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# Cardiovascular disease risk in sexual minority women (18–59 years old): Findings from the National Health and Nutrition Examination Survey (2001–2012)

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## Abstract

**Objective—**Sexual minority women (SMW; lesbian and bisexual) experience significant stigma, which may increase their cardiovascular disease (CVD) risk. The purpose of this study was to examine the prevalence of modifiable risk factors for CVD (including mental distress, health behaviors, blood pressure, glycosylated hemoglobin, and total cholesterol) and CVD in SMW compared to their heterosexual peers.

**Materials and methods—**A secondary analysis of the National Health and Nutrition Examination Survey (2001–2012) was conducted. Multiple imputation with chained equations was performed. Logistic regression models adjusted for relevant covariates were run. Self-report

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(medical history and medication use) and biomarkers for hypertension, diabetes, and high total cholesterol were examined.

**Results—**The final analytic sample consisted of 7,503 that included 346 (4.6%) SMW. SMW were more likely to be younger, single, have lower income and lack health insurance. After covariate adjustment SMW exhibited excess CVD risk related to higher rates of frequent mental distress (AOR 2.05, 95% CI= 1.45, 2.88), current tobacco use (AOR 2.11, 95% CI= 1.53, 2.91), and binge drinking (AOR 1.66, 95% CI= 1.17, 2.34). SMW were more likely to be obese (AOR 1.61, 95% CI= 1.23, 2.33) and have glycosylated hemoglobin consistent with pre-diabetes (AOR 1.56, 95% CI= 1.04, 2.34). No differences were observed for other outcomes.

**Conclusions—**SMW demonstrated increased modifiable risk factors for CVD but no difference in CVD diagnoses. Several emerging areas of research are highlighted, in particular, the need for CVD prevention efforts that target modifiable CVD risk in SMW.

## Introduction

Sexual minorities (lesbian, gay, and bisexual individuals) experience significant health disparities related to stigma (Institute of Medicine, 2011). A growing body of research indicates that sexual minorities are exposed to interpersonal and structural stigma that is associated with negative health outcomes (Meyer, 2003), poor mental health (Collier, van Beusekom, Bos, & Sandfort, 2013; Cramer, McNiel, Holley, Shumway, & Boccellari, 2011), decreased life expectancy, and increased mortality (Hatzenbuehler, Bellatorre, et al., 2014). Approximately 80% of sexual minorities report experiencing some form of harassment (Katz-Wise & Hyde, 2012) and 20–33% have experienced a hate crime in their lifetime (Burks et al., 2015; Herek, 2009). In 2016, sexual orientation motivated violence accounted for 17.7% of all hate crimes reported in the United States, representing a 2% increase compared to the previous year (U.S. Department of Justice, 2017). Social policies represent forms of structural stigma that can also negatively impact the health of sexual minorities. Currently only 31 states have hate crime laws prohibiting bias-motivated violence against sexual minorities and there is no federal law that prohibits discrimination based on sexual orientation (Human Rights Campaign, 2015). Additional factors associated with health disparities in this population include inadequate training of healthcare providers, poverty, and lower rates of health insurance coverage (Institute of Medicine, 2011).

It is well documented that compared to their heterosexual counterparts sexual minority women experience significant health disparities, such as higher rates of poor mental health (King et al., 2008; Pakula & Shoveller, 2013; Plöderl & Tremblay, 2015), obesity, and gynecological cancers (Institute of Medicine, 1999); however, little is known about disparities in other chronic conditions, including cardiovascular disease (CVD) (Lick, Durso, & Johnson, 2013). CVD remains the leading cause of death worldwide (World Health Organization, 2014) and approximately 90% of CVD risk is attributed to modifiable risk factors including psychosocial factors, tobacco use, alcohol consumption, physical inactivity, diet, obesity, hypertension, diabetes, and lipids (Yusuf et al., 2004). Stress is a recognized CVD risk factor (Jood, Redfors, Rosengren, Blomstrand, & Jern, 2009; Rosengren et al., 2004; Steptoe & Kivimäki, 2013; Teo et al., 2009) that has a deleterious effect on the health of sexual minorities (Meyer, 2003). Stress contributes to inflammation

and endothelial dysfunction that increase CVD risk through mediated pathways (Cohen et al., 2012; Xue et al., 2015). Stress is also associated with negative health behaviors that increase CVD risk including tobacco use, binge drinking, physical inactivity, and unhealthy dietary patterns (American Psychological Association, 2017). Maladaptive coping strategies associated with stress, such as tobacco and alcohol use, predispose sexual minority women to increased risk for CVD compared to their heterosexual peers (Bloomfield, Wicki, Wilsnack, Hughes, & Gmel, 2011; Blosnich, Lee, & Horn, 2013). In addition, two recent systematic reviews concluded that sexual minority women demonstrate higher rates of obesity than heterosexual women (Caceres et al., 2017; Eliason et al., 2015).

The National Academy of Medicine underscored the need for research on CVD in sexual minorities (Institute of Medicine, 2011). A recent systematic review examined CVD risk and CVD diagnoses in sexual minority and heterosexual adults (Caceres et al., 2017). Overall, sexual minority women exhibited greater CVD risk compared to heterosexual women. Despite the strength of these findings the authors identified several limitations of the empirical literature. Although stress is posited as a main contributor to health disparities in sexual minorities (Lick et al., 2013), only five studies included any measures of stress. Also, to date, few researchers have used biomarkers to examine CVD in sexual minorities. Most data are based on participant self-report, with only seven studies including biomarkers. The present study sought to address these research gaps.

We hypothesized that sexual minority women would exhibit greater modifiable risk factors for CVD compared to heterosexual women. Thus, the purpose of this study, using data from the National Health and Nutrition Examination Survey (NHANES) (2001–2012), was to examine the prevalence of modifiable risk factors for CVD (including mental distress, tobacco use, alcohol consumption, physical inactivity, and dietary fat intake, hypertension, diabetes, and high total cholesterol) and CVD outcomes in sexual minority and heterosexual women.

## Materials and Methods

A secondary analysis of NHANES (2001–2012) data was conducted. NHANES is a national cross-sectional survey used to monitor the health of the nation by estimating the prevalence of major diseases and risk factors (Johnson, Dohrmann, Burt, & Mohadjer, 2014). NHANES is the largest national survey in the United States that collects information about sexual identity and the biomarkers of interest. NHANES uses a complex multi-stage probability sampling design to achieve a representative sample of individuals from across the United States (Johnson et al., 2014). Data from the 2013–2014 NHANES release was not included because the measure of mental distress used from 2001–2012 was removed starting this cycle. This study was exempt by the Institutional Review Board of New York University.

### Sample Size

**Inclusion criteria—**Only participants between the ages of 18–59 were asked about sexual identity as part of the sexual behavior module in NHANES. All female adult participants who identified as sexual minority women (lesbian and bisexual), regardless of sexual behavior, were included in this study. As we were primarily concerned with the impact of

sexual identity on CVD risk, we only included participants who identified as heterosexual and reported no sexual behavior with women.

**Exclusion criteria—**The following participants were excluded: 1) those who responded "don't know," "refused," "something else," or "not sure" to the sexual identity item, 2) had missing data for sexual identity, blood pressure, glycosylated hemoglobin (HbA1C), total cholesterol, or CVD outcomes, and 3) heterosexual women who reported any history of sexual behavior with women.

## Measures

**Sexual identity—**Sexual identity was measured with the item: "Do you think of yourself as heterosexual or straight, homosexual or lesbian, bisexual, something else, or not sure?" Women who identified as lesbian or bisexual were then categorized as sexual minority women.

**Demographic and clinical characteristics—**Demographic characteristics were selected based on social determinants of health that are significantly associated with increased CVD risk (Havranek et al., 2015). Age was a continuous variable ranging from 18–59. Race/ethnicity was coded as: non-Hispanic white, non-Hispanic Black, Hispanic, and other race. The measure of income was the family income to poverty ratio provided by NHANES. The income to poverty ratio (range 0–5) was calculated by dividing the total household income by the poverty threshold as published by the Federal Register for that specific survey year. Participants with an income to poverty ratio < 1 met the definition of poverty, while higher ratios indicated higher levels of income. Education was categorized as less than high school, high school, some college, or college graduate or greater. Additionally, relationship status (never married, married/partnered, widowed, divorced, separated) was examined. Family history of CVD and health insurance coverage were assessed as clinical characteristics. Family history of CVD was a dichotomous variable based on self-report of having a blood relative with a history of angina, heart attack, or stroke before the age of 50. Current health insurance coverage was also assessed.

**Modifiable risk factors for CVD—**Mental distress was measured using the following item: "Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?" from the CDC Healthy Days/HRQOL-4 (Centers for Disease Control and Prevention, 2011a). This measure has been identified as a clinical marker of depression and anxiety disorders (Strine, Hootman, Chapman, Okoro, & Balluz, 2005). Participants who reported 14 or more days of mental distress were considered to have frequent mental distress (Centers for Disease Control and Prevention, 2011a). Several health behaviors were examined. Participants who reported *tobacco use* (on some days or every day) were considered current smokers. *Binge drinking* in women is commonly defined as consumption of ≥ four alcoholic drinks within a two hour period (National Institute on Alcohol Abuse and Alcoholism, 2017). However, binge drinking was not assessed in this manner in NHANES. Instead, binge drinking was defined as consumption ≥ five alcohol drinks within one day in the previous year. For *physical activity* we calculated the average number of minutes of

moderate- and vigorous-intensity aerobic activity in the past week from participants' self-report. A binary measure of physical activity was created by determining if participants met physical activity recommendations for adults (either ≥ 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, 2015). *Fat intake* data was obtained from the dietary interview of NHANES estimated based on dietary recall of foods and beverages consumed during the previous 24-hour period. The diet measure used in this study was the unsaturated fat (sum of polyunsaturated fatty acid and monounsaturated fatty acid) to saturated fatty acid ratio. This ratio was dichotomized based on the Healthy Eating Index 2010 with an unsaturated to saturated fat ratio of 2.5 or greater considered adequate (Guenther et al., 2013).

Trained health technicians collected biomarker data (including body mass index, blood pressure, HbA1c, and total cholesterol) as part of the physical examination in NHANES. These procedures have been previously described (Centers for Disease Control and Prevention, 2011b). *Overweight* (body mass index ≥ 25.0 kg/m$^2$) and *obesity* (body mass index ≥ 30.0 kg/m$^2$) were defined based on established criteria (Centers for Disease Control and Prevention, 2016). Sexual minorities are less likely to access preventive care (Institute of Medicine, 2011), therefore, we chose to examine hypertension, diabetes, and high total cholesterol using two methods: self-report and biomarkers. Participants completed a questionnaire reporting their medical history and current medication use. We classified participants as having hypertension, diabetes, or high total cholesterol if they reported: 1) a medical history of hypertension, diabetes, or high total cholesterol and/or 2) current use of medications to treat these conditions. We also examined biomarkers to determine presence of hypertension, diabetes, high total cholesterol, and pre-clinical disease states based on established guidelines. A systolic blood pressure (SBP) ≥ 140 mm Hg and/or diastolic blood pressure (DBP) ≥ 90 mm Hg were considered evidence of hypertension. Pre-hypertension was defined as a SBP between 120–129 mm Hg and/or a DBP over 80–89 mm Hg (James et al., 2014). Diabetes was based on a HbA1c ≥ 6.5% and pre-diabetes was defined as a HbA1c between 5.7–6.4% (American Diabetes Association, 2017). HbA1c is an indicator of glycemic status over the preceding 2–3 months (American Diabetes Association, 2017). A total cholesterol ≥ 240 mg/dL was considered high and total cholesterol between 200–239 mg/dL was defined as borderline high (National Heart, Lung, and Blood Institute, 2016).

**Cardiovascular disease—**Presence of CVD diagnoses including angina, coronary heart disease, heart failure, myocardial infarction, and stroke was based on self-report. Participants that reported at least one of these conditions were considered to have CVD.

## Statistical Analysis

**Descriptive statistics—**All statistical analyses were conducted in Stata version 15.1. Two-year sample weights for NHANES (2001–2012) were averaged and combined prior to conducting analyses.

**Missing Data—**The three variables with the most missing data were physical activity (13.7%), binge drinking (11.9%), and income (4.3%). Sexual minority women were significantly less likely to have missing data for binge drinking ($p < .001$). Investigating missing data mechanisms is important to determine the statistical method for handling missing data. After conducting Little's test (Little, 1988) it was evident that data were not missing completely at random. Therefore, listwise deletion may lead to biased findings and multiple imputation is recommended. ***Missing at random*** occurs if the probability that data are missing does not depend on unobserved data, but may be explained by observed data. Analyses indicated that missing values were significantly associated with age and race, thus, the assumption that data were missing at random was deemed plausible.

**Multiple imputation—**Multiple imputation was conducted in Stata version 15.1. Multiple imputation is a simulation-based technique for handling missing data that is preferred over single imputation methods because these tend to overestimate variance. We used multiple imputation with chained equations (MICE) because it does not assume data are normally distributed, which permits flexibility for imputation of non-normal and categorical data. MICE imputes multiple variables iteratively through a sequence of univariate imputations with all variables, except the one being imputed, used to predict missing values (StataCorp, 2013).

Multiple imputation consists of three steps: imputation, estimation, and pooling (Kenward & Carpenter, 2007). The imputation step consisted of generating an imputation model that incorporated outcome and structural variables in NHANES (sampling weights, strata and cluster) to reduce bias (Johnson & Young, 2011). Based on previous recommendations a total of 20 imputations were used (Dong & Peng, 2013). The estimation and pooling steps can be thought of as the analysis stage. Imputation diagnostics were performed and results from imputed datasets were combined into a single imputed dataset for statistical analyses.

**Statistical analyses—**To assess differences in demographic and clinical characteristics, modifiable risk factors for CVD, and CVD between sexual minority and heterosexual participants bivariate analyses were conducted using the student *t*-test and design-adjusted Rao-Scott chi-square test, for continuous and categorical variables, respectively. A significance level of $p < .05$ was pre-determined. We ran multiple logistic regression models for all outcomes with demographic characteristics included as covariates in all models. Additional covariate adjustment was decided a priori based on prior evidence. Mental distress was included as a covariate in logistic regression models that examined health behaviors since it is associated with each health behavior examined (tobacco use, alcohol consumption, physical activity, and dietary fat intake) (American Psychological Association, 2017). Similarly, informed by established evidence, we added mental distress and health behaviors as covariates in logistic regression models for obesity, hypertension, diabetes, total cholesterol, their pre-clinical disease states, and CVD (Benjamin et al., 2017; Havranek et al., 2015).

## Results

The total number of potential participants after aggregating data across six NHANES cycles (2001–2012) was 31,393. After applying the inclusion and exclusion criteria described above, the final analytic sample consisted of 7,503 women, of which 346 (4.6%) identified as sexual minority women. Descriptive statistics are shown in Table 1. Several sexual orientation differences in demographic and clinical characteristics were observed. Sexual minority women were significantly younger ($p<.001$) and reported a lower family income to poverty ratio ($p<.001$) than heterosexual women. Sexual minority women were also less likely to be currently married or living with a partner ($p<.001$) or have health insurance coverage ($p<.001$). In addition, sexual minority women had significantly higher rates of frequent mental distress ($p<.001$), current tobacco use ($p<.001$), binge drinking ($p<.001$), and obesity ($p<0.03$). No other significant differences were observed.

The significant differences between sexual minority and heterosexual women that were noted in bivariate analyses for frequent mental distress, current tobacco use, binge drinking, and obesity remained significant after covariate adjustment. These results are presented in Table 2. Sexual minority women reported significantly higher rates of frequent mental distress (AOR 2.05, 95% CI= 1.45, 2.88), current tobacco use (AOR, 95% CI=2.11, 1.53, 2.91), and binge drinking (AOR 1.66, 95% CI=1.17, 2.34) compared to heterosexual women. No differences in physical activity or dietary fat intake were observed. Sexual minority women did not display a significant difference in being overweight, but were significantly more likely to be obese (AOR 1.61, 95% CI= 1.23, 2.33). In terms of diabetes, sexual minority women had higher but not statistically significant self-report of diabetes (AOR 1.82, 95% CI= 0.89, 3.72). Although they did not demonstrate higher HbA1C values consistent with diabetes (AOR 0.90, 95% CI= 0.35, 2.31), sexual minority women had higher rates of pre-diabetes even after adjusting for body mass index (AOR 1.56, 95% CI= 1.04, 2.34). Despite higher CVD risk related to several risk factors, sexual minority women did not exhibit significant differences in subjective or objective measures of hypertension, total cholesterol, or CVD.

## Discussion

This study contributes to the growing body of research on CVD in sexual minority women. Our findings are consistent with previous studies that demonstrated sexual minority women had higher rates of frequent mental distress (Farmer, Blosnich, Jabson, & Matthews, 2016; Fredriksen-Goldsen, Kim, & Barkan, 2012; Shilo & Mor, 2014), tobacco use (Blosnich, Lee, & Horn, 2013; Emory et al., 2015; Fredriksen-Goldsen, Kim, & Emlet, 2011), and binge drinking (Boehmer, Miao, Linkletter, & Clark, 2012; Coulter, Kinsky, Herrick, Stall, & Bauermeister, 2015; Gonzales & Henning-Smith, 2017; Hughes et al., 2010) than heterosexual women. We did not observe differences in physical activity and diet, which is consistent with the empirical literature. Although most studies indicate there are no physical activity differences (Blosnich et al., 2014; Case et al., 2004; Fredriksen-Goldsen et al., 2013a; Garland-Forshee et al., 2014; Hatzenbuehler et al., 2013; Hatzenbuehler, Slopen, et al., 2014; Matthews & Lee, 2014), a small number of studies suggest sexual minority women have lower rates of physical activity compared to heterosexual women (Everett &

Mollborn, 2013; Herrick & Duncan, 2018). However, a recent study found sexual minority women had higher rates of aerobic activity but also reported more sedentary behaviors than heterosexual women (VanKim, Bryn, Hee-Jin, & Corliss, 2017). Moreover, several studies assert sexual minority women demonstrate similar (Dilley, Wynkoop Simmons, Boysun, Pizacani, & Stark, 2010; Matthews & Lee, 2014) or worse diet quality (Minnis et al., 2015; Roberts et al., 2003; Valanis et al., 2000) compared to heterosexual women. A notable exception is a recent analysis of the Nurses' Health Study that revealed sexual minority women had better diet quality than heterosexual women (VanKim, Austin, Jun, Hu, & Corliss, 2016).

In the present study, sexual minority women also demonstrated higher rates of objectively measured obesity compared to heterosexual women. Two recent systematic reviews identified that most studies rely on self-reported height and weight to determine presence of obesity in this population (Caceres et al., 2017; Eliason et al., 2015). Studies that have objectively measured obesity in sexual minority women report conflicting findings. While some studies report no difference in obesity between sexual minority and heterosexual women (Clark et al., 2015; Farmer, Jabson, Bucholz, & Bowen, 2013; Strutz, Herring, & Tucker Halpern, 2014), others have identified significantly higher rates of obesity in sexual minority women (Everett & Mollborn, 2013; Kinsky, Stall, Hawk, & Markovic, 2016). This is an important area for further research, since both sexual minority and heterosexual women have been shown to underreport their body mass index (Richmond, Walls, & Austin, 2012).

Sexual minority women in the present study did not have a higher prevalence of hypertension, high total cholesterol, or CVD, which supports findings from two recent systematic reviews (Caceres et al., 2017; Simoni, Smith, Oost, Lehavot, & Fredriksen-Goldsen, 2017). The systematic review conducted by Caceres and colleagues (2017) identified that out of 17 studies that examined diabetes, only two identified higher rates of self-reported diabetes in sexual minority women (Diamant, Wold, Spritzer, & Gelberg, 2000; Dilley et al., 2010). Although we did not observe a significant difference for diabetes, sexual minority women had significantly higher rates of pre-diabetes than heterosexual women. This is significant as approximately 18% of individuals with pre-diabetes develop diabetes within two years (Glauber, Vollmer, & Nichols, 2018). Overall, few studies have used biomarkers (HbA1c and/or fasting glucose) to assess glycemic status in sexual minority women. Most researchers have found no significant difference in glycemic status between sexual minority and heterosexual women (Clark et al., 2015; Hatzenbuehler et al., 2013; Hatzenbuehler, Slopen, et al., 2014). However, these studies were all analyses of data from the National Longitudinal Study of Adolescent to Adult Health, which included young adults (mean age under 30 year old). Although Kinsky and colleagues (2016) found significantly higher mean fasting glucose in sexual minority women (35–65 years old), it is important to note they did not examine whether participants met criteria for diabetes or pre-diabetes.

## Study Limitations

This study has several limitations that must be considered. Although NHANES is a nationally representative dataset, its cross-sectional design limits causal inference, which is a

noted weakness of cardiovascular research with sexual minorities (Caceres et al., 2017). Another limitation was that this analysis was limited to young and middle-aged adults as sexual identity was not assessed in participants over the age of 59 in NHANES. In addition, mental distress was assessed with a non-specific measure of acute stress because NHANES does not include measures of chronic stress. It is possible that the random sampling methods used by population-based surveys, such as NHANES, do not produce representative samples of sexual minorities. Sexual minorities who participate in population-based surveys may be inherently different from those who do not. Another limitation is that we examined individual risk factors rather than creating a composite score of CVD risk, such as the Framingham or American College of Cardiology/American Heart Association risk scores. It is possible that sexual minority women exhibit elevations in several CVD risk factors that may not result in CVD morbidity or mortality. Also, to achieve sufficient statistical power we combined lesbian and bisexual women for all analyses. This is a significant weakness that should be addressed in future studies.

## Implications

**Research—**Our findings provide future directions for research on CVD in sexual minority women and add to the nascent body of research highlighting hyperglycemia as a CVD risk factor in this population. Prospective studies are needed to establish temporality of modifiable risk factors and CVD diagnosis. Although few researchers have used objective measures to investigate CVD in sexual minority women, our findings indicate there is a need to employ a combination of subjective and objective measures. In particular we recommend more research using objective measures of obesity and diabetes. In addition, neuroendocrine, coagulation, and inflammatory biomarkers related to CVD should be included in future research to understand if stress in sexual minorities differentially affects these pathways. Despite growing evidence of increased CVD risk there is a dearth of research on subclinical markers of CVD in sexual minority women. Recent studies indicate subclinical measures, including carotid artery intima thickness and coronary artery calcification, may reveal CVD in asymptomatic adults that is undetected by traditional biomarkers (Budoff et al., 2013; Rampersaud et al., 2008; Zaid, Fujiyoshi, Kadota, Abbott, & Miura, 2017). Also, researchers should include measures of chronic and minority stressors (including stigma, expectations of rejection, internalized homophobia, etc.) to assess their association with CVD in sexual minority women. Since participants in the present study were young (mean age 38.4), it is necessary to examine whether the higher rates of mental distress, current tobacco use, binge drinking, obesity, and pre-diabetes we observed persist in older sexual minority women.

**Practice—**Since inadequate training of healthcare providers has been identified to contribute to health disparities in this population, sexual minority health should be incorporated into health professions curricula, as few programs currently include this content (Carabez et al., 2015; Obedin-Maliver et al., 2011). As electronic health records increasingly include sexual orientation items, it is imperative for clinicians to appreciate the importance of collecting these data. Furthermore, there is a need to ensure clinicians assess sexual orientation in a manner that promotes patient trust. These findings indicate that clinicians should screen sexual minority women for modifiable risk factors for CVD including stress, tobacco use, binge drinking, obesity, and hyperglycemia. Thus, there is a need to focus on

lifestyle modification to reduce CVD risk in this population. Clinicians and public health practitioners should develop initiatives to reduce modifiable risk factors for CVD in sexual minority women.

**Policy—**Government agencies concerned with health disparities in this population should advocate for the inclusion of sexual orientation items in national surveys. Although several national surveys have procedures for oversampling underserved populations, such as racial/ethnic minorities and older adults, presently none oversample sexual minorities. This would be an important action to provide larger sample sizes to study health disparities in this population.

We were unable to examine the impact of state-level policies of CVD risk in sexual minority women since NHANES does not release state-level data. However, the impact of structural stigma on the health of sexual minority women cannot be underestimated. There is a lack of measures to assess structural stigma in sexual minorities (Hatzenbuehler et al., 2014). Most research in this area has focused on interpersonal stigma, which does not adequately capture the full extent of stigma that sexual minorities are exposed to (Fredriksen-Goldsen et al., 2014). Future studies should examine the impact of interpersonal and structural stigma on CVD risk in sexual minority women. In addition, policies should be enacted to ensure that healthcare professionals are aware of health issues that impact sexual minorities. One example of such a policy is the mandatory lesbian, gay, bisexual, and transgender cultural competency training for licensed healthcare professionals enacted by the District of Columbia City Council in 2016 (Chibbaro, 2016).

## Conclusion

In summary, this study contributes to the nascent body of research examining CVD risk in sexual minorities. Overall, this sample of sexual minority women exhibited excess risk for CVD related to higher rates of frequent mental distress, current tobacco use, binge drinking, obesity, and pre-diabetes. Even though few differences in other CVD outcomes were observed in sexual minority women, there is evidence of elevated CVD risk in this population. Several emerging areas of research are highlighted including the need to further explore hyperglycemia in this population, use of measures of chronic and minority stress, oversampling of sexual minorities in population-based surveys, and incorporation of novel biomarkers to examine CVD disparities in this population. These findings can help inform the development of primary and secondary CVD prevention efforts.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## Biography

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**Table 1**

Descriptive statistics for demographic/clinical characteristics, modifiable risk factors, and cardiovascular disease in women

| | Heterosexual Women (N=7157) | Sexual Minority Women (N=346) | *p*-value |
|---|---|---|---|
| **Demographic and clinical characteristics** | **% or mean** | | |
| Age (mean) | 40.1 | 34.7 | <0.001 * |
| Family income to poverty ratio (mean) | 2.6 | 2.0 | <0.001 * |
| Race/ethnicity | | | 0.26 |
| Non-Hispanic White | 69.7 | 72.9 | |
| Non-Hispanic Black | 11.8 | 13.0 | |
| Hispanic | 13.0 | 9.2 | |
| Other | 5.5 | 4.9 | |
| Education | | | 0.39 |
| Less than high school | 13.7 | 16.7 | |
| High school | 21.0 | 19.2 | |
| Some college | 34.3 | 37.7 | |
| College graduate or greater | 31.0 | 26.4 | |
| Relationship status | | | <0.001 |
| Married/Partnered | 66.3 | 40.9 | |
| Widowed | 1.8 | 0.1 | |
| Divorced | 11.1 | 13.8 | |
| Separated | 2.9 | 2.3 | |
| Never married | 17.9 | 42.9 | |
| CVD family history | 23.9 | 27.2 | 0.36 |
| Health insurance coverage | 81.9 | 72.5 | <0.001 * |
| **Modifiable risk factors** | | | |
| Frequent mental distress | 14.6 | 28.3 | <0.001 * |

| | Heterosexual Women (N=7157) | Sexual Minority Women (N=346) | *p*-value |
|---|---|---|---|
| **Demographic and clinical characteristics** | **% or mean** | | |
| Current tobacco use | 21.6 | 44.5 | <0.001 * |
| Binge drinking | 26.9 | 46.2 | <0.001 * |
| Meets physical activity recommendations | 30.5 | 34.6 | 0.69 |
| Adequate fat intake | 19.1 | 18.1 | 0.72 |
| Overweight (BMI ≥ 25 kg/m$^2$) | 61.7 | 63.6 | 0.69 |
| Obesity (BMI ≥ 30 kg/m$^2$) | 34.1 | 43.0 | 0.03 * |
| Hypertension self-report | 23.8 | 18.6 | 0.11 |
| Hypertension (SBP ≥ 140 and/or DBP ≥ 90) | 8.4 | 6.8 | 0.51 |
| Pre-hypertension (SBP 120–129 and/or DBP 80–89) | 30.4 | 27.6 | 0.23 |
| Diabetes self-report | 5.3 | 6.5 | 0.46 |
| Diabetes (HbA1c ≥ 6.5%) | 4.1 | 2.7 | 0.29 |
| Pre-diabetes (HbA1c 5.7–6.4%) | 14.1 | 15.7 | 0.56 |
| High total cholesterol self-report | 24.1 | 17.6 | 0.06 |
| High total cholesterol (≥ 240 mg/dL) | 15.3 | 12.5 | 0.36 |
| Borderline high total cholesterol (200–239 mg/dL) | 30.1 | 24.9 | 0.10 |
| **Cardiovascular disease** | | | |
| Cardiovascular disease | 3.3 | 2.8 | 0.67 |

*Note.* N= 7503; BMI = body mass index; SBP= systolic blood pressure; DBP = diastolic blood pressure; HbA1c = glycosylated hemoglobin.

* $p$ <0.05.

**Table 2**

Sexual orientation differences in modifiable risk factors and cardiovascualr disease in women

| | OR (95% CI) | AOR (95% CI) |
|---|---|---|
| Frequent mental distress | | |
| Heterosexual | Ref | Ref |
| Sexual minority | **2.30 (1.67, 3.17)** * | **2.05 (1.45, 2.88)**[a]* |
| Current tobacco use | | |
| Heterosexual | Ref | Ref |
| Sexual minority | **2.91 (2.20, 3.86)** * | **2.11 (1.53, 2.91)**[b]* |
| Binge drinking | | |
| Heterosexual | Ref | Ref |
| Sexual minority | **2.33 (1.67, 3.25)** * | **1.66 (1.17, 2.34)**[b]* |
| Meets physical activity recommendations | | |
| Heterosexual | Ref | Ref |
| Sexual minority | 1.10 (0.76, 1.60) | 1.04 (0.69, 1.56)[b] |
| Adequate fat intake | | |
| Heterosexual | Ref | Ref |
| Sexual minority | 0.94 (0.64, 1.36) | 0.92 (0.62, 1.34)[b] |
| Overweight (BMI ≥ 25 kg/m$^2$) | | |
| Heterosexual | Ref | Ref |
| Sexual minority | 1.08 (0.74, 1.57) | 1.24 (0.84, 1.85)[c] |
| Obesity (BMI ≥ 30 kg/m$^2$) | | |
| Heterosexual | Ref | Ref |
| Sexual minority | **1.46 (1.04, 2.05)** * | **1.61 (1.12, 2.33)**[c]* |
| Hypertension self-report | | |
| Heterosexual | Ref | Ref |

| | OR (95% CI) | AOR (95% CI) |
|---|---|---|
| Sexual minority | 0.73 (0.49, 1.08) | 0.76 (0.49, 1.18)[d] |
| Hypertension (SBP >140 and/or DBP >90) | | |
| Heterosexual | Ref | Ref |
| Sexual minority | 0.79 (0.38, 1.62) | 1.12 (0.52, 2.41)[d] |
| Pre-hypertension (SBP 120–129 and/or DBP 80–89) | | |
| Heterosexual | Ref | Ref |
| Sexual minority | 0.83 (0.62, 1.13) | 1.02 (0.75, 1.39)[d] |
| Diabetes self-report | | |
| Heterosexual | Ref | Ref |
| Sexual minority | 1.25 (0.68, 2.28) | 1.82 (0.89, 3.72)[d] |
| Diabetes (HbA1c ≥ 6.5%) | | |
| Heterosexual | Ref | Ref |
| Sexual minority | 0.64 (0.28, 1.50) | 0.90 (0.35, 2.31)[d] |
| Pre-diabetes (HbA1c 5.7–6.4%) | | |
| Heterosexual | Ref | Ref |
| Sexual minority | 1.13 (0.74, 1.74) | **1.56 (1.04, 2.34)**[d*] |
| High total cholesterol self-report | | |
| Heterosexual | Ref | Ref |
| Sexual minority | 0.67 (0.45, 1.01) | 0.86 (0.47, 1.28)[d] |
| High total cholesterol (≥240 mg/dL) | | |
| Heterosexual | Ref | Ref |
| Sexual minority | 0.79 (0.48, 1.32) | 1.04 (0.61, 1.78)[d] |
| Borderline high total cholesterol (200–239 mg/dL) | | |
| Heterosexual | Ref | Ref |
| Sexual minority | 0.77 (0.56, 1.05) | 0.88 (0.62, 1.25)[d] |

| | OR (95% CI) | AOR (95% CI) |
|---|---|---|
| Cardiovascular disease | | |
| Heterosexual | Ref | Ref |
| Sexual minority | 0.84 (0.38, 1.85) | 0.69 (0.29, 1.66)[e] |

*Note.* N= 7503; referene group = heterosexual women; OR = odds ratio; CI = confidence interval; AOR = adjusted odds ratio; BMI = body mass index; SBP= systolic blood pressure; DBP = diastolic blood pressure; HbA1c = glycosylated hemoglobin.

[a]Adjusted for age, race, education, relationship status, and income;

[b]Adjusted for age, race, education, relationship status, income, and frequent mental distress.

[c]Adjusted for age, race, education, relationship status, income, insurance, CVD family history, frequent mental distress, current tobacco use, binge drinking, physical activity, and fat intake;

[d]Adjusted for age, race, education, relationship status, income, insurance, frequent mental distress, insurance, CVD family history, current tobacco use, binge drinking, physical activity, fat intake, and body mass index;

[e]Adjusted for age, race, education, relationship status, income, insurance, frequent mental distress, insurance, CVD family history, current tobacco use, binge drinking, physical activity, fat intake, body mass index, hypertension, diabetes, and high cholesterol.

[*]$p < 0.05$.