ≥12 drinks in their entire life or in any one year but not in the past 12 months were classified as former drinkers. Participants who reported consuming ≥12 drinks in their entire life or any one year and ≥1 drinks in the past 12 months were classified as current drinkers. To assess presence of depression, we used the first two items of the Patient Health

Questionnaire ("little interest or pleasure in doing things" and "feeling down, depressed, or hopeless"), referred to as the PHQ-2. The screening instrument was administered to determine the frequency of depression symptoms over the past 2 weeks and used to generate depression scores ranging from 0 to 6. Participants with scores ≥ 3 were classified as having depression. The PHQ-2 score and cut points have been validated in other studies to define depression.[56]

Statistical Analysis

All analyses were performed using SAS 9.4 (SAS Institute, Cary NC) and R Studio Version 1.4.1106 (R Studio Inc, Boston, MA). Estimates were weighted using NHANES generated sampling statistical strata, clusters, and weights provided to account for the unequal probabilities of selection resulting from the sample design, nonresponse, and oversampling of certain subgroups.[57] We multiplied the weight variable by 1/6 due to the inclusion 6 survey periods. Continuous variables were presented as means ± standard errors (SE) and categorical variables as unweighted frequencies and weighted percentages. Sociodemographic and health characteristics were stratified by nativity.

Poisson regression models with robust variance estimators were fit to estimate prevalence ratios (PRs) for the association between self-reported sleep duration and sleep difficulties with BMI categories of obesity or overweight vs. normal/underweight, hypertension, and diabetes among Black adults and their corresponding 95% confidence intervals (CIs). In a secondary analysis, we used ordinal logistic regression models to estimate odds ratios (ORs) to examine the association between self-reported sleep duration and self-reported sleep difficulties and CMB comorbidity and their corresponding 95% CIs. We utilized a sequential modeling approach. First crude estimates of sleep duration and sleep difficulties with each CMB risk factor or CMB comorbidity were presented. In tables we present two models, model 1 includes adjustment for

demographic and socioeconomic factors (age, gender, education, income, poverty status, employment, and health insurance), and model 2, which further adjusted for health factors (physical activity, self-reported health status, self-reported diet status, smoking status, alcohol intake, and depression). Fully adjusted models for hypertension and diabetes also adjusted for BMI.

We also conducted secondary analyses among Foreign-born adults with non-missing data on length of residence in the U.S. (N=608). We first assessed for evidence effect modification between self-reported sleep duration and sleep difficulties with prevalence of CMB risk factors by length of U.S. residence. For associations that showed evidence of effect modification based on the interaction between self-reported sleep duration and sleep difficulties with number of years lived in the country on CMB risk factors, we presented stratified results by length of residence (<10 or ≥10 years) . We categorized length of time in the U.S. in order to compare potential trends for several years of residence. Models were fully adjusted for sociodemographic characteristics (age, gender, education, income, poverty status, employment, and health insurance) and health factors (physical activity, self-reported health status, self-reported diet status, smoking status, alcohol intake, and depression).

Results

Study Population

Of the 5,589 Black adults in our study, 89% were U.S.-born and 11% Foreign-born. The distribution of selected characteristics by nativity status are presented in Table 1. Among the overall study population, the mean age of both U.S.-born and Foreign-born participants was 44 years (SD = 0.3 years) and 45.7% of adults were male. The distribution of socioeconomic factors showed that 18.3% of our sample had at least a college degree, 44.3% were married, 36.5% were

unemployed, 42.5% reported an annual household income of ≤ $35,000, 29.8% lived below the poverty line, and 75.5% had health insurance. For health and behavioral factors, 25.2% were current smokers, 58.3% currently consumed alcohol, 82.4% were classified as inactive, 22.5% reported their health status as poor, 35.2% reported poor diet, and 10.5% were classified as having depression. The mean self-reported sleep duration was 6.7 (SD = 0.03) hours. Approximately half (49%) were short sleepers, and 8.8% were long sleepers. For sleep difficulties, 19.8% reported trouble sleeping or sleeping too much over the past two weeks for several days, 7.0% reported having sleep difficulties more than half the days, and 8.2% reported having sleep difficulties nearly every day. Nearly half of the study population was obese (46.4%), 55.5% were hypertensive, and 15.7% were diabetic. Over a third (36.5%) of adults had 1 CMB condition, 27.2% had 2 conditions, and 8.8% had 3 conditions.

Foreign-born compared to their U.S.-born counterparts were more likely to be male (51.8% vs. 45.0%), married (54.5 %vs. 43.0%), have at least a college degree (27.9% vs. 17.1%), and less likely to be unemployed (27.6% vs. 37.6%), live below the poverty line (26.4% vs. 30.3%), be current smokers (11.0% vs. 27.0%), consume alcohol (48.9% vs. 59.4%), report poor general health (12.0% vs. 23.8%), and poor diet (17.8 % vs. 37.4%). Approximately two-thirds of Foreign-born participants lived in the U.S. for at least 10 years (65.6%) and the majority were U.S. citizens (59.6%).

Self-reported sleep duration was similar for both US-born and Foreign-born adults with averages of 6.6 and 6.8 hours respectively. Reports of long sleep ≥ 9 hours were similar, 8.9% and 8.1% for U.S.-born and Foreign-born participants respectively. U.S.-born adults were more likely to be short sleepers (49.4% vs. 45.1%). For sleep difficulties, U.S.-born adults were more likely to report trouble sleeping or sleeping too much over the past two weeks for several days (20.2% vs.

16.0%), more than half the days (7.4% vs. 3.4%), and nearly every day (8.5% vs. 5.0%), than their Foreign-born counterparts. U.S.-born participants were more likely to be obese (48.4% vs. 29.9%), hypertensive (56.4% vs. 46.4%), and diabetic (15.9% vs. 14.4%) than Foreign-born participants. U.S.-born participants also had higher proportions of adults with 1 (36.6% vs. 35.9%), 2 (28.2 vs. 19.0%), and 3 (9.2% vs. 5.6%) CMB conditions compared to Foreign-born participants.

Self-Reported Sleep Duration and Difficulties and CMB Risk Factors in the Overall Study Population

PRs for sleep duration and sleep difficulties for all Black adults in the study are presented in Table 2 (unadjusted estimates not shown). For associations between sleep duration and categories of BMI, there was a 3% lower prevalence of being overweight (PR: 0.97, 95% CI: 0.95, 0.99) and 4% lower prevalence of obesity (PR: 0.96, 95% CI: 0.95, 0.98) for every 1 hour increase in sleep duration. The associations persisted in fully adjusted models. There was also a higher prevalence of being overweight (PR: 1.12, 95% CI: 1.06, 1.18) and obese (PR: 1.09, 95% CI: 1.04, 1.14) among short sleepers compared to participants who obtained the recommended sleep duration. Similar estimates were observed when adjusting for sociodemographic characteristics and health factors. In unadjusted models, long sleep was associated with lower prevalence of being overweight (PR: 0.86, 95% CI: 0.75, 0.99) and obese (PR: 0.85, 95% CI: 0.78, 0.94) compared to those who reported recommended sleep. Associations persisted in adjusted models (Table 2). For sleep difficulties, there was no difference in the prevalence of being overweight status among participants who reported sleep difficulties (vs. none). In unadjusted models we found a 9% higher prevalence of obesity (PR: 1.09, 95% CI: 1.03, 1.16) when among participants who reported trouble sleeping or sleeping too much on several days (vs. none). Associations were attenuated and did not persist in adjusted models. We observed no difference in prevalence of obesity among

participants who reported trouble sleeping or sleeping too much on more than half the days or nearly every day compared those with no sleep difficulties.

There was no association between sleep duration (both continuous and sleep categories) and prevalence of diabetes. For sleep difficulties, participants who reported trouble sleeping or too much nearly every day had a 40% higher prevalence of diabetes (PR: 1.40, 95% CI: 1.12, 1.75).The association persisted with adjustment for sociodemographic characteristics, but the association was attenuated and no longer present in fully adjusted models.

Self-Reported Sleep Duration and Difficulties and CMB Risk Factors by Nativity

Tests for effect modification showed an interaction between continuous sleep duration and nativity on obesity ($p=0.02$), hypertension ($p=0.01$), and diabetes ($p<0.001$). We also observed evidence of effect modification for the interaction between categorical sleep duration and nativity on obesity ($p =0.04$). Stratified analyses are presented in Table 3 (unadjusted estimates not shown). Among U.S.-born adults, longer sleep duration was associated with a 3% lower prevalence of being overweight (PR: 0.97, 95% CI: 0.95, 0.99), however associations did not persist after covariate adjustment. Longer sleep duration was also associated with a 3% lower prevalence of obesity (PR: 0.97, 95% CI: 0.95, 0.98) and estimates were similar in adjusted models. Among Foreign-born adults, we observed a 10% lower prevalence of obesity (PR: 0.90, 95% CI: 0.84, 0.96) for an hour increase in sleep, and similar estimates were observed after model adjustment. We found no associations between sleep duration (continuous) and prevalence of being overweight among Foreign-born adults.

Short sleep (vs. recommended sleep) was associated with a 6% higher prevalence of obesity (PR: 1.06, 95% CI: 1.02, 1.11) among U.S.-born participants, whereas we observed a 36% higher prevalence of obesity (PR: 1.36, 95% CI: 1.08, 1.70) among Foreign-born participants.

Associations between short sleep and obesity persisted in fully adjusted models for Foreign-born adults but not U.S. born. Among U.S.-born participants, short sleepers had a 10% higher prevalence of being overweight (PR: 1.10, 95% CI: 1.03, 1.17). Associations did not persist in fully adjusted models. There was no difference in short sleep and the prevalence of being overweight among Foreign-born adults. Long sleep (vs. recommended sleep) was associated with a lower prevalence of being overweight (PR: 0.84, 95% CI: 0.72, 0.98) and obesity (PR: 0.85 95% CI: 0.77, 0.95) among U.S.-born participants. We observed similar estimates between long sleep and obesity after covariate adjustment. Associations between long sleep and being overweight did not persist in adjusted models. We observed no difference between long sleep and prevalence of being overweight or obesity among Foreign-born adults.

Among U.S.-born adults, there were associations between reporting sleep difficulties more than half the days (vs. none) on overweight and reporting sleep difficulties several days (vs. none) on obesity in unadjusted models, but they were attenuated after adjustment for sociodemographic characteristics and health and behavioral factors. There were no differences in sleep difficulties and prevalence of obesity or overweight among Foreign-born participants.

There were no observed associations between self-reported sleep duration (continuous and categorical) and hypertension among U.S.-born adults. However, among Foreign-born adults, there was a 7% lower prevalence in hypertension for a 1 hour increase in sleep duration (PR: 0.93, 95% CI: 0.88, 0.98). Associations persisted in adjusted models. For sleep difficulties, in unadjusted models we observed a higher prevalence of hypertension among U.S.-born adults who reported sleep difficulties nearly every day (PR: 1.12, 95% CI: 1.03, 1.23). In models including sociodemographic characteristics, we observed a higher prevalence of hypertension among U.S.-born adults reporting sleep difficulties several days (PR: 1.13, 95% CI: 1.06, 1.20), more than half

the days (PR: 1.15, 95% CI: 1.05, 1.26), and nearly every day (PR: 1.15, 95% CI: 1.06, 1.35). In fully adjusted models, we observed a higher prevalence of hypertension among U.S.-born adults reporting sleep difficulties several days only (PR: 1.07 95% CI: 1.01, 1.14). There were no associations between sleep difficulties and hypertension among Foreign-born adults.

There was no evidence of interaction between sleep difficulties and nativity on all CMB risk factors. There was also no evidence of interaction between sleep duration categories and nativity on hypertension and diabetes.

Self-Reported Sleep Duration and Difficulties and CMB Comorbidity by Nativity

Tests for effect modification showed an interaction between continuous (p=0.02) and categorical (p=0.02) sleep duration and nativity on CMB comorbidity. Stratified analyses are presented in Figure 1. In unadjusted models (unadjusted and SES models not shown), among U.S.-born adults, we observed no differences in sleep duration (continuous and categorical) and odds of CMB comorbidity (that is, 1 condition(s) vs. none, 2 condition(s) vs. none, and 3 condition(s) vs. none), whereas among Foreign-born adults, longer sleep duration was associated with 13% lower odds CMB comorbidity (OR: 0.87, 95% CI: 0.80, 0.95); short sleep was associated with 50% higher odds CMB comorbidity (OR: 1.50, 95% CI: 1.06, 2.11) . In models adjusting for sociodemographic characteristics, longer sleep duration was associated with 5% lower odds CMB comorbidity for U.S.-born adults (OR: 0.95, 95% CI: 0.91, 0.98), while Foreign-born adults were 12% less likely to have CMB comorbidity (OR: 0.88, 95% CI: 0.79, 0.98). Short sleep was also associated with 12% higher odds of CMB comorbidity among U.S. born adults only (OR: 1.12, 95% CI: 1.01, 1.25). In fully adjusted models, longer sleep was associated with 13% lower odds of CMB comorbidity among Foreign-born adults only (OR: 0.87, 95% CI: 0.78, 0.97). We

observed no differences between long sleep and CMB comorbidity for both U.S. and Foreign-born adults.

For associations between sleep difficulties and CMB comorbidity, U.S.-born adults who reported trouble sleeping or sleeping too much nearly every day had 44% higher odds of CMB comorbidity in unadjusted models (OR: 1.44, 95% CI: 1.14, 1.50). In models adjusting for sociodemographic characteristics, we observed higher odds of CMB comorbidity among U.S. born participants reporting sleep difficulties several days (OR: 1.33, 95% CI: 1.17, 1.52), more than half the days (OR: 1.38, 95% CI: 1.09, 1.75), and nearly every day (OR: 1.46, 95% CI; 1.14, 1.87). In fully adjusted models, we observed 17% higher odds of CMB comorbidity among U.S.-born participants reporting sleep difficulties several days only (OR: 1.17, 95% CI; 1.02, 1.35). There were no observed associations between sleep difficulties and CMB comorbidity among Foreign-born adults. There was no evidence of interaction between sleep difficulties and nativity on CMB comorbidity.

Self-Reported Sleep Duration and Difficulties and CMB Risk Factors by Years of U.S. Residence

In fully adjusted models, we observed evidence of effect modification between categorical self-reported sleep duration ($p=0.02$) with hypertension and between continuous sleep duration ($p<0.001$) and diabetes, by length of U.S. residence (Figure 2). Among adults in the country less than 10 years, short sleep was associated with 75% higher prevalence of hypertension (PR: 1.71, 95% CI: 1.13, 2.27), whereas among adults in the country more than 10 years, short sleep was associated with 57% lower prevalence of hypertension (PR: 0.57, 95% CI: 0.36, 0.89). There were no associations between long sleep and hypertension as well as longer sleep duration and diabetes regardless of length of residence. We observed no evidence of interaction between sleep duration (continuous and categorical) and length of U.S. residence on overweight/obesity, sleep

(continuous) sleep and length of U.S. residence on hypertension, or sleep duration (categorical) and length of U.S. residence on diabetes. There was no evidence of interaction between sleep difficulties and length of U.S. residence on all CMB risk factors.

Discussion

Among a nationally representative sample of U.S.-born and Foreign-born Black adults in the U.S., we examined self-reported sleep duration and sleep difficulties with CMB risk factors (overweight, obesity, hypertension, and diabetes). In the overall population, self-reported sleep duration was associated with obesity. Short sleepers were more likely to be obese or overweight, while we observed protective effects for obesity among individuals with longer sleep duration. Unexpectedly, long sleep, which is typically associated with poor health outcomes,[58] was associated with a lower prevalence of obesity. In unadjusted analyses, sleep difficulties were associated with higher prevalence of hypertension or diabetes, but associations were attenuated with adjustment for health factors (BMI, physical activity, self-reported health status, self-reported diet status, smoking status, alcohol intake, and depression). Associations between sleep duration or sleep difficulties with CMB risk factors varied by nativity. Among U.S.-born adults, long sleepers were less likely to be obese and sleep difficulties were associated with hypertension. Among Foreign-born adults, short sleep was associated with higher prevalence of obesity and hypertension. In stratifying by years in the U.S., Foreign-born participants residing in the U.S.<10 years, were more likely to be hypertensive than those who have lived in the US for > 10 years. With a growing diverse profile of Black adults in the U.S. few studies have examined variations within Black race for the identification of sleep—health disparities tied to nativity.

The current paper is novel in distinguishing between U.S.-born and Foreign-born Black adults. Due to cultural and lifestyle differences, it is important to examine the health of Black

adults by nativity, given Black race is heterogeneous. Consistent with the literature, we found that Foreign-born adults had generally more favorable health compared to their U.S.-born counterparts. Foreign-born participants were less likely to smoke or consume alcohol, behaviors commonly associated with negative health outcomes, and they self-reported better general health and diet status. They also had a lower BMI on average, and were less likely to be hypertensive, diabetic, and have CMB comorbidity. While the proportion of inactive adults were similar for both groups, Foreign-born adults were more likely to be in the normal weight range. Our findings, indicate overall better health among Foreign-born adults, are in support of the healthy immigrant effect where immigrants to developed countries enjoy health advantages relative to comparable native-born populations.[59] Proposed explanations for this phenomenon include the selective migration of healthier and younger individuals, selection via skills and education by host country immigration authorities, and the practicing of healthier behaviors tied to country of origin.[59]

In general, Foreign-born Black adults had a healthier sleep profile than U.S.-born Black adults. While average sleep duration was similar for both groups (U.S.-born: 6.6 hours, Foreign-born: 6.8 hours), Foreign-born adults were less likely to be short or long sleepers and less likely to report sleep difficulties. The data on the sleep of Foreign-born Black adults is limited and mixed. A previous study, which compared sleep duration between U.S. White and African/Caribbean healthcare workers, reported an average sleep duration measured by actigraphy of 6.3 hours among African/Caribbean immigrants (N=126).[43] In our study, which used self-reported sleep, and observed a slightly higher sleep duration average for Foreign-born Black adults. Studies comparing objective and subjective measured sleep duration have shown that self-report may be biased by systematic over-reporting,[60,61] which could explain why we observed a longer sleep duration. However, while the previous study identified African and Caribbean immigrants, in our study the

country of origin was not identified, and thus, our sample may reflect individuals from a different region and sleep profile. This is particularly important due to health differences among Black immigrants tied to country of origin which may affect sleep outcomes. Thus, future studies should consider country of origin.

In comparing our results to other national representative U.S. samples, we found a higher prevalence of short sleep duration among U.S.-born adults than Foreign-born adults. Cunningham et at. reported an age-adjusted short sleep (<7h) prevalence of 39.4% among Foreign-born adults (N=369) and 35.4% among U.S.-born adults (N=3,685) [28]; whereas in the current study we observed a higher proportion of short sleepers among U.S.-born adults (49.4%) than among Foreign-born adults (45.3%). However, it is important to note that the prevalence of short sleep for both groups were higher in the current study. Jackson and colleagues conducted a study using NHIS data from 2004-2011 and reported across occupation categories that Foreign-born Black adults reported a higher age-adjusted prevalence of short sleep (<7h) compared to U.S. Black adults.[46] The explicit inclusion of an all employed sample of adults in Jackson's et al. study may contribute towards the higher prevalence of short sleep comparing Foreign-born to U.S.-Born Black adults.[46] Specifically, Foreign-born Black adults may be working longer hours or hold multiple jobs in order to send financial support to relatives in their home countries.[46] Increased exposure to occupational-related stressors due to additional time spent working may result in a higher prevalence of short sleep for Foreign-born working individuals.

In the current study, U.S.-born Black adults were more likely to report sleep difficulties than their Foreign-born counterparts. This difference may be due to higher social support for Foreign-born individuals. Increased social support has been linked with less sleep disturbances and overall better sleep quality.[62,63] Due to cultural unfamiliarity, immigrant groups place

increased value on social networks and support groups,[64] which may translate to less disturbed sleep. This is consistent with a study by William's et al., which reported a higher odds of self-reported excessive daytime sleepiness among U.S.-born Black adults than Foreign-born Black adults.[47] Excessive daytime sleepiness is a likely consequence of sleep difficulties. Also, it may be likely that U.S.-born Black adults may have a higher prevalence of sleep difficulties due to a higher prevalence of sleep apnea, commonly associated with obesity.[47] While we did not assess sleep apnea, U.S.-born participants had a higher prevalence of obesity compared to Foreign-born, which may suggest more sleep apnea.

Overall, there was a high prevalence of short sleep duration and sleep difficulties in this sample. Although stress was not assessed, it is likely a contributor to the high prevalence of short sleep and sleep difficulties in this sample. Due to acute and chronic exposures to racial/ethnic discrimination rooted in anti-black sentiments and systemic racism,[65] Black adults are more susceptible to psychosocial stress than White, Asian, and Hispanic adults.[66] A cross sectional study among nearly 250 Black and White Registered Nurses (RNs), Licensed Practical Nurse (LPNs), and Certified Nursing Assistants (CNAs) across four nursing homes in Massachusetts found that 96% of the Black nurses were immigrants.[67] Black nurses were more likely to be employed as CNAs, which was classified as lower-skilled staff compared to RNs and LPNs, and more likely to report job strain, report low control over workplace decisions, and earn less than White counterparts.[67] Direct consequences of stress accumulation and anxiety may include sleep disturbances.[68] Furthermore, experiences from transitioning to the U.S. are added stressors experienced by Foreign-born adults and may contribute to poor sleep.[46] Sleep is not only reflective of overall well-being but lifestyle. While the Black community at large is susceptible to poor sleep, given the heterogeneity of Black Americans, this study illuminates the importance

of examining within race differences by nativity in which variations of cultural factors may drive sleep disparities.

As worsened CMB health continues to be a health burden among Black adults and contribute towards the development of more severe cardiovascular outcomes,[69] addressing modifiable risk factors, such as poor sleep, are necessary. In the current study, short sleep duration was associated with being overweight and obese among Black adults regardless of nativity. This association was consistent with the literature. A cross-sectional analysis with approximately 1,800 African Americans (≥18 years) observed that self-reported short sleep (≤ 6h) was associated with greater BMI.[70] An NHIS study using data from 1977-2009, reported that among approximately 32,000 Black adults (≥18 years), self-reported short sleep (5-6 h) was associated with a 16% increased likelihood of being overweight and 32% increased likelihood of being obese compared to Black adults reporting recommended sleep (7-8h).[71] In our study, short sleepers were 9% more likely to be overweight and 6% more likely to be obese. We also found that longer sleep duration, and unexpectedly long sleep were associated with lower prevalence of obesity. Longer sleep duration is better for health, and this finding was expected, but not the association with long sleep duration (sleeping >9 hours). The prior result was contrary to a NHIS study using data from 2005. Donat et al. reported that among approximately 4,400 Black adults (≥18 years), self-reported long sleep (vs. 7-8h) was associated with nearly 50% higher odds of obesity.[58] Our findings suggest that long sleep may not be associated with poor health in this study and may reflect recovery sleep.

The pathway between sleep duration and obesity has several proposed mechanisms. Sleep deprivation has been linked with upregulation of the activity of orexin neurons and changes in appetite-regulating hormones which affect food intake.[72] Ghrelin, a hormone promoting hunger

increases with sleep restriction, whereas leptin, a hormone contributing to satiety perception, decreases.[72] A small study of 44 African American and White adults found that African Americans, were more likely to eat more carbohydrates, soft-drinks and juices, and less protein after experimental sleep loss.[73] Short and long sleep also may affect energy balance leading to daytime sleepiness and fatigue.[72] Consequences of energy imbalance from lack of sleep include an increase in sedentary behaviors and a decrease both exercise and non-exercise energy expenditure.[72] Over 80% of our study sample were considered inactive, which may account for the high prevalence of adults with obesity and inadequate sleep duration. While we observed lower prevalence of obesity for an hour increase in sleep duration, because of consistent associations between short and long sleep with increased CMB outcomes, "extremes of sleep duration" may be a more useful designation of sleep-related predictors of CMB outcomes such as obesity.[74]

We found no association between self-reported sleep difficulties with prevalence of obesity or being overweight among the overall study sample, despite previous evidence of associations in other literature.[37] In their study consisting of Black (8.77%) and White (69.48%) adults, Grander et al. reported that self-reported sleep disturbance was associated with a 14% higher odds of obesity. Possible explanations for our study findings could be due to a underreporting of sleep difficulties, a frequent problem among U.S. adults.[75] Other studies that have examined sleep difficulties among Black adults reported that despite being less likely to report sleep complaints than White adults, objective measurements indicated worse sleep.[54] Future studies should explore objective measures of sleep difficulties with CMB health.

We observed no association between sleep duration and prevalence of hypertension; however, previous literature provides evidence of associations.[76-78] NHIS data from 2009

conducted among approximately 25,000 Black and White adults reported that self-reported short sleep (<6h) was associated with higher prevalence of hypertension compared to adults with the recommended sleep duration (6-8 h). [65] Another NHIS study among 71,400 adults showed a greater likelihood of hypertension among those self-reported <7 or ≥10 hours of sleep after adjusting for sociodemographic, behavior, and health characteristics.[77] A ten year (1982-1992) longitudinal analysis using the first NHANES survey observed greater risks of hypertension among adults who self-reported ≤ 5 hours of sleep.[78] Previous analyses investigating associations between sleep duration and hypertension consisted of a predominately White samples, whereas our study was exclusive to Black adults, who are known to have a greater risk of hypertension compared to White adults.[76] We also found that self-reported sleep difficulties were associated with higher prevalence of hypertension, however associations did not persist in fully adjusted models. Our results indicate that health factors may explain the association between sleep difficulties and hypertension. Given these findings, future analyses examining sleep difficulties and hypertension should explore possible mediators such as BMI.

Similar to our results regarding hypertension, there was no association between sleep duration and prevalence of diabetes among the overall study population. Analyses conducted among Black populations present mixed findings. A study using 2005 NHIS data, which assessed self-reported sleep duration and ethnicity, observed that among nearly 4,500 Black adults, short (<6h) and long (>8h) sleep duration was not associated with diabetes, after adjustment for BMI.[79] However, other studies have reported an association. A study using NHIS 2004 data reported that among approximately 24,400 Black adults found that short (<7h) or long (>7h) self-reported sleep duration was associated with diabetes.[80] A five year (1992/1994 – 1997/1999) longitudinal study conducted among participants from the Insulin Resistance

Atherosclerosis Study (IRAS) cohort reported that among almost 500 African Americans (aged 40-69), self-reported short sleep (≤7h) compared to recommended (8h) was associated with increased odds of type 2 diabetes.[81] Differences in the studies include that Foreign-born adults were excluded from the analysis.[80] Analogous to our results regarding hypertension, associations between sleep difficulties and higher prevalence of diabetes were attenuated after adjustment for health factors. Primarily, BMI has been demonstrated as a strong predictor of diabetes.[79] Individuals with inadequate or insufficient sleep have been linked with increased risk of diabetes likely because of the presence of obesity, which is a major risk factor for insulin resistance.[82] Approximately 75% of our sample were considered overweight or obese. With the rising proportion of obese Black adults in the U.S., studies examining BMI mediation between sleep and diabetes are necessary to understand the pathway between sleep and CMB health among the racial group.

Despite our hypothesis predicting more pronounced associations among U.S.-born participants, our findings indicate that associations between sleep duration or sleep difficulties and CMB risk factors varied by nativity with some associations being more pronounced among Foreign-born Black adults. Among Foreign-born Black adults, short sleep duration was generally associated with a higher prevalence of obesity, and longer sleep duration was associated with lower prevalence of hypertension, and CMB comorbidity. We expected diet to buffer association between short sleep and obesity among Foreign-born adults given the general diet differences between the two groups.[83] Black immigrants prefer eating traditional meals tied to region of origin in order to preserve cultural identity.[83] Studies comparing the nutritional value of foods consumed by African American and Haitian adults have observed a higher content of fruits, vegetables, and whole grains among the latter group.[83] Black immigrants also prefer to cook with

a variety of natural spices and herbs over salt. [83] In contrast, the western diet, and specifically African American cultural dishes, consist of more fried foods, processed meats, and sugars.[83] Foreign-born adults may be more vulnerable to stress-related weight gain from inadequate sleep than their native counterparts. There were no associations between sleep difficulties and CMB health among Foreign-born participants. It is possible that social support, although not measured in the current study, may explain this association. It is also important to note that increased consumption of unhealthier Western foods may have nullified the effect of social support on obesity alone.[84] Immigrants entering the U.S. prefer to live amongst members of the same ethnic community or with relatives for increased social support.[85] A greater percentage of Foreign-born Blacks reside in the northeast metropolitan areas, highly concentrated multiethnic regions, than U.S.-born Black adults.[86] U.S.-born Black adults are more likely to own homes and live in single family homes, whereas Foreign-born Black adults are more likely to report living multifamily housing.[86] Other immigrant studies have noted that Foreign-born adults prioritize residing with family members over neighborhood quality or space more than their native counterparts for increased financial and social support.[87] We would have expected crowded neighborhoods and suboptimal housing as indicators of sleep difficulties, however, social support may have a bigger impact than housing or environment in preventing sleep difficulties. Future studies should explore social support and other factors related to resilience.

Among U.S.-born Black adults long sleep was unexpectedly associated with lower prevalence of obesity, and sleep difficulties were associated with higher prevalence of hypertension and CMB comorbidity. In our study almost 9% of U.S.-born adults were long sleepers. Nine hours of sleep may occur for individuals recovering from sleep debt, and individuals with illnesses.[16] Our finding of an association between sleep difficulties and

hypertension was consistent with the literature. Previous studies have identified sleep maintenance difficulties as a risk factor for incident hypertension among White and African American adults.[88] Given the alarming high prevalence of hypertensive African Americans, our study highlights the importance of identifying and monitoring sleep difficulties as a preventive measure against hypertension particularly among U.S.-born Black adults. Possible presence of sleep apnea may account for the association between reported sleep difficulties and higher prevalence of hypertension and CMB comorbidity. Previous studies have reported a moderate or severe obstructive sleep apnea prevalence of 37.2% among African American adults, which 95% was undiagnosed.[89] Given that high BMI is both a predictor of both sleep apnea and hypertension,[89] this also would explain the increased prevalence of CMB comorbidity among U.S.-born adults.

Previous studies have found an increase in poor health outcomes among immigrants with longer durations in the U.S.[4] However, we observed that among Foreign-born adults who have resided in the U.S. less than 10 years, short sleepers were 75% more likely to be hypertensive compared to those who have been in the U.S. >10 years. Transitioning to the U.S. often involves sudden drastic lifestyle changes resulting in physical and mental health stressors.[84] These lifestyle changes often involve an increase of sedentary behaviors and consumption of fats and sugars.[84] However, stressors associated with cultural change such as language adaptation, social alienation, and traditional difference are considered to have a greater effect on poor health development than changes in diet or physical activity.[84] Newly migrated adults may be more susceptible to stress accumulation from cultural change than established immigrants; this is emphasized particularly by sudden cultural changes from rural to urban settings[84] and may amplify poor sleep—CMB associations. Similar to U.S.-born Black adults, Foreign-born Black

adults are subject to racial/ethnic discrimination which may be an especially traumatic experience for newer immigrants given most Foreign-born Black adults originate from countries where Black is the predominate race.[27,90] Documentation status and immigration policies are also important factors which may influence the lifestyle and health of Foreign-born adults. Recently migrated adults are more likely to be undocumented or granted temporary legal residence compared immigrants in the country for extended durations.[91] Due to fear of detection combined with racial/ethnic discrimination, undocumented minority immigrants are more likely to live in suboptimal housing, reside in high crime and underfunded neighborhoods, and less likely to be employed in professional or highly skilled positions, be homeowners, or have health insurance.[87,91] Limited opportunities for SES advancement tied to documentation status severely limits resources CMB health management. [93] Consequential short sleep from heightened psychosocial and financial stress due to more recent transitioning may be an important predictor of hypertension among newly immigrated Foreign-born Black adults. It is also possible that those in the country longer may generally have a greater command of English, live in more desirable residential settings, and hold higher positions in employment,[87] which may reflect an elevated SES status and may mitigate the association between short sleep and hypertension. Future analyses among Foreign-born Blacks should examine the sleep—CMB relation by different acculturation factors and SES.

Strengths of the study include having a nationally representative sample of Black adults over a ten-year period. NHANES is a standardized survey on a multitude of health issues, and results are generalizable and have a high level of validity.[92] As a continuous survey of random individuals across the U.S., selection bias is minimized.[92] We also assessed various measures of sleep including the presence of sleep difficulties which is less frequently presented in the

literature compared to sleep duration. Our study also accounted for Black nativity which is largely unaddressed in studies identifying risk factors for the improvement of Black health.

The current study also has several limitations. Being a cross-sectional analysis, we were not able to establish temporality between the different sleep and CMB risk factors which precludes making causal inferences. The majority of NHANES data were collected through interviews and questionnaires which may be subject to recall bias. Information on sleep duration and sleep difficulties were not validated with actigraphy or polysomnography. Subjective and objective sleep are found to have poor to moderate agreement and inclusion of subjective measures alone may introduce misclassification bias.[93,94] Sleep duration data referred to hours of weekday or workday night sleep, and we were not able to account for differences due to daytime naps or sleep duration on weekends or non-workdays. Presence of sleep difficulties was collected from the mental-depression screener and not validated for diagnosing sleep disorders. We were not able to distinguish specific sleep disorders such as sleep apnea or insomnia due to unavailability of consistent data on sleep disorders. Our study also only included participants who self-identified as Non-Hispanic Black. Mixed race or other Black ethnic groups may have been excluded from the analysis. Among Foreign-born adults, we did not have specific information on country/region of origin and therefore were not able to specify participant ethnicity. We also did not have information on documentation status among non-U.S. citizens. We did not have a sufficient sample size of Foreign-born adults to stratify into smaller categories for length of U.S. residence. Although our study included information on depression, the analysis lacked data regarding stress and anxiety which are known markers for psychosocial outcomes and discrimination.[95] Lastly, our findings are based on a sample of Black adults in the U.S. and may not be generalizable to other populations.

In conclusion, the study findings demonstrated that self-reported sleep duration was associated with being overweight and obese among Black adults overall. Associations between sleep difficulties on hypertension and diabetes were attenuated with adjustment for BMI. Therefore, BMI and other health related factors may be mediators in the pathway between sleep difficulties with hypertension and diabetes; future mediation analyses should test these associations. Generally, Foreign-born adults exhibited better sleep with a longer average sleep duration, lower prevalence of adults with extreme sleep durations, and less sleep difficulties. However, short sleep duration was common in both groups, but there could be factors contributing to a lower prevalence among Foreign-born. Sleep duration was associated with hypertension and CMB comorbidity among Foreign-born, while sleep difficulties was associated with hypertension and CMB comorbidity among U.S. born. Future studies should examine the role of social support and stress in these associations. There is a need for longitudinal studies using objective sleep also in order to evaluate proposed mechanisms for the effect of various sleep measures on CMB health among Black adults. Our study highlights the importance of exploring within group differences in order to better understand the health of Black populations, a heterogenous group. Our findings support that sleep and the sleep—CMB relation varied by nativity. As Black adults in the U.S. continue to grow, a one-size fits all approach is not the most appropriate method to implement health interventions amongst a whole racial demographic. For example, increased testing for sleep disturbances, mainly sleep apnea, may be more effective for U.S.-born adults, whereas improved educational programs towards cultural sensitivity or expanded health insurance policies for non-permanent residents may be advantageous for Foreign-born adults. In conclusion, short sleep and sleep difficulties were common and

associated with CMB health among Black adults in the U.S., which underscores the importance of designing culturally relevant interventions.

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Table 1. Sociodemographic and health characteristics of participants in the National Health and Nutrition Examination Survey 2005-2016 in US among Black Adults by Nativity Status (N = 5589)

Characteristic †	Total Sample N (%)	US-born N=4843 N (%)	Foreign-born N= 592 N (%)
Age (years) ‡	44.1 (0.3)	44.1 (0.4)	43.9 (1.0)
Men	2744 (45.7)	2410 (45.0)	334 (51.8)
Education			
< High school	1262 (20.4)	1138 (20.8)	124 (17.2)
High school graduate	1455 (25.8)	1345 (26.8)	110 (17.6)
Some college	1891 (35.5)	1674 (35.3)	217 (37.3)
≥ College graduate	979 (18.3)	816 (17.1)	163 (27.9)
Marital Status			
Married or living with partner	2526 (44.3)	2182 (43.0)	344 (54.5)
Widowed	419 (5.6)	388 (5.9)	31 (3.6)
Divorced or separated	1001 (17.0)	903 (17.2)	98 (15.2)
Never married	1638 (33.2)	1496 (34.0)	142 (26.7)
Unemployed	2333 (36.5)	2135 (37.6)	203 (27.6)
Annual household income (< $35,000 per year)	2283 (42.5)	2081 (43.6)	203 (33.3)
Below poverty line	1657 (29.8)	1494 (30.3)	163 (26.4)
Length of time in United States (years)			
<10	-	-	181 (34.4)
≥10	-	-	427 (65.6)
U.S. citizenship	-	-	384 (59.6)
Health insurance coverage	4345 (75.3)	3903 (76.0)	442 (69.9)
Smoking status			
Never	3203 (60.3)	2729 (58.1)	474 (78.2)
Former	9956 (14.5)	917 (15.0)	79 (10.8)
Current	1383 (25.2)	1323 (27.0)	60 (11.0)
Alcohol consumption			
Never	1872 (33.5)	1599 (32.1)	272 (44.6)
Former	583 (8.2)	535 (8.4)	47 (6.5)
Current	3127 (58.3)	2832 (59.4)	294 (48.9)
Physical Activity			
Active	932 (17.6)	841 (17.8)	91 (16.2)
Inactive	4657 (82.4)	4133 (82.2)	524 (83.8)
Health Status			
Excellent/ very good	1842 (34.1)	1573 (32.7)	269 (45.3)
Good/fair	2420 (43.4)	2160 (43.5)	260 (42.8)
Poor	1326 (22.5)	1241 (23.8)	85 (12.0)

† Percentage may not sum to 100 due to missing values
‡ Data presented as mean (standard deviation)

Table 1. *Cont.*

Characteristic †	Total Sample N (%)	US-born N=4843 N (%)	Foreign-born N= 592 N (%)
Diet Status			
Excellent/ very good	1463 (24.5)	1223 (22.8)	240 (38.6)
Good/fair	2268 (40.2)	1994 (39.8)	274 (43.6)
Poor	1857 (35.2)	1756 (37.4)	101 (17.8)
Depression	584 (10.5)	525 (10.7)	59 (9.1)
Sleep duration (hours)‡	6.7 (0.03)	6.6 (0.04)	6.8 (0.1)
< 7h	2709 (49.0)	2431 (49.4)	278 (45.3)
7h to 8h	2386 (42.3)	2096 (41.7)	290 (46.6)
≥ 9 h	494 (8.8)	447 (8.9)	47 (8.0)
Trouble Sleeping or sleeping too much			
Not at all	3726 (65.1)	3255 (63.8)	471 (75.8)
Several days	1046 (19.8)	953 (20.2)	93 (15.8)
More than half the days	374 (7.0)	353 (7.4)	21 (3.4)
Nearly every day	443 (8.2)	413 (8.5)	30 (5.1)
Body mass index (kg/m^2) ‡	30.6 (0.1)	31.0 (0.1)	27.9 (0.3)
Under/Normal weight	1417 (25.1)	1222 (24.2)	195 (32.1)
Overweight	1619 (28.6)	1387 (27.4)	232 (38.1)
Obese	2553 (46.4)	2365 (48.4)	188 (29.8)
Hypertension	3367 (55.3)	3050 (56.4)	317 (46.5)
Diabetes	1063 (15.7)	951 (15.9)	112 (14.3)
CMB Comorbidity			
No condition(s)	1353 (27.5)	1138 (26.0)	215 (39.6)
1 condition(s)	2081 (36.5)	1855 (36.6)	226 (35.6)
2 condition(s)	1562 (27.2)	1432 (28.2)	130 (19.2)
3 condition(s)	593 (8.8)	549 (9.2)	44 (5.5)

† Percentage may not sum to 100 due to missing values

‡ Data presented as mean (standard deviation)

Table 2. Prevalence Ratios for Cardiometabolic Risk Factors by Sleep Duration and Sleep Difficulties among Black Adults: National Health and Nutrition Examination Survey (2005-2016) (N =5589)

	Model 1				Model 2			
Sleep Variables	Overweight vs. Normal/Under weight (PR, 95% Cl)	Obese vs. Normal/Under weight (PR, 95% Cl)	Hypertension (PR, 95% CI)	Diabetes (PR, 95% CI)	Overweight vs. Normal/Under weight (PR, 95% Cl)	Obese vs. Normal/Under weight (PR, 95% Cl)	Hypertension† (PR, 95% CI)	Diabetes† (PR, 95% CI)
Sleep duration (continuous)	0.98 (0.95 1.00)	**0.96 (0.95, 0.97)**	0.98 (0.97, 1.00)	0.97 (0.94, 1.00)	0.98 (0.96, 1.00)	**0.97 (0.96, 0.99)**	0.99 (0.98, 1.01)	0.99 (0.96, 1.02)
Short sleep vs. recommended	**1.10 (1.05, 1.18)**	**1.09 (1.05, 1.14)**	1.05 (1.00, 1.10)	1.11 (0.98, 1.26)	**1.09 (1.03, 1.16)**	**1.06 (1.01, 1.10)**	1.02 (0.97, 1.07)	1.03 (0.91, 1.16)
Long sleep vs. recommended	0.91 (0.78, 1.07)	**0.86 (0.79, 0.95)**	1.03 (0.96, 1.12)	1.10 (0.93, 1.29)	0.91 (0.78, 1.07)	**0.87 (0.80, 0.95)**	1.05 (0.97, 1.13)	1.11 (0.95, 1.29)
Trouble Sleeping or sleeping too much								
Several days vs. None	1.05 (0.96, 1.15)	1.06 (1.00, 1.13)	**1.12 (1.05, 1.18)**	**1.20 (1.02, 1.40)**	1.03 (0.94, 1.13)	1.01 (0.95, 1.08)	1.06 (1.00, 1.13)	1.05 (0.89, 1.24)
More than half the days vs. None	0.88 (0.73, 1.06)	1.04 (0.94, 1.15)	**1.14 (1.04, 1.24)**	1.20 (0.92, 1.57)	0.84 (0.70, 1.02)	0.98 (0.89, 1.08)	1.06 (0.97, 1.15)	1.00 (0.79, 1.27)
Nearly every day vs. None	1.01 (0.89, 1.13)	1.07 (0.99, 1.16)	**1.14 (1.05, 1.24)**	**1.43 (1.14, 1.80)**	0.96 (0.85, 1.09)	0.98 (0.90, 1.07)	1.06 (0.97, 1.16)	1.18 (0.95, 1.47)

PR = Prevalence Ratio; CI = Confidence Interval; Model 1 adjusted for age, gender, education, marital status, employment, income, poverty, nativity, and health insurance; Model 2 was obtained from previously listed covariates and also smoking status, physical activity, health status, diet, and depression

†Also adjusted for body mass index; Boldface indicates statistically significant results at the 0.05 level

Table 3. Prevalence Ratios for Cardiometabolic Risk Factors by Sleep Duration and Sleep Duration among Black Adults by Nativity Status: National Health and Nutrition Examination Survey (2005-2016) (N = 5589)

	U.S.-born				**Foreign-born**			
	Model 1							
Sleep Variables	Overweight vs. Under/Normal weight (PR, 95% Cl)	Obese vs. Under/ Normal weight (PR, 95% Cl)	Hypertension (PR, 95% CI)	Diabetes (PR, 95% CI)	Overweight vs. Under/Normal weight (PR, 95% Cl)	Obese vs. Under/ Normal weight (PR, 95% Cl)	Hypertension (PR, 95% CI)	Diabetes (PR, 95% CI)
Sleep duration (continuous)	0.98 (0.96, 1.00)	**0.97 (0.95, 0.98)**	0.99 (0.97, 1.00)	0.98 (0.94, 1.01)	0.97 (0.91, 1.03)	**0.89 (0.82, 0.96)**	**0.94 (0.89, 0.99)**	0.91 (0.80, 1.05)
Short sleep vs. recommended	**1.08 (1.01, 1.17)**	**1.07 (1.03, 1.12)**	1.04 (0.99, 1.09)	1.09 (0.96, 1.23)	1.15 (0.92, 1.42)	**1.31 (1.04, 1.66)**	1.19 (0.98, 1.44)	1.27 (0.89, 1.80)
Long sleep vs. recommended	0.87 (0.74, 1.04)	**0.87 (0.79, 0.96)**	1.04 (0.97, 1.13)	1.13 (0.95, 1.34)	1.32 (0.94, 1.86)	0.85 (0.45, 1.59)	0.84 (0.57, 1.25)	0.59 (0.24, 1.44)
Trouble Sleeping or sleeping too much								
Several days vs. None	1.03 (0.93, 1.14)	1.06 (1.00, 1.12)	**1.13 (1.07, 1.20)**	**1.20 (1.02, 1.41)**	1.18 (0.91, 1.51)	1.02 (0.75, 1.40)	0.88 (0.68, 1.13)	0.98 (0.50, 1.90)
More than half the days vs. None	0.85 (0.69, 1.04)	1.03 (0.93, 1.14)	**1.15 (1.06, 1.26)**	1.16 (0.89, 1.51)	1.44 (0.83, 2.50)	1.37 (0.83, 2.28)	0.78 (0.45, 1.35)	1.70 (0.69, 4.15)
Nearly every day vs. None	0.98 (0.86, 1.11)	1.06 (0.98, 1.16)	**1.15 (1.06, 1.26)**	**1.43 (1.12, 1.81)**	1.27 (0.86, 1.87)	1.18 (0.79, 1.76)	0.80 (0.50, 1.30)	1.03 (0.38, 2.78)
	Model 2							
Sleep Variables	Overweight vs. Under/Normal weight (PR, 95% Cl)	Obese vs. Under/ Normal weight (PR, 95% Cl)	Hypertension† (PR, 95% CI)	Diabetes† (PR, 95% CI)	Overweight vs. Under/Normal weight (PR, 95% Cl)	Obese vs. Under/ Normal weight (PR, 95% Cl)	Hypertension† (PR, 95% CI)	Diabetes† (PR, 95% CI)
Sleep duration (continuous)	0.98 (0.96, 1.01)	**0.98 (0.96, 0.99)**	1.00 (0.98, 1.01)	1.00 (0.96, 1.03)	0.97 (0.92, 1.03)	**0.89 (0.82, 0.96)**	**0.94 (0.89, 0.99)**	0.94 (0.83, 1.06)
Short sleep vs. recommended	1.07 (1.00, 1.15)	1.04 (0.99, 1.08)	1.01 (0.96, 1.06)	1.02 (0.90, 1.15)	1.12 (0.90, 1.39)	**1.30 (1.04, 1.63)**	1.15 (0.95, 1.39)	1.12 (0.78, 1.61)
Long sleep vs. recommended	0.88 (0.74, 1.04)	**0.88 (0.80, 0.97)**	1.07 (0.99, 1.15)	1.16 (0.99, 1.36)	1.29 (0.92, 1.81)	0.83 (0.46, 1.49)	0.79 (0.53, 1.17)	0.52 (0.21, 1.30)
Trouble Sleeping or sleeping too much								
Several days vs. None	1.01 (0.91, 1.12)	1.01 (0.95. 1.08)	**1.07 (1.01, 1.14)**	1.04 (0.88, 1.22)	1.18 (0.91, 1.62)	1.06 (0.79, 1.43)	0.89 (0.69, 1.15)	1.08 (0.56, 2.08)
More than half the days vs. None	0.82 (0.68, 1.00)	0.97 (0.88, 1.06)	1.07 (0.98, 1.16)	0.96 (0.76, 1.22)	1.40 (0.81, 2.44)	1.40 (0.86, 2.26)	0.80 (0.46, 1.40)	1.75 (0.75, 4.09)
Nearly every day vs. None	0.94 (0.82, 1.07)	0.97 (0.89, 1.06)	1.07 (0.98, 1.17)	1.17 (0.93, 1.46)	1.31 (0.89, 1.94)	1.27 (0.88, 1.84)	0.88 (0.56, 1.38)	1.18 (0.44, 3.21)

PR = Prevalence Ratio; CI = Confidence Interval; Model 1 adjusted for age, gender, education, marital status, employment, income, poverty, nativity, and health insurance; Model 2 was obtained from previously listed covariates and also smoking status, physical activity, health status, diet, and depression

†Also adjusted for body mass index; Boldface indicates statistically significant results at the 0.05 level

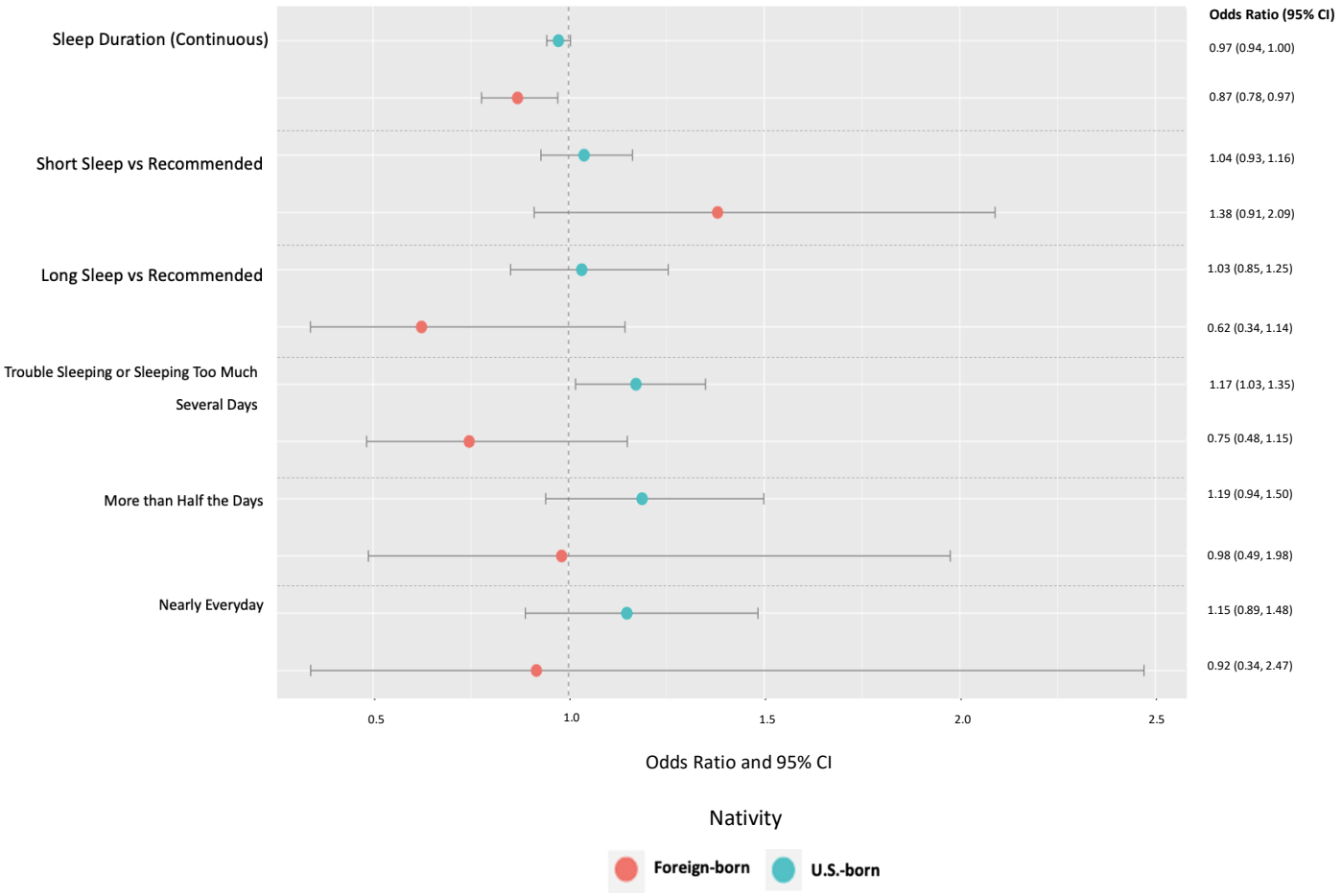

Figure 1. Fully Adjusted Odds Ratios for Self-Reported Sleep Duration and Self-Reported Sleep Difficulties with CMB Comorbidity among Black Adults by Nativity

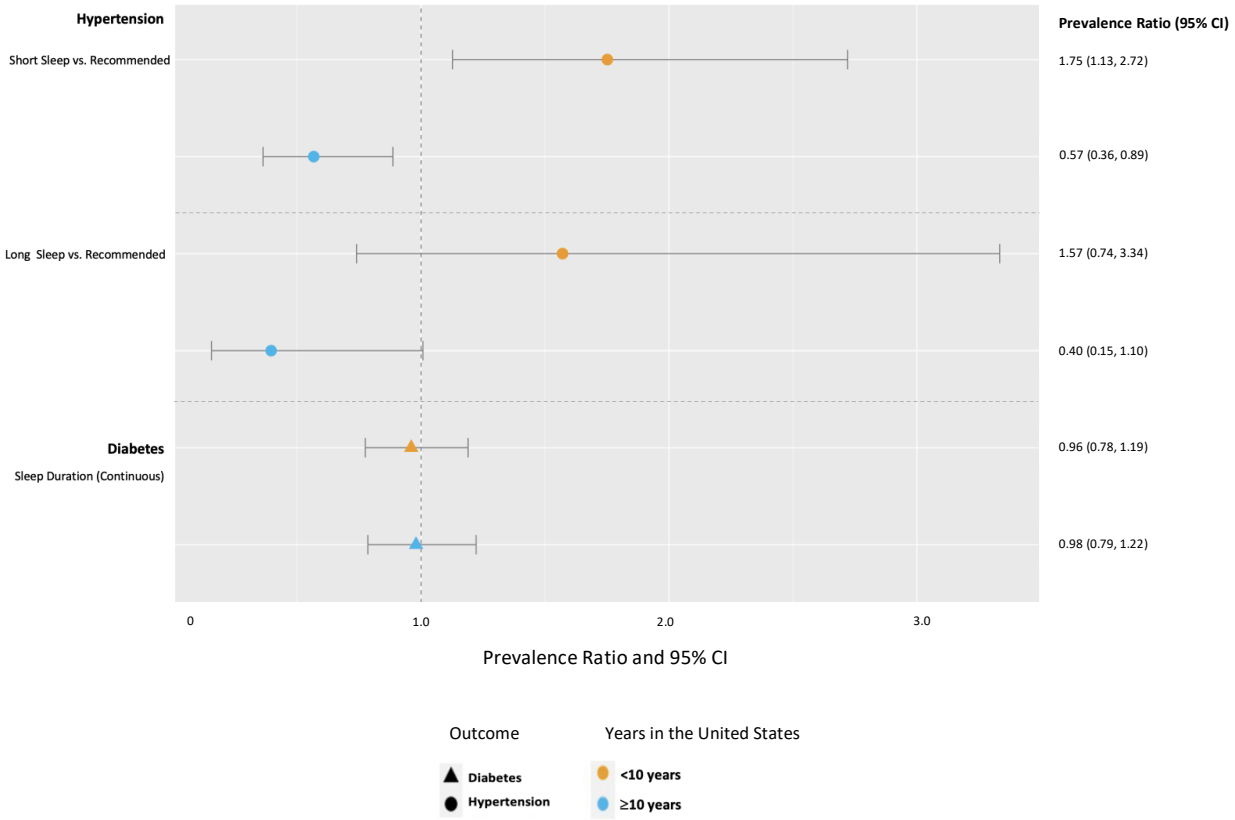

Figure 2. Fully Adjusted Prevalence Ratios for Self-Reported Sleep Duration with Hypertension and Diabetes among Foreign-born Black Adults by Length of Residence in the United States