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A population-based study of the intersection of sexual identity and race/ethnicity on physiological risk factors for CVD among U.S. adults (ages 18–59)

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Abstract

Objectives: Sexual minorities face significant psychosocial stressors (such as discrimination and violence) that impact their health. Several studies indicate that sexual minority women (SMW) and bisexual men may be at highest risk for cardiovascular disease (CVD), but limited research has examined physiological CVD risk or racial/ethnic differences. This study sought to examine racial/ethnic differences in physiological risk factors for CVD among sexual minority and heterosexual adults.

Design: We analyzed data from the National Health and Nutrition Examination Survey (2001–2016) using sex-stratified multiple linear regression models to estimate differences in physiological CVD risk. We compared sexual minorities (gay/lesbian, bisexual, “not sure”) to heterosexual participants first without regard to race/ethnicity. Then we compared sexual minorities by race/ethnicity to White heterosexual participants.

Results: The sample included 22,305 participants (ages 18–59). Lesbian women had higher body mass index (BMI) but lower total cholesterol than heterosexual women. Bisexual women had higher systolic blood pressure (SBP). Gay men had lower BMI and glycosylated hemoglobin (HbA1c) relative to heterosexual men. White and Black lesbian women and bisexual women of

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Data Availability Statement

Data from the National Health and Nutrition Examination Survey (2001–2016) are publicly available.

all races/ethnicities had higher BMI than White heterosexual women; Black bisexual women had higher SBP and HbA1c. Black sexual minority men had higher levels of HbA1c relative to White heterosexual men. Latino “not sure” men also had higher SBP, HbA1c, and total cholesterol than White heterosexual men.

Conclusions: Given evidence of higher CVD risk in sexual minority people of color relative to White heterosexuals, there is a need for health promotion initiatives to address these disparities. Additional research that incorporates longitudinal designs and examines the influence of psychostressors on CVD risk in sexual minorities is recommended. Findings have implications for clinical and policy efforts to promote the cardiovascular health of sexual minorities.

Keywords

Cardiovascular disease; sexual minorities; race/ethnicity; intersectionality; health promotion

Introduction

Although cardiovascular disease (CVD) is the leading cause of death worldwide (World Health Organization 2017; Roth, Johnson, et al. 2017) a large number of risk factors for CVD are modifiable (Centers for Disease Control and Prevention 2017a). Indeed, nine potentially modifiable risk factors (including tobacco use, dietary patterns, physical activity, psychosocial factors, obesity, hypertension, diabetes, and hyperlipidemia) account for over 90% of the risk for heart attack and/or stroke in men and women (Yusuf et al. 2004; Feigin et al. 2016). The continued rise in prevalence of modifiable risk factors, such as obesity and diabetes, poses a significant barrier to curbing rates of CVD (Bhupathiraju and Hu 2016). Therefore, reducing CVD mortality through reduction of modifiable risk factors has been identified as a global public health objective (World Health Organization 2014).

Despite improvements in the prevention and treatment of CVD and a decline in CVD mortality (Roth, Dwyer-Lindgren, et al. 2017), significant racial/ethnic (Havranek et al. 2015) and sex (Wenger 2012; Mosca et al. 2011) differences in the prevalence of CVD persist. However, even though sexual minorities (e.g., gay/lesbian, bisexual, not sure) report higher rates of risk factors for CVD than heterosexual adults (Caceres et al. 2017), they continue to be underrepresented in CVD research. Although substantial disparities in mental health (Plöderl and Tremblay 2015) and substance use (McCabe et al. 2019; Hughes et al. 2010) have been documented among sexual minorities, less is known about physical health disparities in this population, including CVD. There is growing evidence that certain sexual minority groups in the United States (U.S.) have increased risk for CVD compared to their heterosexual counterparts. A systematic review of 31 studies documented higher rates of poor mental health, current tobacco use, alcohol consumption, and obesity among sexual minority women (SMW) and higher rates of poor mental health and current tobacco use among sexual minority men (SMM) than among their heterosexual counterparts (Caceres et al. 2017).

With the exception of a small number of studies (Caceres et al. 2018a; Kinsky et al. 2016; Everett and Mollborn 2013; Caceres et al. 2018b; Hatzenbuehler, McLaughlin, and Slopen 2013), researchers have not objectively assessed physiological risk factors for CVD

(e.g., body mass index [BMI], blood pressure, glycosylated hemoglobin [HbA1c], total cholesterol) in this population (Caceres et al. 2017). The few studies that have used objective measures to examine CVD risk in sexual minorities have found elevated BMI, waist circumference, and hyperglycemia in SMW (Caceres et al. 2018a; Caceres, Markovic, et al. 2019; Kinsky et al. 2016) and elevated BMI, blood pressure, and HbA1c in bisexual men (Caceres et al. 2018b). Further, analyses of data from the National Longitudinal Study of Adolescent to Adult Health (Add Health) suggest that young adult (ages 24–32 years) SMM have higher levels of diastolic blood pressure (DBP) than their heterosexual counterparts (Hatzenbuehler, McLaughlin, and Slopen 2013; Everett and Mollborn 2013).

The National Academy of Medicine recommended that researchers consider the effect of minority stressors (e.g., discrimination and violence) and overlapping minority identities on health outcomes among lesbian, gay, bisexual and transgender (LGBT) people (Institute of Medicine 2011). The prevailing explanation for health disparities in sexual minorities is the minority stress model. The minority stress model posits that, as members of a stigmatized population, sexual minorities are exposed to minority stresors that can negatively impair their health (Meyer 2003). Further, intersectionality recognizes that stigmatized identities (e.g., sexual minority, racial/ethnic minority) are interrelated and may adversely impact health through exposure to chronic stress that accumulates over time (Bowleg 2008; Crenshaw 1991). Therefore, individuals that belong to multiple stigmatized populations, such as sexual minorities of color, may have greater susceptible to the negative health effects associated with stigma.

Studies focusing on CVD risk across racial/ethnic groups by sexual identity are sparse, based largely on self-reported data, and report mixed findings. Data from population-based studies indicate that White and Black SMW are more likely to report being overweight and obese than their heterosexual peers of the same race/ethnicity (Newlin Lew et al. 2018; Trinh et al. 2017). Similarly, Latina lesbian women report higher rates of obesity compared to White heterosexual women (Newlin Lew et al. 2018). Longitudinal analyses of Add Health data have found that both White and Latina bisexual women have higher objectively measured BMI compared to heterosexual women of the same race/ethnicity, but no sexual identity differences were identified among Black women (Katz-Wise et al. 2014). With the exception of a few studies (Molina et al. 2014; Newlin Lew et al. 2018; Mays et al. 2002; Trinh et al. 2017), there is a paucity of research that has examined the intersection of sexual identity and race/ethnicity on hypertension and diabetes in women.

Fewer studies have examined how the intersection of sexual identity and race/ethnicity is associated with CVD risk in men. Trinh et al. (2017) found that White and Latino SMM reported lower rates of being overweight, but higher rates of hypertension compared to heterosexual men of the same race/ethnicity. In addition, data from the California Health Interview Survey (Deputy and Boehmer 2014) and Add Health (Katz-Wise et al. 2014) suggest that among White, Black, and Latino men, being a sexual minority might be protective against elevated BMI.

Existing data on CVD risk in sexual minorities are limited by the lack of objective measurements, which provides an inadequate understanding of their cardiovascular health

and related healthcare needs. In addition, to date, there is limited research on CVD risk in sexual minorities of color. These factors limit the ability of clinicians and public health practitioners to develop tailored interventions for CVD risk reduction for sexual minorities that may be most at risk, such as racial/ethnic minorities. Given evidence of higher CVD risk factors in SMW and bisexual men, understanding variations in CVD risk by race/ethnicity is an important step to identify which individuals within the sexual minority population are most at risk for CVD.

Therefore, the present study builds on previous research to advance knowledge of CVD risk in sexual minorities with attention to potential heterogeneity across racial/ethnic groups. The findings of this study have the potential to inform future practice and research to improve the cardiovascular health of sexual minorities. We sought to address knowledge gaps in the literature (including the lack of focus on intersecting identities and an overreliance on self-reported measures) to compare physiological risk factors for CVD between sexual minorities and their hetersoexual counterparts. We used data from NHANES (2001–2016), a nationally representive study, to examine the intersection of sexual identity and race/ethnicity on physiological risk factors (including BMI, systolic blood pressure [SBP], DBP, HbA1c, and total choelsterol) among adults (ages 18 to 59) in the U.S. We compared heterosexual participants to gay/lesbian, bisexual, and “not sure” groups first without regard to race/ethnicity and then across racial/ethnic groups. Based on previous evidence and consistent with an intersectional approach, we hypothesized that sexual minorities of color would have higher CVD risk than their White heterosexual peers.

Materials and Methods

Sample

NHANES is the largest nationally representative survey that includes measures of both sexual identity and CVD biomarkers. The sampling design of NHANES permits representative sampling of non-institutionalized individuals across all 50 states and the District of Columbia. NHANES uses a complex multi-stage probability sampling design. The first stage consists of selection of primary sampling units, including individual counties or smaller contiguous counties. In the second stage, segments are selected from within these counties. Then dwelling units or households are selected within each segment. Selection of individuals within households occurs at random with an average of 1.6 persons selected per household. NHANES oversamples Black, Hispanic, and persons at or below 130% of the federal poverty level. Detailed information on NHANES sampling design is described elsewhere (Johnson et al. 2014; Curtin, Mohadjer, and Dohrmann 2013; Curtin et al. 2012). Data collection consists of home interviews and a standardized physical examination, which includes body measures and blood draws.

Inclusion criteria.—NHANES participants under the age of 18 and over the age of 59 do not complete the sexual identity and sexual behavior questionnaire. Therefore, we included all participants between the ages of 18 and 59. A total of 32,797 adult participants were deemed potentially eligible.

Exclusion criteria.—We excluded participants missing data for sexual identity (men=3,073; women=3,666) and those that reported their sexual identity was “something else” (men=61; women=98), refused to answer the sexual identity item (men=30; women=46), or responded “don’t know” (men=65; women=75). We excluded participants who identified as other race (e.g., Asian, American Indian, Pacific-Islander; n=2,317) due to low sample sizes to conduct intersectional analyses. Because elevations in BP and hyperglycemia may occur during pregnancy (The American College of Obstetricians and Gynecologists 2017), we excluded 936 women with a confirmed pregnancy at the time of data collection. An additional 125 participants were excluded because they responded “refused” or “don’t know” to demographics and/or health behaviors.

Measures

Sexual identity.—Sexual identity was categorized as heterosexual, gay/lesbian, bisexual, or “not sure” based on participant responses to the item: “Do you think of yourself as heterosexual or straight, homosexual or lesbian, bisexual, something else, or not sure?”

Demographics.—Demographics included age (continuous), race/ethnicity (White, Black, Latino/a), education (less than high school, high school graduate, some college or Associate’s degree, college or technical college graduate), relationship status (married/living with partner, single, other), employment (employed, unemployed [looking], and unemployed [not looking]) and health insurance coverage. The family income to poverty ratio, hereafter referred to as income ratio, was calculated by dividing the total household income by the poverty threshold as published by the Federal Register for that specific survey year and provided by NHANES. Higher levels of the income ratio represent higher income.

Health behaviors.—We assessed current tobacco use (yes vs. no). Based on established criteria, women who reported more than 3 drinks per day or 7 drinks per week were classified as risky drinkers. Men who reported more than 4 drinks per day or 14 drinks per week were classified as a risky drinkers (National Institute on Alcohol Abuse and Alcoholism 2017). Next, we assessed whether participants met physical activity recommendations for adults. Participants were categorized as meeting physical activity recommendations if they reported ≥ 150 minutes of moderate-intensity aerobic activity per week, ≥ 75 minutes of vigorous-intensity aerobic activity per week, or an equivalent combination of moderate- and vigorous-intensity aerobic activity per week (Centers for Disease Control and Prevention 2019).

Medication use.—The use of anti-hypertensives, anti-diabetic (i.e., oral hypoglycemics and insulin) and cholesterol-lowering medications was assessed based on participant self-report.

Physiological risk.—Trained health technicians used standardized procedures (described elsewhere) for the collection of biomarkers (Centers for Disease Control and Prevention 2011). BMI (kg/m^2) was calculated from objectively measured height and weight (Centers for Disease Control and Prevention 2017b). Approximately 99% of participants in the present study had at least three BP measurements. We used the average of all available BP

measurements to assess average SBP and DBP (mm Hg). Data for HbA1c (%) and total cholesterol (mg/dL) were obtained via venipuncture.

Statistical Analyses

All analyses were conducted in Stata version 15. Two-year survey weights were averaged and combined prior to conducting analyses, as recommended (Johnson et al. 2013). Multiple imputation with chained equations with 50 imputations was used to impute missing values (Sullivan et al. 2015). All biomarkers (BMI, SBP, DBP, HbA1C, and total cholesterol) were log-transformed to normalize their distributions. We used chi-square and Student's *t* tests to examine sexual identity differences for categorical and continuous variables, respectively. In all analyses, gay/lesbian, bisexual, and "not sure" participants were separately compared to heterosexual participants of the same sex (reference group). We used sex-stratified multiple linear regression models adjusted for pre-determined covariates to examine differences in physiological risk factors for CVD between sexual minority and heterosexual participants. Model 1 was unadjusted, Model 2 added adjustment for demographic characteristics, and Model 3 added health behaviors, BMI, and medication use. The relatively small number of sexual minority people of color per strata in NHANES caused missing strata when we applied survey weights. Therefore, we were unable to compare sexual minority participants to heterosexuals within same race/ethnicity categories. Instead we added created a variable to account for the intersection of sexual identity (heterosexual, gay/lesbian, bisexual, or not sure) and race/ethnicity (White, Black, or Latino/a). We then conducted sex-stratified linear regression models that included this variable to examine differences in CVD risk across race/ethnicity with White heterosexuals (the largest group) as the reference group. These models were fully adjusted for demographic characteristics, health behaviors, and medication use.

Results

After applying exclusion criteria, the final sample consisted of 22,305 participants. The sample included 10,995 women, of which 10,194 were heterosexual (93.5%), 160 lesbian (1.5%), 418 bisexual (3.7%), and 223 (1.3%) were "not sure" of their sexual identity (Table 1). Bisexual women were younger ($p<0.001$), less likely to identify as Latina ($p=0.02$), and less likely to have graduated college or technical college ($p=0.01$) than heterosexual women. Compared to heterosexual women, "not sure" women were less likely to identify as White ($p<0.001$), to have graduated college or technical college ($p<0.001$), and to be currently employed ($p<0.001$). All SMW reported a lower income ratio, were less likely to be married/living with a partner, and had lower rates of health insurance coverage relative to heterosexual women. Lesbian and bisexual women reported higher rates of current tobacco use ($p<0.001$) and risky drinking ($p<0.001$) than heterosexual women. Bisexual women reported lower rates of anti-hypertensive ($p<0.001$) and cholesterol lowering medication use ($p<0.01$). Compared to heterosexual women, bisexual women had higher BMI ($p=0.03$) but lower SBP ($p=0.02$), DBP ($p<0.01$), and total cholesterol ($p<0.001$). "Not sure" women had higher SBP ($p=0.04$) and HbA1c ($p=0.02$), but lower DBP ($p<0.01$) than heterosexual women (see Figure 1).

The sample included 11,310 men of which 10,773 were heterosexual (95.3%), 219 gay (2.4%), 167 bisexual (1.4%), and 151 (0.9%) were “not sure” of their sexual identity (Table 2). Compared to heterosexual men, gay men were more likely to be White (p=0.01), have graduated college or technical college (p<0.001), and have health insurance coverage (p<0.001). Gay (p<0.001) and bisexual (p<0.001) men were more likely than heterosexual men to be single. Bisexual (p=0.01) and “not sure” men (p<0.001) had lower income ratios than heterosexual men. “Not sure” men were more likely than heterosexual men to identify as Latino (p<0.001), have not graduated high school (p<0.001), and have lower rates of health insurance coverage (p<0.001). Gay men reported lower rates of risky drinking than heterosexual men (p<0.001). Compared to heterosexual men, bisexual men reported higher rates of current tobacco use (p=0.04), anti-hypertensive (p<0.01), and anti-diabetic medication use (p<0.001). Gay men had lower BMI (p<0.01), SBP (p=0.04), and HbA1c (p<0.001) than heterosexual men. Bisexual men had lower total cholesterol relative to heterosexual men (p=0.04). “Not sure” men had higher SBP (p=0.02) and HbA1c (p<0.01) than heterosexual men (see Figure 1).

Table 3 presents physiological risk factors for CVD for all participants stratified by sex. Lesbian (*B(SE)* 0.052(0.020), p <0.05) and bisexual (*B(SE)* 0.054(0.018), p <0.01) women had higher BMI than heterosexual women. Bisexual women (*B(SE)* 0.004(0.006), p <0.05) also had higher SBP relative to heterosexual women. Lesbian women (*B(SE)* −0.050(0.016), p <0.01) had lower total cholesterol than heterosexual women. Compared to heterosexual men, gay men had lower BMI (*B(SE)* −0.041(0.017), p <0.01) and HbA1c (*B(SE)* −0.017(0.007), p <0.05).

Table 4 shows results of the analysis examining the intersection of sexual identity and race/ethnicity on physiological CVD risk in women. White (*B(SE)* 0.077(0.025), p <0.01) and Black lesbian women (*B(SE)* 0.088(0.040), p <0.05) as well as each racial/ethnic group of bisexual women (White *B(SE)* 0.058(0.021), p <0.01); Black *B(SE)* 0.104(0.027), p <0.001); Latina *B(SE)* 0.106(0.030), p <0.01) had higher BMI compared to White heterosexual women. Black bisexual women (*B(SE)* 0.025(0.012), p <0.05) had higher SBP relative to White heterosexual women, whereas Latina “not sure” women (*B(SE)* −0.047(0.018), p <0.05) had lower DBP. Black (*B(SE)* 0.024(0.010), p <0.001) bisexual women, and Latina “not sure” women (*B(SE)* 0.043(0.014), p <0.01) had higher HbA1c than White heterosexual women. White lesbian women (*B(SE)* −0.075(0.022), p <0.001) and Black bisexual women (*B(SE)* −0.048 (0.018), p <0.01) had lower total cholesterol relative to White heterosexual women.

Table 5 presents results of the analysis examining the intersection of sexual identity and race/ethnicity on physiological CVD risk in men. Black (*B(SE)* 0.056(0.027), p <0.05) and Latino “not sure” men (*B(SE)* 0.031(0.010), p <0.01) had higher SBP relative to White heterosexual men. Black bisexual men had higher DBP than White heterosexual men (*B(SE)* 0.055(0.025), p <0.05). All Black SMM (gay *B(SE)* 0.028(0.010), p <0.01; bisexual *B(SE)* 0.079(0.035), p <0.05; “not sure” *B(SE)* 0.066(0.026), p <0.05) and Latino “not sure” men (*B(SE)* 0.051(0.018), p <0.01) had higher HbA1c than White heterosexual men. Compared to their White heterosexual peers, Latino “not sure” men also had higher total cholesterol (*B(SE)* 0.046(0.020), p <0.05).

Discussion

This study is an important contribution to understanding how the intersection of sexual identity and race/ethnicity is associated with physiological risk factors for CVD among adults. Research is in this area is limited with only one previous study identified (Katz-Wise et al. 2014). Our study builds on the work of Katz-Wise et al. (2014) by examining physiological risk factors for CVD in addition to BMI.

Using an intersectional approach we identified significant racial/ethnic differences in the association of sexual identity and CVD risk factors. With the exception of lower total cholesterol for some SMW, bisexual women, in particular Black women, had higher levels of several CVD risk factors compared to White heterosexual women. White and Black lesbian women and all bisexual women, regardless of race/ethnicity, had higher BMI than White heterosexual women. Black bisexual women also had higher SBP and HbA1c relative to White heterosexual women. Although we identified fewer differences among men it appears that Black and Latino SMM have higher risk for CVD than their White heterosexual peers. Indeed, “not sure” Latino men had higher SBP, HbA1c, and total cholesterol than White heterosexual men. Also, compared to White heterosexual men, all groups of Black SMM had higher HbA1c.

There is a need for future research that explores how sociocultural factors (e.g., experiences of discrimination and family support) might contribute to the racial/ethnic differences in CVD risk identified in the present study. This is important to consider since Black and Latino sexual minorities report higher rates of multifactorial discrimination (discrimination due to multiple sources and for several reasons) and stressful life events (e.g., interpersonal violence) compared to White sexual minorities (Khan, Ilcisin, and Saxton 2017; Caceres, Veldhuis, and Hughes 2019). In addition, sexual minorities of color might face discrimination and rejection from both members of their family (Smith, Perrin, and Sutter 2019; Li et al. 2017; Shelton and Delgado-Romero 2011) and White sexual minorities (Teunis 2007; Keene et al. 2017). Exposure to these additional stressors is a possible explanation for the higher CVD risk we identified in sexual minorities of color. Therefore, psychosocial mechanisms that might contribute to higher CVD risk in sexual minorities of color should be examined in future work.

A notable strength of the present study was the inclusion of “not sure” or questioning individuals, who are understudied within the sexual minority health literature. Multiple studies indicate that “not sure” individuals report higher rates of interpersonal violence (Hughes et al. 2010; Coulter et al. 2017), poor mental health (Bostwick et al. 2010), and substance use disorders (Boyd et al. 2019; Corliss et al. 2014) compared to their heterosexual counterparts. Despite a dearth of research on CVD risk in “not sure” populations, the higher HbA1c in Latina “not sure” women and higher SBP and HbA1c in “not sure” Black and Latino men in the present study warrant increased attention to CVD risk in these groups.

Clinicians should be educated about the potential influence of minority stressors and other sociocultural factors on the cardiovascular health of sexual minorities. Leading professional

organizations have affirmed a commitment to promoting the health of sexual minorities (ANA Center for Ethics and Human Rights 2018; American Psychological Association 2016; American Medical Association 2018). Despite these efforts, health professions curricula generally do not prepare students to address the healthcare needs of sexual minorities (Dorsen 2012; Obedin-Maliver et al. 2011; White et al. 2015; Greene et al. 2018). Strengthening sexual minority health content in these curricula is a critical step for addressing CVD and other health concerns in this population.

Furthermore, the collection of sexual orientation and gender identity (SOGI) data as part of the electronic health records (EHRs) presents unique challenges and opportunities for studying CVD risk in sexual minority populations. Since January 2018 the assessment of SOGI data has been included as part of meaningful use of EHRs (Office of the National Coordinator for Health Information Technology 2015); however, this policy does not require clinicians to assess SOGI data (Cahill et al. 2016). The availability of EHR data on SOGI has potential to advance the study of CVD in sexual minority populations. However, clinicians must understand the importance of capturing these data (Bosse et al. 2018). Therefore, in addition to addressing the aforementioned gaps in the health professions curricula, content on sexual minority health should be included within continuing education programs for practicing clinicians.

Our findings have implications for health promotion and disease prevention for sexual minorities, particularly people of color. Although additional research is needed to better understand racial/ethnic differences in CVD risk in this population, there is a need for risk reduction for elevated BMI in SMW and elevated blood pressure and HbA1c in Black bisexual women and Black and Latino SMM. Given the lack of existing interventions for sexual minorities (Coulter, Kenst, and Bowen 2014), behavioral interventions are needed that target well-established CVD risk factors in this population (including tobacco use, heavy drinking, and poor mental health). As sexual minorities report low rates of preventive care utilization (Qureshi et al. 2018; Whitehead, Shaver, and Stephenson 2016; Gahagan and Subirana-Malaret 2018), the feasibility and effectiveness of implementing targeted interventions for CVD risk reduction in community-based settings (e.g., LGBT community centers or senior centers) should be assessed. We recommend that clinicians and public health practitioners partner with LGBT community organizations to develop tailored interventions to improve the cardiovascular health of sexual minorities at highest risk. Further, public health campaigns focused on reducing CVD risk in racial/ethnic minorities should address the potential differential impact of sexual identity on CVD risk in these populations.

Limitations

This study has several limitations that provide opportunities for future research. First, we compared all sexual minorities to White heterosexuals rather than to heterosexual participants of the same race/ethnicity. Analyses comparing SMW and SMM to heterosexuals of the same race/ethnicity are important given the mixed results reported in prior studies. However, due to sample size constraints, we were unable to compare Black and Latina SMW to their heterosexual counterparts of the same race/ethnicity. By

comparison, Katz-Wise and colleagues (2014) found that White and Latina bisexual women had higher BMI than their heterosexual peers of the same race/ethnicity.

The inclusion of sexual orientation as a measure in all national population-based studies would hopefully address this concern and provide an opportunity to expand research on the synergistic effect of sexual identity and race/ethnicity on health outcomes. Given mounting evidence of higher CVD risk in SMW and bisexual men we encourage federal agencies to implement policies to: 1) add multidimensional measures of sexual orientation (including sexual identity, sexual behavior, and attraction) to population-based surveys and 2) adopt methods for oversampling sexual minorities in a similar manner in which other underserved populations (e.g., racial/ethnic minorities, low-income, and older adults) are oversampled. Implementation of these recommendations will require changes to existing policies and collaboration between stakeholders (including government agencies, health systems, LGBT community groups, and sexual minority health researchers).

Although the present study was informed by the minority stress model and intersectionality, data on minority stressors (e.g., victimization, discrimination) that are posited to contribute to poor cardiovascular health among sexual and racial/ethnic minorities are not available in NHANES. Similarly, we did not assess mental distress or depression as factors that can influence CVD risk since these variables were not measured consistently across all NHANES years included in this study. This is important to consider as sexual minorities report higher rates of mental distress and depression than their heterosexual counterparts (Meyer, Dietrich, and Schwartz 2008; Bränström and Pachankis 2018; Caceres, Makarem, et al. 2019). It is possible that the differences in CVD risk observed in our study may be attributed to the burden of minority stressors and/or poor mental health. Future studies should examine whether these factors explain some of the differences in CVD risk that we identified in sexual minorities of color.

Moreover, NHANES is a cross-sectional survey, which limits causal inference. Longitudinal studies that examine the association of sexual identity and CVD risk factors over time are needed since most existing studies are cross-sectional (Caceres et al. 2017). Longitudinal designs will permit researchers elucidate factors that contribute to the higher CVD risk we observed in certain subgroups. This is especially important to establish the temporality of potential risk (e.g., minority stressors and mental distress) and protective factors (e.g., social support and coping).

Due to the lack of previous studies that have examined the intersection of sexual identity and race/ethnicity on blood pressure, HbA1c, and total cholesterol we are unable to compare these results to previous work. Therefore, there is a need for future research to assess whether the racial/ethnic differences described in the present study are consistent in other samples of sexual minorities.

Conclusions

Using nationally representative data we used an intersectional approach to assess racial/ethnic differences in CVD risk between sexual minority and heterosexual adults in the

U.S. Despite the identified limitations the present study used the strongest available nationally representative data to examine the heterogeneity of CVD risk factors among sexual minorities using objective measures. We found that CVD risk was more pronounced among Black lesbian women and bisexual women of color due to higher levels of BMI and HbA1c. Among men, Black SMM and Latino "not sure" men showed the highest CVD risk factors, reflected by elevations in SBP and HbA1c. White gay men had lower risk of CVD compared with White heterosexual men. These findings have important implications for health promotion efforts focused on reducing CVD risk in sexual minorities. Additional research is needed to elucidate potential explanations for these findings.

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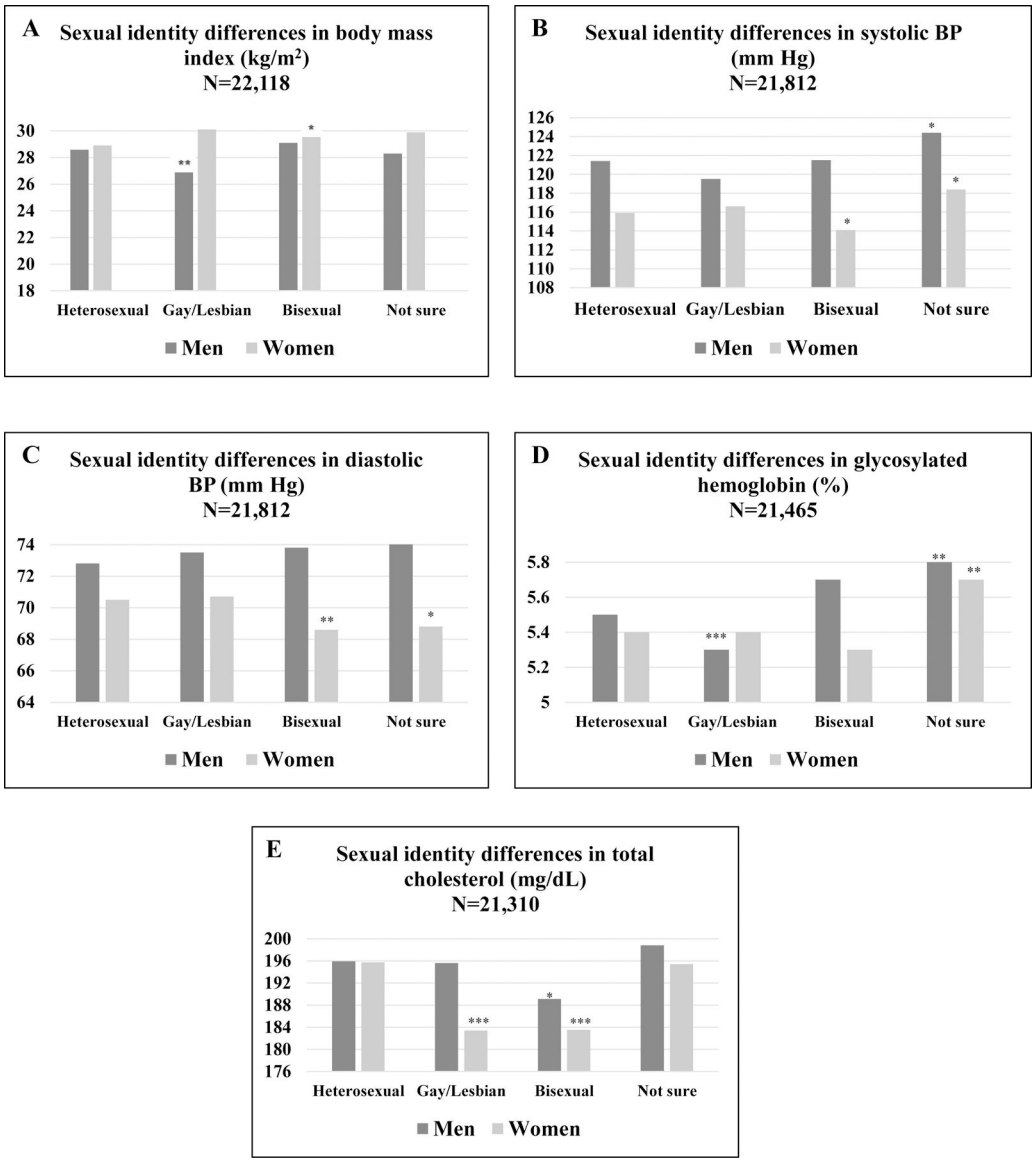

Figure 1. Sexual identity differences in physiological risk factors for CVD

Note. Sample sizes vary due to missing data. Analyses were unadjusted; reference group = same-sex heterosexuals; * $p < 0.05$; **$p < 0.01$; ***$p < 0.001$

Table 1.

Sexual identity differences in demographic characteristics, health behaviors, medication use, and physiological risk in women (ages 18–59), NHANES 2002–2016 (N=10,995)

		Heterosexual (n=10,194)	Lesbian (n=160)	p-value Heterosexual vs. Lesbian women	Bisexual (n=418)	p-value Heterosexual vs. Bisexual women	Not sure (n=223)	p-value Heterosexual vs. Not sure women
Demographic characteristics	Sample size	weighted %/mean (SE)						
Age (mean)	10,995	39.9 (0.2)	37.5 (1.2)	0.06	32.1 (0.6)	<0.001***	40.2 (1.0)	0.77
Race/ethnicity	10,995			0.08		0.02*		<0.001***
Non-Hispanic White		72.1%	70.9%		73.5%		40.5%	
Non-Hispanic Black		13.1%	18.5%		15.7%		19.2%	
Hispanic		14.8%	10.6%		10.8%		40.3%	
Family income to poverty ratio (mean)	10,304	3.0 (0.0)	2.6 (0.2)	<0.01**	2.4 (0.1)	<0.001***	1.9 (0.1)	<0.001***
Education	10,995			0.94		0.01*		<0.001***
Did not graduate high school		13.6%	12.1%		17.6%		42.6%	
Graduated high school		21.3%	21.7%		24.1%		26.3%	
Attended college/technical college		35.1%	37.5%		38.4%		17.4%	
Graduated college/technical college		30.0%	28.7%		19.9%		13.7%	
Relationship status	10,533			<0.001***		<0.001***		<0.001***
Married/living with partner		64.7%	30.9%		45.5%		48.9%	
Single		18.5%	51.2%		39.1%		27.8%	
Other		16.8%	17.9%		15.4%		23.3%	
Employment status	10,992			0.87		0.07		<0.001***
Employed		70.4%	70.1%		67.1%		55.5%	
Unemployed, looking		2.7%	2.0%		4.8%		5.8%	
Unemployed, not looking		26.9%	27.9%		28.1%		38.7%	
Health insurance coverage	10,970	81.7%	74.5%	0.04*	72.0%	<0.001***	57.0%	<0.001***

		Heterosexual (n=10,194)	Lesbian (n=160)	p-value Heterosexual vs. Lesbian women	Bisexual (n=418)	p-value Heterosexual vs. Bisexual women	Not sure (n=223)	p-value Heterosexual vs. Not sure women
Health behaviors								
Tobacco use	10,785	22.3%	38.9%	<0.001***	41.0%	<0.001***	21.5%	0.79
Risky drinking	9,087	17.3%	31.6%	<0.001***	31.3%	<0.001***	21.3%	0.29
Meets physical activity recommendation	9,755	34.5	44.1	0.08	39.1	0.14	29.9%	0.31
Medication use								
Anti-hypertensive	10,416	15.0%	11.7%	0.32	5.1	<0.001***	14.7%	0.91
Anti-diabetic	10,522	2.3%	0.4%	0.04*	1.2%	0.24	4.9%	0.03*
Cholesterol-lowering	9,252	8.9%	5.4%	0.24	3.2%	<0.01**	11.2%	0.40
Physiological risk								
BMI (kg/m^2)	10,885	28.9 (0.1)	30.1 (0.6)	0.06	30.1 (0.6)	0.03*	29.9 (0.7)	0.16
SBP (mm Hg)	10,703	115.9 (0.2)	116.6 (1.5)	0.67	114.1 (0.7)	0.02*	118.4 (1.2)	0.04*
DBP (mm Hg)	10,703	70.5 (0.2)	70.7 (0.9)	0.82	68.6 (0.6)	<0.01**	68.9 (0.7)	0.02*
HbA1c (%)	10,600	5.4 (0.1)	5.4 (0.1)	0.96	5.3 (0.1)	0.08	5.7 (0.1)	<0.01**
Total cholesterol (mg/dL)	10,502	195.7 (0.6)	183.4 (3.4)	<0.001***	183.5 (2.4)	<0.001***	195.4 (3.1)	0.92

Note. Reference group = same-sex heterosexual participants;

* $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$.

Table 2.

Sexual identity differences in demographic characteristics, health behaviors, medication use, and physiological risk in men (ages 18–59), NHANES 2002–2016 (N=11,310)

		Heterosexual (n=10,773)	Gay (n=219)	p-value Heterosexual vs. Gay men	Bisexual (n=167)	p-value Heterosexual vs. Bisexual men	Not sure (n=151)	p-value Heterosexual vs. Not sure men
Demographic characteristics	Sample size	weighted %/mean (SE)						
Age (mean)	11,310	38.8 (0.2)	40.5 (1.2)	0.15	38.6 (1.2)	0.80	40.6 (1.3)	0.16
Race/ethnicity	11,310			0.01 *		0.87		<0.001 ***
Non-Hispanic White		71.7%	81.3%		73.0%		28.7%	
Non-Hispanic Black		11.7%	8.4%		11.6%		11.3%	
Hispanic		16.6%	10.3%		15.4%		60.0%	
Family income to poverty ratio (mean)	10,568	3.1 (0.0)	3.4 (0.2)	0.10	2.6 (0.1)	0.01 *	1.6 (0.1)	<0.001 ***
Education	11,310			<0.001 ***		0.88		<0.001 ***
Did not graduate high school		16.6%	2.2%		16.5%		66.8%	
Graduated high school		26.1%	13.2%		26.3%		18.6%	
Attended college/technical college		31.4%	35.6%		34.3%		6.3%	
Graduated college/technical college		25.9%	49.0%		22.9%		8.3%	
Relationship status	10,837			<0.001 ***		<0.001 ***		0.54
Married/living with partner		64.5%	38.8%		33.3%		60.8%	
Single		22.6%	56.2%		43.9%		27.0%	
Other		10.9%	5.0%		22.8%		12.2%	
Employment status	11,307			0.70		0.12		0.15
Employed		82.5%	80.4%		75.1%		74.7%	
Unemployed, looking		4.0%	3.8%		6.8%		5.3%	
Unemployed, not looking		13.5%	15.8%		18.1%		20.0%	
Health insurance coverage	11,282	75.2%	88.8%	<0.001 ***	71.2%	0.30	48.4%	<0.001 ***

		Heterosexual (n=10,773)	Gay (n=219)	p-value Heterosexual vs. Gay men	Bisexual (n=167)	p-value Heterosexual vs. Bisexual men	Not sure (n=151)	p-value Heterosexual vs. Not sure men
Health behaviors								
Tobacco use	11,077	27.6%	28.3%	0.89	36.5%	0.04*	20.7%	0.12
Risky drinking	10,350	27.3%	12.9%	<0.001***	32.5%	0.23	32.1%	0.36
Meets physical activity recommendation	9,977	48.6%	44.2%	0.38	43.9%	0.30	52.6%	0.49
Medication use								
Anti-hypertensive	10,507	13.1%	8.2%	0.08	24.1%	<0.01**	10.9%	0.46
Anti-diabetic	10,858	2.0%	0.0%	18.6	7.7%	<0.001***	4.0%	0.11
Cholesterol-lowering	9,523	10.6%	9.6%	0.75	13.4%	0.46	8.2%	0.36
Physiological risk								
BMI (kg/m^2)	11,233	28.6 (0.1)	27.2 (0.5)	<0.01**	29.1 (0.7)	0.48	28.3 (0.6)	0.59
SBP (mm Hg)	11,109	121.4 (0.2)	119.5 (0.9)	0.04*	121.5 (1.5)	0.97	124.4 (1.3)	0.02*
DBP (mm Hg)	11,109	72.8 (0.2)	73.45 (0.79)	0.40	73.8 (1.06)	0.36	74.1 (0.98)	0.20
HbA1c (%)	10,865	5.5 (0.1)	5.3 (0.4)	<0.001***	5.7 (0.1)	0.09	5.8 (0.1)	<0.01**
Total cholesterol (mg/dL)	10,808	195.9 (0.6)	195.6 (3.2)	0.92	189.1 (3.5)	0.04*	198.8 (3.0)	0.34

Note. Reference group = same-sex heterosexual participants;

* $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$.

Table 3.

Sexual identity differences in physiological risk factors among NHANES participants (2002–2016; N=22,305)

	Women (n=10,995)			Men (n=11,310)		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Physiological risk factors	*B*(SE)			*B*(SE)		
Body mass index						
Heterosexual	Ref	Ref	Ref	Ref	Ref	Ref
Gay/Lesbian	0.041 (0.021)	0.042 (0.020) *	0.052 (0.020) *	−0.051 (0.016) **	−0.045 (0.017) *	−0.041 (0.017) *
Bisexual	0.030 (0.018)	0.045 (0.017) *	0.054 (0.018) **	0.005 (0.023)	0.018 (0.022)	0.020 (0.022)
Not sure	0.032 (0.023)	−0.019 (0.023)	−0.020 (0.023)	−0.012 (0.019)	−0.029 (0.018)	−0.037 (0.019)
SBP [a]						
Heterosexual	Ref	Ref	Ref	Ref	Ref	Ref
Gay/Lesbian	0.010 (0.012)	0.011 (0.010)	0.012 (0.010)	−0.015 (0.001)	−0.019 (0.008) *	−0.013 (0.008)
Bisexual	−0.015 (0.010) *	0.012 (0.006) *	0.04 (0.006) *	−0.001 (0.012)	−0.003 (0.011)	−0.008 (0.011)
Not sure	0.017 (0.010)	0.002 (0.009)	0.003 (0.009)	0.024 (0.010) *	0.010 (0.010)	0.013 (0.010)
DBP [a]						
Heterosexual	Ref	Ref	Ref	Ref	Ref	Ref
Gay/Lesbian	0.003 (0.014)	0.011 (0.012)	0.013 (0.012)	0.012 (0.011)	0.005 (0.013)	0.007 (0.012)
Bisexual	−0.028 (0.010) **	0.003 (0.010)	0.010 (0.010)	0.015 (0.014)	0.019 (0.014)	0.018 (0.014)
Not sure	−0.029 (0.014) *	−0.024 (0.014)	−0.026 (0.014)	0.020 (0.013)	0.026 (0.013)	0.025 (0.013)
HbA1c [b]						
Heterosexual	Ref	Ref	Ref	Ref	Ref	Ref
Gay/Lesbian	0.003 (0.010)	0.005 (0.010)	0.012 (0.008)	−0.027 (0.007) ***	−0.024 (0.006) ***	−0.017 (0.007) *
Bisexual	−0.015 (0.007) *	0.005 (0.007)	0.004 (0.005)	0.027 (0.018)	0.027 (0.018)	0.010 (0.013)
Not sure	0.038 (0.013) **	0.008 (0.011)	0.001 (0.009)	0.053 (0.018) **	0.012 (0.014)	0.010 (0.012)

	Women (n=10,995)			Men (n=11,310)		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Total cholesterol [c]						
Heterosexual	Ref	Ref	Ref	Ref	Ref	Ref
Gay/Lesbian	−0.061 (0.018) **	−0.046 (0.17) **	−0.050 (0.016) **	0.001 (0.018)	0.010 (0.017)	0.010 (0.016)
Bisexual	−0.067 (0.013) ***	−0.015 (0.012)	−0.018 (0.012)	−0.034 (0.018)	−0.023 (0.018)	−0.022 (0.018)
Not sure	0.005 (0.015)	0.001 (0.014)	−0.001 (0.014)	0.020 (0.015)	0.016 (0.017)	0.016 (0.017)

Note. Biomarkers were log transformed; Model 1: unadjusted; Model 2 added demographic characteristics; Model 3 added health behaviors;

[a] Model 3 added adjustment for use of anti-hypertensive medications;

[b] Model 3 added adjustment for use of anti-diabetic medications;

[c] Model 3 added adjustment for use of cholesterol-lowering medications;

* $p < 0.05$;

** $p < 0.01$;

*** $p < 0.001$.

Table 4.

Intersection of sexual identity and race/ethnicity on physiological risk factors among women in NHANES (N=10,995)

	Body mass index	Systolic BP [a]	Diastolic BP [a]	Glycosylated hemoglobin [b]	Total cholesterol [c]
	B(SE)				
Heterosexual					
White	Ref	Ref	Ref	Ref	Ref
Black	0.100 (0.007) ***	0.032 (0.004) ***	0.010 (0.010) *	0.031 (0.004) ***	−0.041 (0.010) ***
Latina	0.024 (0.008) **	−0.007 (0.003) *	−0.028 (0.005) **	0.026 (0.003) ***	−0.013 (0.010)
Lesbian					
White	0.077 (0.025) **	0.009 (0.013)	0.008 (0.017)	0.014 (0.011)	−0.075 (0.022) **
Black	0.088 (0.040) *	0.018 (0.014)	0.044 (0.023)	0.026 (0.015)	−0.043 (0.030)
Latina	0.009 (0.063)	−0.005 (0.015)	−0.047 (0.030)	0.001 (0.015)	0.004 (0.032)
Bisexual					
White	0.058 (0.021) **	0.009 (0.007)	0.001 (0.011)	0.003 (0.010)	−0.025 (0.017)
Black	0.104 (0.027) ***	0.025 (0.012) *	−0.006 (0.021)	0.024 (0.010) **	−0.048 (0.018) **
Latina	0.106 (0.030) **	0.004 (0.013)	−0.011 (0.020)	0.014 (0.010)	−0.013 (0.023)
Not sure					
White	0.017 (0.045)	0.001 (0.016)	−0.038 (0.028)	−0.014 (0.010)	0.031 (0.024)
Black	−0.023 (0.46)	0.026 (0.020)	0.009 (0.026)	0.040 (0.027)	−0.073 (0.044)
Latina	0.021 (0.024)	0.011 (0.012)	−0.047 (0.018) *	0.043 (0.014) **	−0.025 (0.018)

Note. Biomarkers were log transformed; Model 1: unadjusted; Model 2 added age, race/ethnicity, family income to poverty ratio, education, relationship status, employment status, and health insurance coverage; Model 3 added tobacco use, risky drinking, physical activity, and body mass index;

[a] Model 3 added adjustment for use of anti-hypertensive medications;

[b] Model 3 added adjustment for use of anti-diabetic medications;

[c] Model 3 added adjustment for use of cholesterol-lowering medications;

* $p < 0.05$;

** $p<0.01$;

*** $p<0.001$.

Table 5.

Intersection of sexual identity and race/ethnicity on physiological risk factors among men in NHANES (N=11,310)

	Body mass index	Systolic BP [a]	Diastolic BP [a]	Glycosylated hemoglobin [b]	Total cholesterol [c]
	B(SE)				
Heterosexual					
White	Ref	Ref	Ref	Ref	Ref
Black	0.021 (0.010) **	0.030 (0.003) ***	0.010 (0.006) *	0.033 (0.003) ***	−0.020 (0.010) **
Latino	0.024 (0.010) **	−0.005 (0.002)	−0.017 (0.006) *	0.029 (0.004) ***	0.024 (0.010) ***
Gay					
White	−0.038 (0.020)	−0.006 (0.009)	0.014 (0.014)	−0.014 (0.010)	0.023 (0.019)
Black	−0.021 (0.034)	0.014 (0.015)	−0.001 (0.030)	0.028 (0.010) **	−0.056 (0.031)
Latino	−0.038 (0.031)	−0.016 (0.015)	0.003 (0.025)	0.020 (0.019)	−0.033 (0.030)
Bisexual					
White	0.041 (0.028)	−0.011 (0.013)	0.009 (0.0.16)	0.005 (0.016)	−0.025 (0.022)
Black	−0.051 (0.035)	0.14 (0.015)	0.055 (0.025) *	0.079 (0.035) *	−0.005 (0.042)
Latino	0.013 (0.051)	0.002 (0.017)	0.017 (0.028)	−0.001 (0.044)	−0.034 (0.034)
Not sure					
White	−0.058 (0.050)	−0.018 (0.016)	0.043 (0.023)	−0.007 (0.016)	0.001 (0.035)
Black	0.013 (0.065)	0.056 (0.027) *	0.020 (0.033)	0.066 (0.026) *	−0.010 (0.053)
Latino	−0.010 (0.015)	0.031 (0.010) **	0.011 (0.016)	0.051 (0.018) **	0.046 (0.020) *

Note. Biomarkers were log transformed; Model 1: unadjusted; Model 2 added age, race/ethnicity, family income to poverty ratio, education, relationship status, employment status, and health insurance coverage; Model 3 added tobacco use, risky drinking, physical activity and body mass index;

[a] Model 3 added adjustment for use of anti-hypertensive medications;

[b] Model 3 added adjustment for use of anti-diabetic medications;

[c] Model 3 added adjustment for use of cholesterol-lowering medications;

* $p < 0.05$;

** $p<0.01$;

*** $p<0.001$.