The association of sexual orientation with allostatic load and cardiovascular health: An analysis of the National Health and Nutrition Examination Survey (NHANES)

Elaine Louden, Honors Undergraduate Student

The Ohio State University
College of Public Health
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Advisor: Dr. Shawnita Sealy-Jefferson, PhD
Second Reader: Dr. Claire Kamp-Dush, PhD
Committee Member: Dr. Ashley Felix, PhD

ABSTRACT

Background: Cardiovascular disease (CVD) is an important health problem among sexual minorities given increased stress, according to minority stress theory. Allostatic load (AL), a measure of chronic wear and tear on the body's systems physiological regulation, may be higher among sexual minorities, who also exhibit increased risk factors for cardiovascular disease. We examined the relationship between AL and cardiovascular health (CVH) according to sexual orientation.

Methods: We used data from the National Health and Nutrition Examination Survey (NHANES) 2001-2008 cycles to examine the relationship between sexual orientation, AL, and CVH. We categorized participants as straight/heterosexual, gay/lesbian, bisexual, or homosexually experienced, according to their sexual orientation. AL was defined based on ten biomarkers and CVH was quantified using the American Heart Association's (AHA) Life's Simple 7 ideal health score in addition to the use of self-reported medical diagnoses. Logistic regressions were used to estimate odds ratios and 95% CIs for associations between sexual orientation and AL, CVH, and self-reported CVD.

Results: Sexual orientation was not associated with AL or self-reported CVD among the population included in the analysis but was significantly associated with worse American Heart Association Simple 7 CVH scores among sexual minority females.

Conclusion: Sexual minority females have elevated CVD risk factors, yet do not have increased rates of CVD diagnoses, which is not fully understood. The findings indicate the importance of continued research of health behaviors, biomarkers, and sociocultural stressors among sexual minority individuals. More research is needed to fully illuminate the mechanism between sexual minority status and the development of chronic disease.

Keywords: allostatic load, cardiovascular health, sexual orientation, NHANES

INTRODUCTION

Cardiovascular disease (CVD) is the single largest cause of death in the United States, and there are many potential social mechanisms by which this disease may present itself. Sexual and gender minority discrimination may play a key part, according to the minority stress theory [1]. An expanding body of research points to the role of stress and allostatic load (AL) in the etiology of chronic health problems such as CVD. AL refers to the chronic imbalance and possible degradation of the proper function of multiple body systems, including the sympathetic nervous system, the HPA axis, and the immune system, which can be measured through a range of biomarkers [2,3]. Those who experience social stigma and discrimination due to race, ethnicity, sexual orientation, among many other factors may exhibit increased physiological stress responses and allostatic imbalance, which are detrimental to their physical health [3].

Adverse social experiences as well as internalized biases that arouse minority group-related stress are linked to health disparities across multiple contexts [1,3]. Sexual minority status is hypothesized to increase stress due to discrimination, which leads to AL, and is associated with increased rates of both risk factors and diagnoses for CVD. Few studies have examined AL among sexual minority populations. Mays, et al. found that AL did not differ between sexual minorities and heterosexual women; gay men were found to have lower AL compared to heterosexual men, and bisexual men were found to experience lower amounts of allostatic load as compared to heterosexual men [4]. Sexual minorities experience increased risk factors for cardiovascular disease, including higher rates of dieting and eating problems, general health problems, mental distress, depression, smoking, and heavy drinking [5,6]. Lesbian and bisexual women are also more likely to report a family history of CVD, be overweight or obese, receive a CVD diagnosis, and have greater abdominal/visceral adiposity when being compared to heterosexual women [5,7-9]. Despite multiple recorded instances of increased CVD risk factors among sexual minorities, there is conflicting evidence that these increased risk factors lead to increased cardiovascular disease diagnoses among both male and female sexes [10,11].

This study aims to incorporate analyses of AL and CVH in order to attempt to explain the effects of sexual minority status and minority stress on health outcomes related to CVD. We examine the potential impacts that sexual orientation may have on AL, CVH, and self-reported diagnoses of CVD. Analyzing this association may provide important insights into how sexual orientation affects allostasis and leads to chronic dysregulation of human body systems. It will evaluate how cardiovascular outcomes, including CVH, AL, and self-reported CVD may be impacted by sexual orientation. We hypothesize that sexual minority individuals will have higher AL scores than straight/heterosexual participants. In addition, we hypothesize that higher AL scores may be indicative of increased diagnoses of CVD conditions and worse CVH scores among both sexual minorities and straight/heterosexual participants.

METHODS

Data Source and Sample

A secondary analysis was performed using publicly available data from the continuous 2001-2008 National Health and Nutrition Examination Survey (NHANES). The data source only asked participants aged 20-59 about their sexuality in the NHANES questionnaire, thus only including participants of this age group in our analysis. N=293 were excluded from the original NHANES survey group based on age. N=737 number of females were excluded from the analysis due to a current pregnancy, which likely will have altered their AL biomarkers. From the sample, we also excluded those who did not have their blood drawn at the time of their NHANES interviews (n=8,737), those who were not measured for height, weight, blood pressure (n=2,185), as well as those who deny any sexual activity and also do not report sexual orientation (n=19,931). We controlled for survey cycle and used survey weighted procedures to perform our statistical analysis on a sample size of 9,775.

Sexual Orientation

We used two types of data to construct the variable of sexual orientation: self-reported sexual identity and sexual behavior. Sexual orientation was categorized as: (1) those who reported lesbian or gay sexual orientation regardless of past sex partners ("gay/lesbian", n=168), (2) those who reported bisexual orientation regardless of past sex partners ("bisexual," n=205), (3) those who indicated lifetime histories of same-sex sexual partners who did not identify as lesbian, gay, or bisexual ("homosexually experienced", n=301), and (4) those who were identified as exclusively heterosexual/straight, or those who reported no same-sex sexual activity or a lesbian, gay, or bisexual orientation ("heterosexual/straight" n=9,101). We structured our categories of sexual orientation similarly to Mays et al. [4] and stratified each analysis by sex in order to examine potential differences between the male and female sexes. The NHANES questionnaire does not collect data on transgender participants, thus the categories used in our analysis correspond to sex, as opposed to gender.

Cardiovascular Health

We used the American Heart Association's (AHA) "Simple 7", a composite measure of seven health behaviors and health factors, in order to quantify cardiovascular health. This scale includes four health behaviors: (1) smoking status, (2) BMI measured in kg/m^2, (3) physical activity, (4) healthy diet score, and three health factors: (5) total cholesterol, (6) blood pressure, both systolic and diastolic, and (7) fasting plasma glucose [12]. The AHA provides guidelines that serve as cutoffs for these variables to be quantified into three levels: (1) poor health, (2) intermediate health, and (3) ideal health. Poor health was assigned a score of 0, intermediate health was assigned a score of 1, and ideal health was assigned a score of 2. CVH scores were assigned to participants who had not previously received a cardiovascular disease diagnosis (n=6,768) and values from each health factor were added up and quantified on a scale of 0-14. Inadequate CVH scores were considered a 0-4, Average CVH scores were numbered 5-9, and Optimum CVH scores were numbered 10-14.

In order to account for those who have already received a diagnosis of cardiovascular disease, we included self-reported diagnoses of cardiovascular conditions, where participants self-identified being diagnosed by a medical professional with coronary heart disease (n=128), angina (n=125), myocardial infarction (n=151), heart failure (n=113), and stroke (n=130).

Allostatic Load

Calculations for AL were modeled off of a similar analysis performed by Mays, et al. [4], which used nine commonly measured biomarkers to calculate an allostatic load score among different sexual orientations in NHANES. However, NHANES has been utilized to calculate AL scores in at least 21 distinct ways [13]. We used the nine biomarkers used by Mays, et al. and added one additional biomarker, creatinine clearance, which was one of the most common metabolic biomarkers used in the calculation of AL in the systematic review presented by Duong, et al.[13]. The ten biomarkers from NHANES were consistent across the four survey cycles of interest. They represent different aspects of biological allostasis and physiological functioning, including cardiovascular (systolic, diastolic blood pressure, resting heart rate), metabolic (glycosylated hemoglobin, BMI, total cholesterol, high density lipoprotein cholesterol, creatinine clearance) and immune system (serum albumin, C-reactive protein) functioning. These scores were coded as a binary variable according to their clinical cutoffs [4].

Those who had healthier measurements than the clinical cutoff received a 0, and those who had measurements less healthy than the clinical cutoff received a 1. The numbers were then added up to an index from 0-10 with a 0 indicating that a participant had all healthy/desirable allostatic load indicators and a 10 indicating all unhealthy/undesirable allostatic load indicators. Participant blood pressure was measured 3-4 times during the NHANES data collection, and an average of all readings was taken for our analysis. C-reactive protein and cholesterol were also averaged for 2001-2002 cycle as they were measured twice; in subsequent cycles they were only measured once, and the calculation was unnecessary.

Estimated creatinine clearance was calculated using serum creatinine data. If participants identified receiving prescribed medication including blood pressure medication for high blood pressure, cholesterol lowering drugs for high cholesterol, and insulin/other diabetes medications for those with diabetes, they automatically received a positive score of 1 for systolic/diastolic blood pressure, total cholesterol, and glycosylated hemoglobin for their AL score, respectively.

Health Indicators

We included various other health indicators in our analysis that may be significant to the association between sexual orientation, CVH, and AL. This includes: mental distress (categorized into a binary yes and no), illegal drug usage (categorized into a binary yes and no), health insurance (categorized into a binary yes and no), binge drinking (categorized into a binary yes and no), HIV status (categorized into a binary of positive and negative status), and self-rated general health (categorized into “excellent”, “very good”, “good”, “fair”, or “poor”). The categories “fair” and “poor” were combined in the data cleaning step of our analysis of self-rated general health according to sexual orientation. Binge drinking was defined as having gone through a period of one’s life in which participants drank five or more drinks per day. The definition for female binge drinking was lowered to four instead of five drinks for the latter two survey cycles.

Demographics

We considered age (categorized into “20-29”, “30-39”, “40-49”, and “50-59”), educational attainment (categorized into “less than high school”, “high school graduate”, “some college”, and “college graduate or greater”), race/ethnicity (categorized into “non-Hispanic white”, “non-Hispanic black”, “Hispanic”, and “non-Hispanic other or multiracial”), foreign birth status (categorized into “foreign born”, “not foreign born”, and “unknown birth status”), and family income in relation to the federal poverty line (FPL) (categorized into “less than 138% of the

FPL", "138-250% of the FPL", "250-400% of the FPL", and "greater than 400% of the FPL") as demographic variables relevant to our analysis. We performed moderation analyses on these variables if they had large enough numbers to be statistically significant, and placed an emphasis on race/ethnicity.

Statistical analysis

Data analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC). All analyses applied sample weights to account for the complex sample design. We compared demographic factors, AL, cardiovascular ideal health, and self-reported cardiovascular disease diagnoses according to sexual orientation with the use of a Rao Scott Chi Square analysis. Logistic regression was used to estimate odds ratios and 95% CIs for associations between sexual orientation and AL, CVH, and self-reported CVD diagnoses. We controlled for survey weighting, stratification, and clustering with the use of SAS survey procedures.

RESULTS

Table 1 shows distributions of participant characteristics according to sexual orientation. For the male sex, the variables family income and HIV status were statistically associated with sexual orientation. Gay males were more likely to be in the highest family income bracket, greater than 400% of the Federal Poverty Line; 63.1% of gay males belonged to this category, in comparison to only 24.3% of bisexual males. 40.4% of homosexually experienced males, and 42.7% of heterosexual/straight males. Gay males were more likely to have tested positive for HIV, with 13.1% of gay males having a positive HIV status, as compared to 4.8% of bisexual males, 0.6% of homosexually experienced males, and 0.1% of heterosexual/straight males.

For the female sex in Table 1, the variables age, race/ethnicity, foreign birth, and binge drinking were statistically associated with sexual orientation. Younger females were more likely to belong to a sexual minority group in comparison to older females. Among those who were

gay/lesbian, 26.6% were between the ages 20-29, compared to 39.0% of bisexual females, 26.9% homosexually experienced females, and 20.3% heterosexual/straight females. Race/ethnicity seemed to follow a fairly even pattern across different sexual identities for the female sex, with the exception of non-Hispanic Blacks (NHB). Of all females who were as gay/lesbian, 11.1% were NHB, compared to 7.1% of bisexual females, 6.3% of homosexually experienced females, and 12.5% heterosexual/straight females. Foreign birth status was also found to be associated with sexual orientation among the female sex subgroup with 5.8% gay/lesbian females being foreign born as compared to 1.1% bisexual females, 6.8% homosexually experienced females, and 9.4% heterosexual/straight females. Moreover, 71.6% of gay/lesbian females were born in the United States, in comparison to 63.8% of bisexual females, 62.0% of homosexually experienced females, and 65.1% of heterosexual/straight females, indicating that lesbian/gay females were more likely to be born in the United States as opposed to out of the country. Sexual minority females were found to be more likely to binge drink with 20.9% of gay females saying yes to ever having gone through a period of time in which they consumed five (or four, depending on the survey cycle) or more drinks per day. 23.1% of bisexual females went through a time in which they binge drank daily, compared to 32.3% of homosexually experienced females and only 15.3% of heterosexual/straight females.

Table 2 shows the analysis of health outcomes according to sexual orientation for both male and female sex participants. For male sex participants, sexual orientation was significantly associated with the AHA Life's Simple 7 variable physical activity. Among male participants, 82.0% of gay males had intermediate or ideal levels of physical activity compared to 66.6% of bisexual males, 70.4% of homosexually experienced males, and 68.9% of heterosexual/straight males. Gay males had higher levels of physical activity than all other sexual identities and bisexual males had, on average, lower levels of physical activity. For males, the allostatic load variables glycosylated hemoglobin, total cholesterol, and systolic blood pressure were also significantly associated with sexual orientation. Among gay males, 99.3% had healthy values for

glycosylated hemoglobin, which was found to be significantly higher as compared to 85.3% of bisexual males, 94.6% of homosexually experienced males, and 94.9% of heterosexual/straight males. Total cholesterol also was found to be significantly different among different male sexual orientations. Among gay males, 79.6% had healthy total cholesterol values, compared to 80.1% of bisexual males, 64.8% of homosexually experienced males, and 77.5% of heterosexual/straight males. Gay males, in addition to having healthier values of glycosylated hemoglobin, also had healthier values (91.0%) for systolic blood pressure as compared to 70.4% of bisexual males, 80.9% of homosexually experienced males, and 82.5% of heterosexual/straight males. Bisexual males had the lowest percentage of healthy allostatic load biomarker levels for both systolic blood pressure and glycosylated hemoglobin. There was not sufficient data to calculate p-values for self-reported CVD diagnoses among the male sex.

For females, the AHA Life's Simple 7 variables of smoking status and BMI were significantly associated with sexual orientation. Sexual minority females had a smaller percentage of ideal smoking behaviors; 59.8% of lesbian females, 51.8% of bisexual females; 49.7% of homosexually experienced females, and 73.1% of heterosexual/straight females were categorized into the ideal smoking behaviors. Lesbian females also tended to have less healthy BMI's, with 36.4% of lesbian females, 42.6% of bisexual females, 42.9% of homosexually experienced females, and 40.4% of heterosexual/straight females having ideal values for BMI. The allostatic load biomarker variables HDL cholesterol, diastolic blood pressure, and systolic blood pressure were significantly associated for females as well. Bisexual and homosexually experienced females had worse values for HDL cholesterol with 24.5% and 31.4% having healthy values, respectively, in comparison to 45.1% of lesbian females and 44.9% of straight/heterosexual females. Heterosexual/straight females had worse values, on average for both diastolic blood pressure and systolic blood pressure. 83.8% of heterosexual/straight females had healthy values for diastolic blood pressure compared to 88.8% of lesbian females, 94.2% of bisexual females, and 86.1% of homosexually experienced females. Similarly, 81.4%

of heterosexual/straight females had healthy values for systolic blood pressure, compared to 85.8% of lesbian females, 90.3% of bisexual females, and 86.4% of homosexually experienced females. No p-values were able to be calculated for cardiovascular disease diagnosis outcomes due to limited numbers of females diagnosed with the disease, likely attributable to the young age of the population (ages 20-59) included in the analysis. Male CVH scores had a maximum of 12 and a minimum of 0. Female CVH scores had a maximum of 13 and a minimum of 0.

Tables 3-5:

Significant demographic variables from Table 1 were analyzed to determine potential confounder variables that might affect the association between sexual orientation and CVH-related outcomes. For the AHA's Life's Simple 7, confounder variables that were found to be significant for males were income, and for females, the variables age, race/ethnicity, and foreign birth status were also significant. In the logistic regression model for males, family income was found to have a significant effect on the AHA's Life's Simple 7 scores, but sexual orientation was not associated. Males with lower family income values, in relation to the FPL, were more likely to have inadequate or average Life's Simple 7 scores, rather than optimal scores, in comparison to the reference group of males with family incomes greater than 400% of the FPL. In comparison to the reference group, males whose family income was less than 138% of the FPL had an OR of 3.46 (95% CI; 1.79-6.70) for inadequate CVH scores and an OR of 1.59 (95% CI; 1.22-2.08) for average CVH. Males with family income values between 138% and 250% of the FPL had OR values of 1.44 (95% CI; 0.74-2.83) and 1.24 (95% CI; 0.97-1.60) for inadequate and average CVH scores, respectively, and males with family income values between 250% and 400% of the FPL had OR values of 2.96 (95% CI; 1.47-5.98) and 1.33 (95% CI; 1.06-1.67) for inadequate and average CVH scores, respectively, when compared to the reference group.

Among the female sex, sexual orientation, age, and race/ethnicity were found to significantly affect Life's Simple 7 CVH scores. Lesbian, bisexual and homosexually

experienced females were more likely to have worse CVH scores in comparison to the straight/heterosexual reference group, indicating that some sexual minority females are at higher risk for CVD. There was not enough data to derive an OR for lesbian females in the inadequate CVH score category, in comparison to the straight/heterosexual reference group, however, lesbian females had OR values of 1.84 (95% CI; 0.89-3.81) for average CVH scores. Bisexual females and homosexually experienced females had increased OR values for both inadequate (3.49 (95% CI; 0.65-18.72) and 3.87 (95% CI; 1.07-14.04), respectively) and average CVH scores (2.21 (95% CI; 1.15-4.25) and 1.70 (95% CI; 1.02-2.87), respectively) in comparison to the reference group. Females in higher age categories were much more likely to have inadequate or average CVH scores in comparison to those in the reference category of 20-29 years; females in the age category 30-39 were 11.33 times more likely to have an inadequate CVH score (95% CI; 1.38-92.95) and 1.35 times more likely to have an average score (95% CI; 1.08-1.68) in comparison to the aforementioned reference group. Among the age category 40-49, females were 31.28 times more likely to have an inadequate score (95% CI; 3.87-252.77) and 1.64 times more likely to have an average score (95% CI; 1.30-2.07) in comparison to the reference group, and a similar trend was seen in the age category of 50-59 with OR values of 46.77 (95% CI; 5.75-380.53) and 2.99 (95% CI; 2.26-3.95) for inadequate and average CVH scores, respectively. The category race/ethnicity also associated with worse CVH scores among female sex. In comparison to the non-Hispanic white reference group, Hispanic females were 1.05 times more likely to have an inadequate CVH score (95% CI; 0.41-2.68) and 1.46 times more likely to have an average CVH score (95% CI; 1.17-1.82). Non-Hispanic black females were 1.67 times more likely to have an inadequate CVH score (95% CI; 0.87-3.21) and 1.79 times more likely to have an average CVH score (95% CI; 1.47-2.19). Non-Hispanic others and multiracial females were 2.12 times more likely to have an inadequate CVH score (95% CI; 0.66-6.79 and 0.68 times more likely to have an average CVH score (95% CI; 0.45-1.04).

To measure the effect of sexual orientation on Allostatic Load, the variables included in the logistic regression model for males were sexual orientation and HIV status. Among the male sex, sexual orientation was not associated with allostatic load risk. Of the two variables included, HIV status was the only of the two found to be associated with the outcome variable, allostatic load risk. In comparison to the reference group of males with a known negative HIV status, HIV positive males were 0.94 less likely to have a moderate AL risk score (95% CI; 0.28-3.21) and 1.94 times more likely to have a high AL risk score (95% CI; 0.74-5.12) rather than a low AL risk score. Males with unknown HIV test statuses were 1.86 times more likely to have moderate AL risk scores (95% CI; 1.51-2.27) and 3.64 times more likely to have high AL risk scores (95% CI; 3.11-4.26) in comparison to the reference group.

For the logistic regression model for females, sexual orientation, age, race/ethnicity, foreign birth, and binge drinking were included in the model, and all of the variables except for sexual orientation were found to be significant. In comparison to the reference age category of ages 20-29, females aged 30-39 were 1.45 times more likely to have a moderate AL risk score (95% CI; 0.98-2.16) and 1.74 times more likely to have a high AL risk score (95% CI; 1.18-2.56). Females in the age category 40-49 were 1.47 times more likely to have a moderate AL risk score (95% CI; 1.00-2.17) and 3.54 times more likely to have a high AL risk score (95% CI; 2.35-5.32) than females who belonged to the reference group. Females aged 50-59 years were 2.57 times more likely to have a moderate AL risk score (95% CI; 1.61-4.10) and 9.54 times more likely to have a high AL risk score (95% CI; 5.82-15.66) in comparison to the reference group, thus, females in higher age groups were more likely to have higher AL. AL risk scores also differed between different race/ethnicity groups among females. In comparison to the reference group of non-Hispanic white females, Hispanic females were 0.89 less likely to have moderate AL risk scores (95% CI; 0.56-1.39) and 0.95 times less likely to have high AL risk scores (95% CI; 0.64-1.41). Non-Hispanic black females were 1.17 times more likely to have moderate AL risk scores (95% CI; 0.79-1.74) and 1.60 times more likely to have high AL risk

scores (95% CI; 1.09-2.37) in comparison to the reference group. Females who were multiracial or categorized as a non-Hispanic other were 1.09 times more likely to have moderate AL risk scores (95% CI; 0.60-1.97) and 0.59 times less likely to have high AL risk scores (95% CI; 0.35-1.00) in comparison to the reference group. In comparison to the reference group of females born in the United States, foreign born females were 0.91 times less likely to have moderate AL risk scores (95% CI; 0.55-1.50) and 0.69 times less likely to have high AL risk scores (95% CI; 0.42-1.14). Females with unknown birth locations were 1.83 times more likely to have moderate AL risk scores (95% CI; 1.24-2.71) and 2.27 times more likely to have high AL risk scores (95% CI; 1.50-3.43) in relation to the reference category of native born females. Females who have binge drank were 1.06 times more likely to have moderate AL risk scores (95% CI; 0.66-1.73) and 1.49 times more likely to have high AL risk scores (95% CI; 0.88-2.54) in comparison to the reference category of females who have never binge drank for a continuous period of their life.

For self-reported CVD diagnoses, the logistic regression model for the male sex included sexual orientation, HIV status, and family income, of which only HIV status and family income had a significant effect. Sexual orientation was not found to have an effect on self-reported CVD diagnoses. Compared to the reference group of males with family incomes greater than 400% of the FPL, males with family income less than 138% of the FPL had OR values of 2.48 (95% CI; 1.67-3.68) for self-reported cardiovascular disease diagnoses. Males with family incomes from 138% to 250% of the FPL were 1.03 times more likely (95% CI; 0.61-1.74) to self-report a CVD diagnosis, and males with family incomes from 250% to 400% of the FPL were 1.18 times more likely (95% CI; 0.72-1.95) to self-report a CVD diagnosis in comparison to the reference group. Lower income males were more likely to report CVD diagnoses than higher income males. HIV status was also shown to have a significant effect on self-reported CVD diagnoses, and males with a positive HIV status were 1.23 times more likely (95% CI; 0.13-11.44) to self-report a CVD diagnosis and males with an unknown HIV test status were 5.31 times more likely (95% CI;

3.45-8.18) to self-report a CVD diagnosis in comparison to the reference group of males who tested negative for HIV.

For the female sex, the variables sexual orientation, age, race/ethnicity, and binge drinking, were included in the logistic regression model. Of these variables, only age and race/ethnicity were found to have a significant association with a self-reported CVD diagnosis. Sexual orientation was not associated with self-reported CVD diagnoses. Compared to the reference category of females between the ages of 20 and 29, females aged 30-29 were 3.09 times more likely (95% CI; 0.64-14.86) to self-report any CVD diagnoses. Females aged 40-49 were 10.04 times more likely (95% CI; 2.52-40.11) and females aged 50-59 were 14.06 times more likely (95% CI; 3.43-57.68) to self-report CVD diagnoses in comparison to the reference group. Hispanic females were 0.49 times less likely (95% CI; 0.25-0.93) to self-report CVD diagnoses in comparison to the non-Hispanic white female reference group. Non-Hispanic black females were 1.22 times more likely (95% CI; 0.73-2.06) and multiracial or other non-Hispanic females were 1.32 times more likely (95% CI; 0.67-2.61) to self-report any CVD diagnosis in comparison to the reference group.

DISCUSSION

Given the social context that corresponds to differing sexual identities, it was expected that sexual minorities, due to increased rates of risk factors for CVD in previous literature, should have experienced worse CVH scores, higher AL, and increased rates of self-reported CVD diagnoses. However, of the associations examined in this study, the only one found to be associated with sexual orientation was the AHA's Life's Simple 7 CVH score, which was observed to be associated with sexual orientation for the female sex, but not the male sex, which concurs with available literature. Both AL and self-reported CVD diagnoses were not associated with sexual orientation for both female and male sex, which, among the male sex, were two unexpected results given previous studies which have examined these associations.

Among the female sex, minimal differences in AL and CVD diagnoses were expected, which was also observed in this analysis. However, there were many observed and notable nuances in the data in which socioeconomic and other demographic factors were associated with sexual orientation, CVH, AL, or CVD.

Among males, lower family incomes were associated with worse CVH scores and among females, higher age and racial/ethnic minority group status were associated with worse CVH scores. Sexual minority females experienced worse CVH scores in comparison to their straight/heterosexual counterparts, indicating higher CVD risk. Among males, positive HIV status was associated with higher AL risk and among females, higher age was associated with higher AL risk scores. Hispanic females experienced less AL risk than their non-Hispanic white female counterparts and non-Hispanic black females experienced more AL risk than their non-Hispanic white counterparts. Foreign birth status was associated with lower levels of AL risk, and binge drinking was associated with higher levels of AL risk among the female sex. Low income males were also more likely to self-report CVD diagnosis, and positive HIV status was also associated with an increased likelihood of CVD diagnosis. Age was associated with greater chances of CVD diagnosis among the female sex, and Hispanic females were found to be less likely to receive a CVD diagnosis in comparison to their non-Hispanic white counterparts. Non-Hispanic black, non-Hispanic others, and multiracial females experienced higher odds of a CVD diagnosis compared to their non-Hispanic white counterparts.

The comparison between straight/heterosexual populations and their sexual minority counterparts is important to understand the relationship between AL biomarkers and the development of chronic diseases, such as CVD. AL is consistently calculated using a mix of CVD-related biomarkers [13], and thus had to be analyzed separately from CVH and CVD because they are not mutually exclusive. Few prior studies have examined the association between CVD and sexual minority status using a combination of both physiological biomarkers and self-reported health data [11], and no prior studies have looked at both AL and CVH

outcomes among sexual minorities. Similar to the results found in this analysis, most studies report higher rates of CVD risk factors among female sexual minorities but are surprisingly unable to identify higher rates of CVD diagnoses [5,9-11,14]. AL has also been found to be the same among females in previous literature, regardless of sexual orientation, a result also observed in this analysis [4]. Among male sexual minorities in this analysis, sexual minority males and heterosexual males had similar rates of AL and self-reported CVD, which differed from previous literature findings; in previous studies, bisexual males have been found to exhibit greater rates of CVD risk factors in comparison to straight/heterosexual males, but gay males demonstrate similar risk profiles in comparison to their straight/heterosexual counterparts [15]. Bisexual males have also been found to exhibit higher rates of AL than their straight/heterosexual counterparts and gay males experience significantly less AL than straight/heterosexual males [4,16], which were not found in this analysis. Sexual minority status has also been associated with a number of other chronic conditions in both males and females, including some cancers, asthma, bronchitis, and arthritis [1,14], however was not found to be associated with any chronic CVD diagnoses in this analysis. Sexual minority status has previously been found to be associated with the diagnosis multiple chronic conditions among lesbian and bisexual females [17], and social experiences of anti-gay stress and stigma, which contribute to higher AL, may contribute to this relationship.

This study yielded two interesting sets of results in relation to the “Hispanic health paradox” and the “immigrant health paradox” within the female sex. Both AL risk and self-reported CVD diagnoses were lower among Hispanics in comparison to both non-Hispanic whites and non-Hispanic blacks. These results align with the idea of the Hispanic health paradox, an association consistently observed in previous health analyses in which Hispanics are in better health compared to other minority racial/ethnic groups in the United States [18]. This was observed among the female sex in this analysis, who experienced lower AL and CVD diagnoses than their white and NHB counterparts, though it was not observed in the male sex.

Typically, health benefits such as lower CVD rates are notable in both male and female Hispanic populations, however, this result may not have been observed in our statistical model because of differences in lifestyle, health behaviors, and rates of acculturation between Hispanic males and females [19]. Differences between Hispanic males and females may also have been observed due to varying levels of social support, which has been shown to be a health protective factor [18]. In the literature, Furthermore, the association found between foreign birth status and AL among the female sex was indicative of the immigrant health paradox, which is a similar concept to the Hispanic health paradox. According to the immigrant health paradox, in spite of intersectional stressors including racism and xenophobia they may experience while living in a new country, immigrants tend to have better health outcomes than their native born counterparts [20]. Health protective factors start to worsen the longer that immigrants live in the United States, and disappear especially after the first generation [18].

Among females in this analysis, non-Hispanic blacks experienced higher rates of risk factors, including worse CVH scores and higher AL risk, as well as increased rates of CVD diagnoses. These results were expected according to the literature which indicates that AL is higher among African-Americans compared to white Americans [21]. In our analysis, this association was found in females but not among males; results among the male sex did not agree with previous associations between sexual orientation and AL found in the literature in this analysis, perhaps due to the limited sample size and young age range (20-59) taken from the NHANES survey set. The young nature of the population means that fewer respondents to the NHANES survey, statistically, will have poor CVH or will have received a CVD diagnosis, because chronic conditions tend to increase with age.

Limitations to this analysis primarily arise the cross-sectional nature of the NHANES data set. Longitudinal data is typically a more effective manner to determine causal pathways, and secondary data analyses such as this one often yield correlational data. Moreover, as the operationalization of AL includes cardiovascular system-related biomarkers, it is difficult to

understand the effect that AL may have on the development of CVD because of the overlap of measurable cardiovascular system biomarkers between AL and the AHA's Life's Simple 7 CVH risk factors: systolic blood pressure, diastolic blood pressure, cholesterol, and body mass index (BMI) [22]. Moreover, the inability to study the role of AL in the development of CVD due to the overlap of risk factors and the potential for confounding remains a limitation this data analysis. AL is also an unstandardized variable and, in the literature, has been calculated in at least 21 different ways [13], which makes comparisons between AL studies difficult. Another factor that this analysis was unable to account for is potential geographic variability of stigma, minority stress, and discrimination for sexual minority populations; that is, those who live in urban areas may experience different stressors than those in suburban or rural areas of the country [23]. Furthermore, intersectionality theory suggests that sexual minorities will have different experiences according to the intersection of their many identities; participants who are both a sexual minority and a racial/ethnic minority are likely to have heightened levels of social stressors due to the intersections of social disadvantage and marginalization [24]. These heightened levels of stress are likely to multiply health risks, which may result in higher levels of AL and increased risk for chronic conditions such as CVD; these potential differences in sexual minority stress were unable to be accounted for in this analysis.

In the NHANES sample, there is a possibility for the underreporting of the sexual orientation of sexual minorities due to gender differences in social desirability bias during data collection [25]. Moreover, sexual minorities are more likely to avoid health care settings and even cite fears of discrimination from health care workers as one of their primary reasons for avoiding doctors' visits [26]. Thus, participants who identify as a sexual minority may not have been willing to disclose their sexual orientation to an interviewer due to mistrust of health care workers or fear of stigma that they may receive as a result. This may have led to fewer sexual minorities disclosing their sexual orientation, and smaller numbers of sexual minorities in this analysis,

which could have impacted the results by making important relationships less noticeable in the data.

Future directions in this field include the study of allostatic load within the transgender population. NHANES does not collect data from transgender individuals and a similar analysis on transgender individuals using a different nationally representative data set could be used to examine associations between gender status, AL, and CVH in future studies. The inclusion of minority stress as a risk factor for CVD in sexual minority populations has been indicated in the literature as a recommendation for future directions in research [27]. Furthermore, the associations of various factors that may increase resilience to life-course stress should be investigated, such as social support, marital status, and cohabitation with a partner. The potential associations of social support and AL or social support and CVH should be investigated, as they could illuminate the mechanisms by which social support can foster resilience among those who identify with a sexual minority status, and how this may also affect certain CVD risk factors.

CONCLUSION

Female sexual minorities were found to experience worse CVH scores and thus CVD risk in comparison to their heterosexual/straight counterparts but did not experience higher AL risk or self-reported CVD diagnoses. Within the male sex, sexual minority status was not associated with CVH score, AL, or self-reported CVD diagnoses. The paradox between the elevation of CVD risk among sexual minority females, yet the lack of increased CVD diagnosis is not fully understood. The findings indicate the importance of continued research of health behaviors, biomarkers, and sociocultural stressors among sexual minorities. More research is needed to fully illuminate the mechanism between sexual minority status and the development of chronic disease.

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REFERENCES

1. Lick DJ, Durso LE, Johnson KL. Minority Stress and Physical Health Among Sexual Minorities. *Perspect Psychol Sci.* 2013;8(5):521-548.

2. McEwen BS. Stress, adaptation, and disease. Allostasis and allostatic load. *Ann N Y Acad Sci.* 1998;840:33-44.

3. Logan JG, Barksdale DJ. Allostasis and allostatic load: expanding the discourse on stress and cardiovascular disease. *J Clin Nurs.* 2008;17(7b):201-208.

4. Mays VM, Juster RP, Williamson TJ, Seeman TE, Cochran SD. Chronic Physiologic Effects of Stress Among Lesbian, Gay, and Bisexual Adults: Results From the National Health and Nutrition Examination Survey. *Psychosom Med.* 2018;80(6):551-563.

5. Caceres BA, Makarem N, Hickey KT, Hughes TL. Cardiovascular Disease Disparities in Sexual Minority Adults: An Examination of the Behavioral Risk Factor Surveillance System (2014-2016). *Am J Health Promot.* 2019;33(4):576-585.

6. Lock J, Steiner H. Gay, lesbian, and bisexual youth risks for emotional, physical, and social problems: results from a community-based survey. *J Am Acad Child Adolesc Psychiatry.* 1999;38(3):297-304.

7. Diamant AL, Wold C. Sexual orientation and variation in physical and mental health status among women. *J Womens Health (Larchmt).* 2003;12(1):41-49.

8. Roberts SA, Dibble SL, Nussey B, Casey K. Cardiovascular disease risk in lesbian women. *Womens Health Issues.* 2003;13(4):167-174.

9. Farmer GW, Jabson JM, Bucholz KK, Bowen DJ. A population-based study of cardiovascular disease risk in sexual-minority women. *Am J Public Health.* 2013;103(10):1845-1850.

10. Caceres BA, Brody AA, Halkitis PN, Dorsen C, Yu G, Chyun DA. Cardiovascular Disease Risk in Sexual Minority Women (18-59 Years Old): Findings from the National Health and Nutrition Examination Survey (2001-2012). *Womens Health Issues.* 2018;28(4):333-341.

11. Caceres BA, Brody A, Luscombe RE, et al. A Systematic Review of Cardiovascular Disease in Sexual Minorities. *Am J Public Health.* 2017;107(4):e13-e21.

12. Sanchez E. Life's Simple 7: Vital But Not Easy. *J Am Heart Assoc.* 2018;7(11).

13. Duong MT, Bingham BA, Aldana PC, Chung ST, Sumner AE. Variation in the Calculation of Allostatic Load Score: 21 Examples from NHANES. *J Racial Ethn Health Disparities.* 2017;4(3):455-461.

14. Patterson JG, Jabson JM. Sexual orientation measurement and chronic disease disparities: National Health and Nutrition Examination Survey, 2009-2014. *Ann Epidemiol.* 2018;28(2):72-85.

15. Caceres BA, Brody AA, Halkitis PN, Dorsen C, Yu G, Chyun DA. Sexual Orientation Differences in Modifiable Risk Factors for Cardiovascular Disease and Cardiovascular Disease Diagnoses in Men. *LGBT Health.* 2018;5(5):284-294.

16. Juster RP, Smith NG, Ouellet E, Sindi S, Lupien SJ. Sexual orientation and disclosure in relation to psychiatric symptoms, diurnal cortisol, and allostatic load. *Psychosom Med.* 2013;75(2):103-116.

17. Gonzales G, Przedworski J, Henning-Smith C. Comparison of Health and Health Risk Factors Between Lesbian, Gay, and Bisexual Adults and Heterosexual Adults in the United States: Results From the National Health Interview Survey. *JAMA Intern Med.* 2016;176(9):1344-1351.

18. Markides KS, Rote S. Immigrant Health Paradox. In: *Emerging Trends in the Social and Behavioral Sciences.*1-15.

19. Abraído-Lanza AF, Chao MT, Flórez KR. Do healthy behaviors decline with greater acculturation? Implications for the Latino mortality paradox. *Soc Sci Med.* 2005;61(6):1243-1255.

20. Viruell-Fuentes EA, Miranda PY, Abdulrahim S. More than culture: structural racism, intersectionality theory, and immigrant health. *Soc Sci Med.* 2012;75(12):2099-2106.

21. Tomfohr LM, Pung MA, Dimsdale JE. Mediators of the relationship between race and allostatic load in African and White Americans. *Health Psychol.* 2016;35(4):322-332.

22. Crook Z, Booth T. Considering the Appropriateness of the Factor Analytic Operationalization of Allostatic Load. *Psychosom Med.* 2017;79(1):117-119.

23. Lee MG, Quam JK. Comparing supports for LGBT aging in rural versus urban areas. *Journal of Gerontological Social Work.* 2013;56(2):112-126.

24. Cho S, Crenshaw KW, McCall L. Toward a field of intersectionality studies: Theory, applications, and praxis. *Signs: Journal of women in culture and society.* 2013;38(4):785-810.

25. Dalton D, Ortegren M. Gender differences in ethics research: The importance of controlling for the social desirability response bias. *Journal of Business Ethics.* 2011;103(1):73-93.

26. Petroll AE, Mosack KE. Physician awareness of sexual orientation and preventive health recommendations to men who have sex with men. *Sex Transm Dis.* 2011;38(1):63-67.

27. Caceres BA, Brody A, Chyun D. Recommendations for cardiovascular disease research with lesbian, gay and bisexual adults. *J Clin Nurs.* 2016;25(23-24):3728-3742.

Appendix A: Tables and Figures

Table 1: Demographic Indicators according to sexual orientation showing Rao Scott Chi Square analysis p-values

	Sexual Orientation					
	N	**Gay**	**Bisexual**	**Homosexually Experienced**	**Exclusively Heterosexual**	**p**
Male sex						
Age						0.15
20-29 years	1265	23 (15.9)	16 (23.4)	15 (14.4)	1211 (24.4)	
30-39 years	1259	33 (32.9)	20 (27.5)	35 (31.8)	1171 (24.7)	
40-49 years	1329	34 (34.7)	19 (24.4)	32 (24.7)	1244 (28.2)	
50-59 years	1079	13 (16.5)	21 (24.6)	32 (29.0)	1013 (22.6)	
Educational Attainment						-----
< HS	1129	5 (3.0)	18 (20.3)	25 (11.4)	1081 (15.3)	
HS graduate	1268	8 (7.5)	19 (20.6)	26 (18.6)	1215 (26.7)	
Some college	1458	35 (29.3)	23 (34.1)	41 (45.5)	1359 (31.4)	
≥ College graduate	1075	55 (60.2)	16 (24.9)	22 (24.5)	982 (26.5)	
Race/ethnicity						0.12
Non-Hispanic White	2491	54 (73.7)	38 (72.0)	49 (67.7)	2350 (72.5)	
Hispanic	1014	16 (6.8)	16 (11.2)	21 (10.1)	961 (9.9)	
Non-Hispanic Black	1246	25 (9.6)	20 (15.2)	38 (17.9)	1163 (13.1)	
Non-Hispanic Other/Multiracial	181	8 (9.9)	2 (1.6)	6 (4.4)	165 (4.4)	
Foreign Birth						0.80
No	2827	64 (72.0)	43 (66.7)	59 (62.4)	2661 (64.5)	
Yes	776	7 (4.8)	11 (11.0)	22 (10.7)	736 (10.9)	
Unknown	1329	32 (23.1)	22 (22.3)	33 (26.9)	1242 (24.6)	
Family Income						0.0004
<138%	1475	18 (11.1)	28 (30.6)	35 (21.1)	1394 (21.1)	
138-250%	955	17 (11.7)	24 (29.2)	31 (19.8)	883 (16.9)	
250%-400%	935	13 (14.0)	8 (14.9)	16 (14.4)	898 (21.5)	
>400%	1567	55 (63.1)	16 (25.3)	32 (42.7)	1464 (40.4)	
Mental distress						------
No	4438	86 (87.2)	60 (79.5)	91 (79.7)	4201 (90.9)	
Yes	490	17 (12.8)	16 (20.4)	23 (20.2)	434 (8.9)	
Drug usage						------
No	3556	70 (68.4)	39 (51.4)	60 (50.2)	3387 (73.0)	
Yes	1366	33 (31.5)	37 (48.6)	54 (49.8)	1242 (26.8)	
Health insurance						------
No	1510	14 (7.6)	26 (34.6)	38 (29.8)	1432 (23.6)	
Yes	3392	88 (91.0)	50 (65.3)	76 (70.1)	3178 (75.8)	
Binge drinking						0.90

No	503	8 (33.0)	7 (24.4)	8 (18.1)	480 (24.1)	
Yes	625	9 (28.7)	7 (24.2)	16 (32.1)	593 (27.6)	
HIV status						<0.0001
Negative	3798	74 (70.4)	47 (70.5)	80 (69.8)	3597 (76.9)	
Positive	32	16 (13.1)	8 (4.8)	1 (0.6)	7 (0.1)	
Self-rated general health						------
Excellent	667	14 (14.8)	4 (4.8)	10 (10.1)	639 (14.7)	
Very good	1600	41 (45.1)	24 (39.0)	32 (31.9)	1503 (36.8)	
Good	1887	38 (33.7)	33 (43.3)	48 (41.1)	1768 (35.9)	
Fair or Poor	775	10 (6.3)	15 (12.8)	24 (16.8)	726 (12.5)	
Female sex						
Age						0.0001
20-29 years	1111	20 (26.6)	54 (39.0)	54 (26.9)	983 (20.3)	
30-39 years	1219	17 (24.6)	40 (31.1)	40 (23.0)	1122 (24.7)	
40-49 years	1390	17 (29.8)	26 (20.9)	55 (29.6)	1292 (29.9)	
50-59 years	1123	11 (18.9)	9 (8.9)	38 (20.4)	1065 (25.0)	
Educational Attainment						0.26
< HS	1038	10 (10.0)	32 (20.9)	34 (13.3)	962 (13.9)	
HS graduate	1075	13 (19.4)	28 (20.2)	27 (16.6)	1007 (22.8)	
Some college	1633	27 (45.1)	49 (38.4)	75 (41.4)	1482 (35.0)	
≥ College graduate	1097	15 (25.5)	20 (20.5)	51 (28.6)	1011 (28.3)	
Race/ethnicity						0.03
Non-Hispanic White	2369	32 (69.3)	73 (76.3)	108 (77.0)	2156 (71.1)	
Hispanic	1036	16 (13.9)	37 (14.3)	42 (10.7)	941 (11.5)	
Non-Hispanic Black	1257	13 (11.1)	17 (7.2)	27 (6.3)	1200 (12.5)	
Non-Hispanic Other/Multiracial	181	4 (5.7)	2 (2.2)	10 (6.0)	165 (4.8)	
Foreign Birth						0.001
No	2771	40 (71.6)	75 (63.8)	100 (62.0)	2556 (65.1)	
Yes	620	4 (5.8)	3 (1.1)	17 (6.8)	596 (9.4)	
Unknown	1452	21 (22.5)	51 (35.2)	70 (32.2)	1310 (25.4)	
Family Income						0.14
<138%	1599	22 (26.6)	51 (34.2)	58 (27.2)	1468 (24.0)	
138-250%	973	17 (27.5)	33 (22.4)	37 (18.7)	886 (17.5)	
250%-400%	880	10 (15.1)	21 (20.3)	34 (18.9)	815 (20.2)	
>400%	1391	16 (30.9)	24 (23.1)	58 (35.2)	1293 (38.3)	
Mental distress						-----
No	4061	58 (91.3)	92 (72.7)	150 (82.4)	3761 (85.2)	
Yes	777	7 (8.7)	37 (27.3)	37 (17.6)	696 (14.7)	
Drug usage						------
No	4041	45 (67.0)	68 (52.0)	101 (49.7)	3827 (84.4)	
Yes	786	20 (33.0)	60 (47.6)	85 (50.1)	621 (15.4)	

Health insurance						------
No	1139	23 (28.0)	39 (27.4)	41 (17.6)	1036 (17.6)	
Yes	3678	42 (72.0)	89 (72.2)	144 (80.7)	3403 (82.0)	
Binge drinking						<0.0001
No	234	8 (38.2)	11 (35.2)	16 (23.3)	199 (12.3)	
Yes	294	6 (20.9)	13 (23.1)	22 (32.3)	253 (15.3)	
HIV status						------
Negative	3698	53 (810.2)	119 (90.3)	149 (79.6)	3377 (74.7)	
Positive	11	1 (0.8)	1 (0.7)	0 (0.0)	9 (0.1)	
Self-rated general health						-----
Excellent	505	2 (4.5)	9 (7.4)	22 (14.1)	472 (12.6)	
Very good	1528	19 (32.2)	33 (29.2)	61 (34.0)	1415 (37.7)	
Good	1821	29 (43.9)	48 (39.3)	80 (41.6)	1664 (35.0)	
Fair or Poor	986	15 (19.3)	39 (24.0)	24 (10.3)	908 (14.6)	

[1] Unknowns have been included in the denominators of the listed column percentages and p-value calculations, however, have been omitted from the table

Table 2: Allostatic Load and Cardiovascular-Related Indicators according to sexual orientation showing Rao Scott Chi Square Analysis p-values

	Sexual Orientation					
	N	**Gay**	**Bisexual**	**Homosexually Experienced**	**Exclusively Heterosexual**	**p**
Male Sex						
AHA Simple 7						
Smoking status						0.42
Poor	1633	30 (28.3)	33 (44.7)	39 (33.6)	1531 (31.2)	
Intermediate	188	2 (1.8)	4 (2.8)	5 (3.9)	177 (4.0)	
Ideal	3104	71 (69.9)	39 (52.5)	70 (62.5)	2924 (64.8)	
BMI						0.29
Poor	1521	25 (24.6)	24 (37.2)	32 (26.6)	1440 (30.9)	
Intermediate	1937	39 (36.0)	29 (34.6)	44 (36.4)	1825 (40.0)	
Ideal	1474	39 (39.4)	23 (28.1)	38 (37.0)	1374 (29.0)	
Physical Activity						0.04
Poor	1720	24 (18.0)	29 (33.4)	44 (29.6)	1623 (31.1)	
Intermediate or Ideal	3163	78 (82.0)	45 (66.6)	69 (70.4)	2971 (68.9)	
Healthy Diet Score						0.19
Poor	3581	61 (63.9)	55 (76.8)	80 (74.2)	3385 (74.8)	
Intermediate	1269	40 (36.0)	21 (23.2)	32 (25.8)	1176 (25.2)	
Total Cholesterol						0.29
Poor	680	9 (15.5)	9 (14.7)	23 (28.0)	639 (20.4)	
Intermediate	164	3 (4.0)	6 (12.9)	5 (4.9)	150 (4.8)	
Ideal	2656	64 (80.5)	39 (72.4)	53 (67.1)	2500 (74.8)	
Blood Pressure						0.98
Poor or Intermediate	1120	22 (22.5)	18 (19.9)	24 (22.7)	1056 (22.3)	
Ideal	3812	81 (77.5)	58 (80.0)	90 (77.2)	3583 (77.7)	
Fasting Plasma Glucose						0.10
Poor or Intermediate	1009	17 (14.8)	22 (30.4)	17 (14.9)	953 (20.0)	
Ideal	3923	86 (85.1)	54 (69.5)	97 (85.1)	3686 (80.0)	
Simple 7 Mean Score (0-12)	8.35 (0.05)	9.11 (0.29)	8.00 (0.27)	8.34 (0.23)	8.34 (0.06)	-----
Simple 7 Categorized						0.09
Inadequate (0-4)	110	2 (1.6)	3 (3.7)	3 (3.8)	102 (2.9)	
Average (5-9)	2323	41 (56.5)	43 (83.5)	57 (69.2)	2182 (67.8)	
Optimum (10-14)	972	31 (41.9)	6 (12.8)	18 (26.9)	917 (29.2)	
Allostatic Load Markers						
Creatinine Clearance						0.50
Healthy	4426	95 (90.2)	69 (94.2)	97 (84.6)	4165 (90.5)	

Unhealthy	506	8 (9.8)	7 (5.7)	17 (15.3)	474 (9.5)	
Glycosylated Hemoglobin						0.0007
Healthy	4628	101 (99.3)	67 (85.3)	107 (94.6)	4353 (94.9)	
Unhealthy	304	2 (0.7)	9 (14.7)	7 (5.4)	286 (5.1)	
Serum Albumin						0.84
Healthy	4823	100 (98.0)	75 (97.4)	112 (99.1)	4536 (98.2)	
Unhealthy	109	3 (2.0)	1 (2.6)	2 (0.8)	103 (1.7)	
C-Reactive Protein						0.08
Healthy	3585	82 (82.4)	50 (60.8)	90 (78.9)	3363 (74.0)	
Unhealthy	1347	21 (17.6)	26 (39.2)	24 (21.1)	1276 (26.0)	
Total Cholesterol						0.05
Healthy	3885	85 (79.6)	60 (80.1)	76 (64.8)	3664 (77.5)	
Unhealthy	1047	18 (20.3)	16 (19.9)	38 (35.2)	975 (22.5)	
HDL Cholesterol						0.42
Healthy	1800	30 (30.1)	22 (26.3)	39 (36.2)	1709 (36.8)	
Unhealthy	3132	73 (69.9)	54 (73.7)	75 (63.8)	2930 (63.1)	
BMI						0.31
Healthy	3411	78 (75.4)	52 (62.7)	82 (73.4)	3199 (69.1)	
Unhealthy	1521	25 (24.6)	24 (37.2)	32 (26.6)	1440 (30.9)	
Resting Heart Rate						0.20
Healthy	4543	95 (91.5)	67 (86.5)	101 (86.3)	4280 (92.3)	
Unhealthy	389	8 (8.5)	9 (13.5)	13 (13.7)	359 (7.7)	
Diastolic Blood Pressure						0.06
Healthy	4085	92 (90.1)	58 (78.9)	97 (89.9)	3838 (83.2)	
Unhealthy	847	11 (9.9)	18 (21.1)	17 (10.1)	801 (16.7)	
Systolic Blood Pressure						0.02
Healthy	4042	94 (91.0)	53 (70.4)	91 (80.9)	3804 (82.5)	
Unhealthy	890	9 (8.9)	23 (29.6)	23 (19.1)	835 (17.4)	
AL Mean Score (range 0-10)	2.01 (0.04)	1.72 (0.14)	2.57 (0.22)	2.11 (0.18)	2.01 (0.04)	-----
AL Risk categorized						0.13
High Risk	1597	25 (23.7)	33 (43.6)	44 (37.3)	1495 (31.9)	
Moderate Risk	1138	21 (23.1)	20 (26.9)	21 (18.7)	1076 (23.0)	
Low Risk	2197	57 (53.2)	23 (29.4)	49 (44.0)	2068 (45.1)	
Cardiovascular Diagnoses (self-reported)						
Coronary Heart Disease						------
Yes	86	0 (0.0)	2 (2.1)	5 (5.7)	79 (1.7)	
No	4838	103 (100.0)	75 (97.9)	108 (93.4)	4553 (98.2)	
Angina						------
Yes	61	0 (0.0)	2 (2.1)	1 (1.8)	58 (1.2)	
No	4861	103 (100.0)	73 (95.3)	112 (97.3)	4573 (98.6)	

Myocardial Infarction						------
Yes	95	0 (0.0)	3 (3.0)	1 (0.5)	91 (1.7)	
No	4833	103 (100.0)	73 (97.0)	112 (98.6)	4545 (98.2)	
Heart Failure						------
Yes	62	0 (0.0)	3 (4.0)	1 (0.5)	58 (1.0)	
No	4866	103 (100.0)	73 (96.0)	112 (98.6)	4578 (99.0)	
Stroke						
Yes	45	1 (0.7)	1 (1.5)	1 (0.5)	42 (0.7)	------
No	4880	102 (99.3)	75 (98.5)	112 (98.6)	4591 (99.2)	
Female Sex						
AHA Simple 7						
Smoking status						<0.0001
Poor	1217	26 (34.8)	60 (41.2)	73 (39.4)	1058 (24.3)	
Intermediate	135	3 (5.4)	6 (6.9)	16 (10.9)	110 (2.5)	
Ideal	3487	36 (59.8)	63 (51.8)	98 (49.7)	3290 (73.1)	
BMI						0.04
Poor	1826	26 (43.6)	57 (43.4)	56 (28.6)	1687 (33.9)	
Intermediate	1299	14 (20.0)	24 (13.9)	54 (28.4)	1207 (25.7)	
Ideal	1718	25 (36.4)	48 (42.6)	77 (42.9)	1568 (40.4)	
Physical Activity						0.86
Poor	1899	24 (38.2)	47 (33.3	70 (34.3)	1758 (32.9)	
Intermediate or Ideal	2891	40 (61.7)	80 (66.7)	116 (65.7)	2655 (67.1)	
Healthy Diet Score						-----
Poor	3212	50 (77.8)	93 (75.5)	135 (74.5)	2934 (66.6)	
Intermediate	1538	15 (22.2)	31 (24.5)	49 (25.4)	1443 (33.3)	
Ideal	3	0 (0.0)	0 (0.0)	0 (0.0)	3 (0.1)	
Total Cholesterol						0.48
Poor	564	5 (7.9)	13 (13.0)	24 (19.0)	522 (17.3)	
Intermediate	180	2 (5.2)	3 (3.6)	5 (3.3)	170 (5.4)	
Ideal	2728	46 (86.9)	93 (83.4)	110 (77.6)	2479 (77.3)	
Blood Pressure						0.88
Poor or Intermediate	684	7 (12.5)	15 (13.7)	26 (11.9)	636 (14.1)	
Ideal	4159	58 (87.5)	114 (86.3)	161 (88.0)	3826 (85.9)	
Fasting Plasma Glucose						0.09
Poor or Intermediate	650	5 (6.4)	10 (6.9)	23 (11.6)	612 (12.7)	
Ideal	4193	60 (93.6)	119 (93.0	164 (88.4)	3850 (87.3)	
Simple 7 Mean Score (0-13)	8.83 (0.05)	8.57 (0.28)	8.50 (0.21)	8.30 (0.27)	8.87 (0.05)	-----
Simple 7 Categorized						-----

Inadequate (0-4)	79	0 (0.0)	3 (2.9)	6 (5.2)	70 (2.3)	
Average (5-9)	2055	38 (71.4)	71 (70.5)	87 (64.6)	1859 (57.0)	
Optimum (10-14)	1229	14 (28.6)	28 (26.6)	42 (30.1)	1145 (40.7)	
Allostatic Load Markers						
Creatinine Clearance						0.24
Healthy	3911	55 (88.0)	110 (81.0)	146 (76.9)	3600 (77.3)	
Unhealthy	932	10 (12.0)	19 (19.0)	41 (23.0)	862 (22.7)	
Glysoloated Hemoglobin						0.74
Healthy	4532	61 (91.0)	125 (95.6)	178 (94.2)	4168 (95.4)	
Unhealthy	311	4 (8.9)	4 (4.4)	9 (5.8)	294 (4.6)	
Serum Albumin						0.07
Healthy	4386	64 (99.2)	118 (93.4)	172 (93.1)	4032 (92.2)	
Unhealthy	457	1 (0.8)	11 (6.6)	15 (6.8)	430 (7.7)	
C-Reactive Protein						0.70
Healthy	2740	39 (55.7)	66 (53.8)	114 (60.0)	2521 (59.5)	
Unhealthy	2103	26 (44.3)	63 (46.1)	73 (40.0)	1941 (40.5)	
Total Cholesterol						0.53
Healthy	3940	56 (85.5)	112 (84.5)	155 (81.9)	3617 (80.2)	
Unhealthy	903	9 (14.5)	17 (15.5)	32 (18.1)	845 (19.8)	
HDL Cholesterol						<0.0001
Healthy	2013	27 (45.1)	33 (24.5)	57 (31.4)	1896 (44.9)	
Unhealthy	2830	38 (54.9)	96 (75.5)	130 (68.6)	2566 (55.1)	
BMI						0.06
Healthy	3017	39 (56.4)	72 (56.6)	131 (71.3)	2775 (66.0)	
Unhealthy	1826	26 (43.6)	57 (43.4)	56 (28.7)	1687 (33.9)	
Resting Heart Rate						0.70
Healthy	4307	56 (88.5)	113 (86.6)	165 (86.4)	3973 (89.2)	
Unhealthy	536	9 (11.5)	16 (13.4)	22 (13.6)	489 (10.8)	
Diastolic Blood Pressure						0.01
Healthy	4053	57 (88.8)	121 (94.2)	157 (86.1)	3718 (83.8)	
Unhealthy	790	8 (11.2)	8 (5.8)	30 (13.9)	744 (16.2)	
Systolic Blood Pressure						0.05
Healthy	3923	54 (85.8)	118 (90.3)	156 (86.4)	3595 (81.4)	
Unhealthy	920	11 (14.2)	11 (9.6)	31 (13.6)	867 (18.5)	
AL Mean Score (range 0-10)	2.30 (0.03)	2.16 (0.25)	2.39 (0.18)	2.32 (0.14)	2.30 (0.03)	-----
AL Categorized						
High Risk	2001	27 (42.7)	52 (39.1)	69 (36.8)	1853 (39.6)	0.97
Moderate Risk	1137	14 (20.0)	32 (26.2)	46 (24.1)	1045 (23.8)	
Low Risk	1705	24 (37.3)	45 (34.6)	72 (39.0)	1564 (36.6)	

Cardiovascular Diagnoses (self-reported)						
Coronary Heart Disease						-----
Yes	42	1 (0.8)	0 (0.0)	0 (0.0)	41 (0.9)	
No	4795	64 (99.2)	129 (100.0)	187 (100.0)	4415 (99.0)	
Angina						-----
Yes	64	2 (2.1)	2 (0.7)	3 (1.9)	57 (1.1)	
No	4769	63 (97.9)	127 (99.2)	183 (97.3)	4396 (98.8)	
Myocardial Infarction						-----
Yes	56	1 (1.5)	3 (1.9)	4 (2.2)	48 (1.0)	
No	4784	64 (98.5)	126 (98.1)	183 (97.8)	4411 (98.9)	
Heart Failure						-----
Yes	51	2 (3.9)	1 (0.4)	1 (0.2)	47 (0.8)	
No	4785	63 (96.1)	128 (99.6)	186 (99.8)	4408 (99.1)	
Stroke						-----
Yes	85	1 (1.5)	4 (3.5)	6 (2.0)	74 (1.5)	
No	4753	64 (98.5)	125 (96.5)	180 (97.7)	4384 (98.4)	

[1] Unknowns have been included in the denominators of the listed column percentages and p-value calculations, however, have been omitted from the table

Table 3: Logistic Regression of Sexual Orientation and AHA Simple 7 showing 95% Confidence Intervals for Odds Ratios				
	AHA Simple 7			
	Inadequate (0-4)	**Average (5-9)**	**Optimum (10-14)**	**p**
Male Sex				
Sexual Orientation (ref Straight/Heterosexual)				0.29
Gay/Lesbian	0.44 (0.09-2.23)	0.61 (0.30-1.27)	1.00	
Bisexual	2.74 (0.60-12.58)	2.68 (0.94-7.68)	1.00	
Homosexually Experienced	1.61 (0.37-6.93)	1.15 (0.68-1.94)	1.00	
Family Income (ref >400% of Federal Poverty Line)				0.002
<138%	3.46 (1.79-6.70)	1.59 (1.22-2.08)	1.00	
138-250%	1.44 (0.74-2.83)	1.24 (0.97-1.60)	1.00	
250%-400%	2.96 (1.47-5.98)	1.33 (1.06-1.67)	1.00	
Female Sex				
Sexual Orientation (ref Straight/Heterosexual)				<0.0001
Gay/Lesbian		1.84 (0.89-3.81)	1.00	
Bisexual	3.49 (0.65-18.72)	2.21 (1.15-4.25)	1.00	
Homosexually Experienced	3.87 (1.07-14.04)	1.70 (1.02-2.87)	1.00	
Age (ref 20-29 years)				<0.0001
30-39 years	11.33 (1.38-92.95)	1.35 (1.08-1.68)	1.00	
40-49 years	31.28 (3.87-252.77)	1.64 (1.30-2.07)	1.00	
50-59 years	46.77 (5.75-380.53)	2.99 (2.26-3.95)	1.00	
Race/ethnicity (ref Non-Hispanic White)				<0.0001
Hispanic	1.05 (0.41-2.68)	1.46 (1.17-1.82)	1.00	
Non-Hispanic Black	1.67 (0.87-3.21)	1.79 (1.47-2.19)	1.00	
Non-Hispanic Other/Multiracial	2.12 (0.66-6.79)	0.68 (0.45-1.04)	1.00	
Foreign Birth (ref No)				0.11
Yes	0.49 (0.13-1.80)	0.68 (0.50-0.93)	1.00	
Unknown	1.12 (0.58-2.18)	1.15 (0.85-1.56)	1.00	

Table 4: Logistic Regression of Sexual Orientation and Allostatic Load showing 95% Confidence Intervals for Odds Ratios				
Allostatic Load				
	Low Risk	**Moderate Risk**	**High Risk**	**p**
Male Sex				
Sexual Orientation (ref Straight/Heterosexual)				0.21
Gay/Lesbian	1.00	0.88 (0.48-1.60)	0.61 (0.36-1.04)	
Bisexual	1.00	1.81 (0.86-3.82)	2.06 (0.97-4.37)	
Homosexually Experienced	1.00	0.81 (0.44-1.48)	1.11 (0.62-1.97)	
Health Indicators				
HIV status (ref Negative)				<0.0001
Positive	1.00	0.94 (0.28-3.21)	1.94 (0.74-5.12)	
Unknown	1.00	1.86 (1.51-2.27)	3.64 (3.11-4.26)	
Female Sex				
Sexual Orientation (ref Straight/Heterosexual)				0.51
Gay/Lesbian	1.00	1.09 (0.34-3.46)	1.46 (0.45-4.76)	
Bisexual	1.00	1.93 (0.78-4.78)	1.81 (0.63-5.19)	
Homosexually Experienced	1.00	1.21 (0.62-2.35)	0.80 (0.35-1.87)	
Age (ref 20-29 years)				<0.0001
30-39 years	1.00	1.45 (0.98-2.16)	1.74 (1.18-2.56)	
40-49 years	1.00	1.47 (1.00-2.17)	3.54 (2.35-5.32)	
50-59 years	1.00	2.57 (1.61-4.10)	9.54 (5.82-15.66)	
Race/ethnicity (ref Non-Hispanic White)				0.04
Hispanic	1.00	0.89 (0.56-1.39)	0.95 (0.64-1.41)	
Non-Hispanic Black	1.00	1.17 (0.79-1.74)	1.60 (1.09-2.37)	
Non-Hispanic Other/Multiracial	1.00	1.09 (0.60-1.97)	0.59 (0.35-1.00)	
Foreign Birth (ref No Foreign Birth Status)				0.0003
Yes	1.00	0.91 (0.55-1.50)	0.69 (0.42-1.14)	
Unknown	1.00	1.83	2.27	

		(1.24-2.71)	(1.50-3.43)	
Health Indicators				
Binge Drinking (ref No Binge Drinking)				0.04
Yes	1.00	1.06 (0.66-1.73)	1.49 (0.88-2.54)	

Table 5: Logistic Regression of Sexual Orientation and CVD Diagnosis showing 95% Confidence Intervals for Odds Ratios			
Cardiovascular Disease Diagnosis			
	No	**Yes**	**p**
Male Sex			
Sexual Orientation (ref Straight/Heterosexual)			0.37
Gay/Lesbian	1.00	0.23 (0.03-1.86)	
Bisexual	1.00	1.59 (0.52-4.88)	
Homosexually Experienced	1.00	1.33 (0.44-3.99)	
Family Income (ref >400% Federal Poverty Line)			<0.0001
<138%	1.00	2.48 (1.67-3.68)	
138-250%	1.00	1.03 (0.61-1.74)	
250%-400%	1.00	1.18 (0.72-1.95)	
Health Indicators (ref Negative HIV Status)			
HIV status			<0.0001
Positive	1.00	1.23 (0.13-11.44)	
Unknown	1.00	5.31 (3.45-8.18)	
Female Sex			
Sexual Orientation (ref Straight/Heterosexual)			0.83
Gay/Lesbian	1.00	1.58 (0.35-7.06)	
Bisexual	1.00	1.75 (0.40-7.57)	
Homosexually Experienced	1.00	0.79 (0.17-3.67)	
Age (ref 20-29 years)			<0.0001
30-39 years	1.00	3.09 (0.64-14.86)	
40-49 years	1.00	10.04 (2.52-40.11)	
50-59 years	1.00	14.06 (3.43-57.68)	
Race/ethnicity (ref Non-Hispanic White)			0.02
Hispanic	1.00	0.49 (0.25-0.93)	
Non-Hispanic Black	1.00	1.22 (0.73-2.06)	

Non-Hispanic Other/Multiracial	1.00	1.32 (0.67-2.61)	
Health Indicators			
Binge drinking (ref No Binge Drinking)			0.24
Yes	1.00	0.83 (0.24-2.88)	