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Assessing gender identity differences in cardiovascular disease in US adults: An analysis of data from the 2014-2017 BRFSS

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Introduction

The National Academy of Medicine's landmark lesbian, gay, bisexual, and transgender (LGBT) health report in 2011 identified a paucity of research about the health of gender minorities and called for increased attention to the health needs of this underserved population (Institute of Medicine 2011). Gender minorities are individuals that have a gender identity that is different than their sex assigned at birth. It is estimated that 0.5% of adults in the United States (U.S.) identify as gender minorities (Meyer et al. 2017). Gender minority is an umbrella term that includes various subgroups, including people who identify as a woman and were assigned the male sex at birth (transgender women) and people who identify as a man and were assigned the female sex at birth (transgender men). A third group of gender minorities, commonly referred to as gender nonconforming or gender nonbinary, identifies outside of conventional binary notions of gender (i.e., they may identify as neither man nor woman, both man and woman, or another gender).

Most research about health disparities that affect gender minorities has focused on mental health (Reisner et al. 2016; Valentine and Shipherd 2018) and has identified disparities in

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The authors have no conflicts of interest to disclose.

Research involving human participants and/or animals
All procedures performed in studies involving human participants were in accordance with ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This study did not include animals. The Institutional Review Board at Columbia University Irving Medical Center deemed these analyses exempt due to the use of public access data.

Informed consent
Informed consent was obtained for all participants included in the BRFSS.

depression and anxiety (Bockting et al. 2013; Connolly et al. 2016), substance abuse (Staples et al. 2017), suicidality and nonsuicidal self-injury (Marshall et al. 2016; Peterson et al. 2017). However, a recent analysis of Medicare claims data showed that gender minority beneficiaries have higher rates of multiple chronic physical health conditions compared to their cisgender (non-transgender) counterparts (Dragon et al. 2017). The physical health of gender minorities may be further compromised by reduced access to preventative care, including cancer screenings (Narayan et al. 2017; Tabaac et al. 2018) and poor access to healthcare generally (Safer et al. 2016).

Despite improvements in prevention and treatment, cardiovascular disease (CVD) remains the leading cause of death worldwide (World Health Organization 2017). CVD disparities related to race/ethnicity and sex are well documented (Havranek et al. 2015; Mehta et al. 2016), yet little is known about the impact of gender minority identity on CVD risk (Institute of Medicine 2011). Gender minorities may be at increased risk for CVD related to use of gender affirming exogenous hormone therapy (Getahun et al. 2018; Velho et al. 2017) and higher rates of HIV (particularly among transgender women) (Gogia et al. 2018). Although current evidence is inconclusive, there appears be a pattern of increased body mass index (Velho et al. 2017), low-density lipid cholesterol (Maraka et al. 2017; Velho et al. 2017), and triglycerides (Maraka et al. 2017) as well as decreased high-density lipid cholesterol levels (Maraka et al. 2017; Velho et al. 2017) in transgender men. Among transgender women, estrogen therapy is associated with higher triglyceride levels, but no additional cardiometabolic changes (Maraka et al. 2017). Transgender women have also exhibited higher rates of ischemic stroke and venous thromboembolic events compared to cisgender individuals (Getahun et al. 2018; Streed et al. 2017).

Therefore, the purpose of this study, using data from the Behavioral Risk Factor Surveillance System (BRFSS; 2014-2017), was to examine gender identity differences in CVD risk (health behaviors [tobacco use, heavy drinking, and exercise) and metabolic risk factors [elevated body mass index and diabetes]) and CVD conditions (angina/coronary heart disease, stroke, and myocardial infarction) among adults in the U.S. It is important to note that the present study builds on the limited work that has investigated CVD in gender nonconforming persons. With the exception of the work of Downing & Prezedworski (2018) few studies have assessed CVD disparities among gender nonconforming persons. However, those investigators found higher rates of self-reported CVD (angina/coronary heart disease or myocardial infarction combined) in gender conforming persons compared to cisgender women. Informed by previous evidence, we hypothesized that gender minority (i.e., transgender women, transgender men, and gender nonconforming) participants would report higher rates of CVD risk factors and CVD conditions than cisgender participants. In addition, we explored differences in CVD risk and CVD conditions within gender minority participants.

Methods

Sample

The BRFSS is a national telephone survey initiated in 1984 to assess the health of non-institutionalized Americans over the age of 18. The BRFSS uses random digit dialing

techniques to collect self-reported health information from more than 400,000 individuals every year in all 50 states, the District of Columbia, and three U.S. territories. The BRFSS 2014-2017 response rate ranged from 47.7-48.2% for landlines and 40.5-47.2% for cellular phones (Centers for Disease Control and Prevention 2017a). BRFSS methodology is described in detail elsewhere (Centers for Disease Control and Prevention 2018).

An optional *sexual orientation and gender identity* module was introduced in the 2014 BRFSS. The module was used by 19 states in 2014, 22 states in 2015, 25 states in 2016, and 27 states in 2017. All participants over the age of 18 who completed the *sexual orientation and gender identity* module in the 2014-2017 BRFSS were eligible for inclusion (n=729,589). After excluding participants who answered "don't know/not sure" to the gender identity item (n=3,792) and those who refused to answer this (n=5,777), 720,020 remained. Participants with missing data for health behaviors, metabolic risk factors, and CVD conditions were also excluded (n=57,117).

Measures

Sex and gender identity.—The sex of BRFSS participants was classified as male or female. To assess gender minority status, adult participants were asked: "Do you consider yourself to be transgender?" Participants who answered "No" were classified as cisgender men or cisgender women based on their reported sex. Those who responded affirmatively were categorized as either transgender women, transgender men, and gender nonconforming based on their response to this follow-up question: "Do you consider yourself to be male to female, female to male, or gender nonconforming?"

Demographic characteristics.—*Age* in years (18-24, 25-34, 35-44, 45-54, 55-64, over 65); *race/ethnicity* (Non-Hispanic White, Non-Hispanic Black, Hispanic, other, or multi-racial, missing); *income* (less than $15,000, $15,000-24,999, $25,000-34,999, $35,000-49,999, over $50,000, missing); *education* (less than high school, graduated high school, attended college or technical college, graduated from college or technical college, missing); *marital status* (married/unmarried couple, divorced, widowed, separated, never married, missing); and *employment status* (employed/self-employed, unemployed, homemaker, student, retired, unable to work, missing) were assessed.

Self-rated health.—Participants were also asked to rate their general health (excellent, very good, good, fair, poor, missing).

Healthcare access and utilization.—Three measures of *healthcare access and utilization* were assessed, including: 1) healthcare coverage in past year (yes, no, missing); 2) delay in healthcare in the past year due to costs (yes, no, missing), and 3) length of time since last routine checkup (within past year, more than one year ago, missing).

Health behaviors.—Health behaviors assessed included *current tobacco use* (yes vs. no), *heavy drinking* based on established criteria (National Institute on Alcohol Abuse and Alcoholism 2017), and *exercise (any recreational physical activity) in the past 30 days* (yes vs. no).

Metabolic risk factors.—Overweight (body mass index of 25.0 to < 30.0 kg/m^2) and obesity (body mass index of 30.0 kg/m^2 or higher) were based on self-reported height and weight and dichotomized based on established guidelines (Centers for Disease Control and Prevention 2017b). Participants were also asked if they had ever been told that they had diabetes (dichotomized yes or no).

CVD conditions.—Participants were asked whether a doctor, nurse, or other health professional had ever told them that they had any of the following CVD conditions: angina/coronary heart disease, stroke, or myocardial infarction. A dichotomous measure of CVD was created based on report of any type of CVD condition (yes or no).

Statistical Analysis

Analyses were conducted in Stata version 15 using survey weights and the *svy* command to account for the complex survey design of the BRFSS. The Rao Scott X^2 test was used to compare gender minorities to both cisgender men and women across demographic characteristics, self-rated health, and healthcare access and utilization. A two sided p-value < 0.05 was considered statistically significant. We then used binary logistic regression models to estimate unadjusted (OR) and adjusted odds ratios (AOR) with 95% confidence intervals (CI) for the association of gender minority identity with health behaviors, metabolic risk factors, and CVD conditions, adjusting for potential confounders. Models for health behaviors were adjusted for potential confounders including state of residence, survey year, demographic characteristics, and self-rated health. Models for metabolic risk factors added adjustment for healthcare access and utilization and health behaviors. Models for CVD conditions added adjustment for metabolic risk factors. We first compared gender minority participants to cisgender men and then to cisgender women. Additional analyses used binary logistic regression models to compare transgender men to transgender women and gender nonconforming participants to both transgender men and women.

Results

The final analytic sample consisted of 662,903 participants of which 291,911 (49.5%) were cisgender men, 368,220 were cisgender women (50.0%), 1,373 (0.3%) were transgender women, 829 (0.1%) were transgender men, and 570 (0.1%) were gender nonconforming (Table 1). All gender minorities were younger, had lower income, and were less likely to have healthcare coverage in the past year than cisgender participants. Gender nonconforming participants were less likely to identify as Non-Hispanic White than cisgender participants. Transgender men and women were more likely to have lower educational attainment and to report they had delayed receiving healthcare due to cost than their cisgender counterparts. In addition, transgender men and gender nonconforming participants were more likely to have never married relative to cisgender participants. Compared to cisgender participants, transgender women and gender nonconforming participants were less likely to rate their health as excellent. Transgender men were less likely to have a routine checkup in the past year compared to cisgender women, but were more likely to than cisgender men.

Results of analyses comparing gender minorities to cisgender men are presented in Table 2. Compared to cisgender men, transgender women (AOR 0.75, 95% CI=0.57-0.98) and gender nonconforming (AOR 0.58, 95% CI=0.40-0.84) participants were less likely to have exercised in the past 30 days. No differences in metabolic risk factors were detected between gender minorities and cisgender men. Transgender women were more likely to have a history of stroke (OR 1.93, 95% CI= 1.24-3.02) and myocardial infarction (OR 1.52, 95% CI= 1.09-2.13) relative to cisgender men in unadjusted models. Although these differences were attenuated in the fully adjusted models, transgender women were more likely to report at least one type of CVD condition than cisgender men (AOR 1.38, 95% CI=1.01-1.88).

Results of analyses comparing gender minorities to cisgender women are shown in Table 3. No differences in health behaviors were noted between gender minorities and cisgender women. Both transgender women (AOR 1.34, 95% CI= 1.05-1.72) and transgender men (AOR 1.54, 95% CI= 1.07-2.24) were more likely than cisgender women to be overweight. Transgender women also had higher rates of diabetes (AOR 1.45, 95% CI= 1.05-1.99), angina/coronary heart disease (AOR 1.90, 95% CI=1.34-2.68), stroke (AOR 1.88, 95% CI=1.16-3.03), and myocardial infarction (AOR 2.98, 95% CI=2.14-4.17) than cisgender women. Compared to cisgender women, transgender women had higher rates of reporting any CVD condition (AOR 2.98, 95% CI= 1.65-3.06). In addition, gender nonconforming participants (AOR 2.68, 95% CI=1.14-6.30) had higher rates of myocardial infarction relative to cisgender women. No differences in CVD were noted between transgender men and cisgender women.

Additional analyses comparing subgroups of gender minorities to one another were conducted (Table 4). No differences in health behaviors, metabolic risk factors, or CVD conditions were detected between subgroups of gender minorities.

Discussion

This is one of a few studies that use a nationally representative sample to examine CVD disparities between gender minority and cisgender adults. Few gender identity differences in health behaviors were noted, but significant differences in CVD prevalence were identified. These findings have important implications for the prevention and assessment of CVD in gender minorities.

Compared to cisgender men, transgender women and gender nonconforming participants reported lower rates of having exercised in the past 30 days. Although there is limited research examining physical activity in gender minorities, a recent study found that, even though gender minorities engaged in lower levels of physical activity than cisgender persons, gender minorities who had received exogenous hormone therapy reported higher levels of physical activity than those who had not (Jones et al. 2018). Future studies should explore factors that promote physical activity in gender minorities.

Despite similar rates of health behaviors to cisgender women, transgender women and transgender men were more likely to be overweight, but not obese. Few studies have examined the presence of overweight and obesity in gender minorities. However, two recent

studies found that middle-aged and older gender minorities report higher rates of obesity than cisgender individuals (Dragon et al. 2017; Fredriksen-Goldsen et al. 2014). Analyses for transgender participants in both of those studies were aggregated, regardless of gender identity, making it difficult to compare to our findings. More research is needed examining the influence of exogenous hormone and other risk factors (e.g., minority stress) use on body mass index in gender minorities.

Transgender women exhibited the highest risk of any group as they reported higher rates of diabetes, angina/coronary heart disease, stroke, myocardial infarction, and any CVD condition than cisgender women and higher rates of any CVD condition compared to cisgender men. Transgender women were more likely to have had a stroke than cisgender women, which contradicts findings of a recent chart review that found no difference in stroke or myocardial infarction between gender minority and cisgender individuals (Getahun et al. 2018). Getahun and colleagues (2018) found that transgender women who were on exogenous hormone therapy had higher rates of ischemic stroke. Similarly, Wierckx and colleagues (2013) found that transgender women who had a myocardial infarction also had one or more risk factors for CVD (primarily tobacco use) and had pursued gender affirming hormone therapy. Although we were not able to investigate the association of exogenous hormone use with CVD using BRFSS data, given previous findings, future research should investigate the short- and long-term cardiovascular effects of gender affirming hormone therapy in transgender populations.

A strength of the present study is that we accounted for health behaviors and metabolic risk factors known to contribute to CVD risk. The higher rates of myocardial infarction we identified among transgender women compared to cisgender women are consistent with previous analyses (Downing and Przedworski 2018; Meyer et al. 2017). However, those studies did not comprehensively adjust for traditional CVD risk factors, potentially biasing results. The higher rates of CVD we observed among transgender women, relative to both cisgender men and women, were unexplained by traditional CVD risk factors. These findings could be attributed to minority stressors (e.g., discrimination, victimization, internalized stigma), which are associated with negative mental and physical health outcomes among gender minorities (Fredriksen-Goldsen et al. 2014; Mustanski et al. 2016). Indeed, among gender minorities, experiencing discrimination and family rejection have been associated with higher rates of current tobacco use (Bradford et al. 2013; Gamarel et al. 2016; Shires and Jaffee 2016) and alcohol misuse, respectively (Klein and Golub 2016). This suggests that CVD prevention efforts tailored to gender minority populations should focus on mitigating the effects of other potential risks (e.g., minority stressors and low social support). A limitation of the BRFSS is that measures of minority stress and exogenous hormones use are not available. Additional research examining how minority stressors and resilience factors (e.g., body satisfaction, self-esteem, social support) might impact CVD risk in this population is needed.

Investigation of health disparities affecting gender nonconforming persons is imperative since this group, although understudied, has been identified as being at increased risk for multiple chronic conditions compared to cisgender people (Downing and Przedworski 2018). This is especially important as we found higher rates of myocardial infarction in

gender nonconforming participants compared to cisgender women. A previous study reported similar findings, however, a noted limitation of that work was that angina/coronary heart disease and myocardial infarction were combined into one category (Downing and Przedworski 2018). Given that BRFSS does not include a variable for sex assigned at birth we were unable to examine differences between gender conforming persons assigned male versus female at birth. Future work is needed to examine differences in CVD risk between subgroups of gender conforming persons based on sex assigned at birth.

A novel aspect of our study was the comparison of CVD risk and CVD conditions within subgroups of the gender minority population. We identified no differences between transgender women, transgender men, and gender nonconforming participants. More research is needed to identify which groups within the gender minority population are most at risk for CVD.

Our findings suggest that CVD prevention efforts should be tailored to address the unique risks observed in different subgroups of gender minorities. Although health promotion initiatives have been targeted to racial/ethnic minority and low-income populations, there is a dearth of health promotion initiatives focused on gender minorities (National Forum for Heart Disease & Stroke Prevention 2014). Despite higher rates of CVD compared to cisgender women, transgender women and gender nonconforming participants exhibited few differences in health behaviors compared to their cisgender counterparts. Healthcare providers should be educated about the importance of screening for CVD in this population and be prepared to address the cardiovascular health of gender minorities within the context of other medical interventions they may concurrently pursue. Preventive care for CVD among gender minorities should take into account their complete medical history, including history of exogenous hormone therapy or surgeries, which may include removal of gonads. Collection of data about gender identity in clinical settings is essential to providing high quality care to gender minorities by allowing healthcare providers to identify this vulnerable population and implement appropriate health screenings (Cahill and Makadon 2014). Future cardiovascular research with gender minority populations should examine traditional CVD risk factors, minority stressors, and gender minority-specific factors (e.g., use of exogenous hormones, length of hormone use, or history of gender affirming surgeries that may involve removal of gonads).

Limitations

As the BRFSS data is cross-sectional this limits the ability to infer causality from our findings. For instance, since we focused on understanding current CVD risk we chose to examine current health behaviors rather than examining lifetime behaviors (e.g., lifetime tobacco and alcohol use). This is especially important as individuals may alter their health behaviors upon being diagnosed with CVD (e.g., quit smoking, lose weight, and reduce drinking). Therefore, longitudinal studies examining gender identity differences in CVD risk are needed to establish temporality of CVD risk factors and diagnosis of CVD.

Further, BRFSS includes self-reported data, which are prone to recall bias. In the general population significant discrepancies between self-report and objective data from health records exist for CVD conditions (Muggah et al. 2013; Woodfield and Sudlow 2015).

However, evidence of which method is most accurate to assess presence of CVD is inconclusive (Fortin et al. 2017). There is limited research that has used health records to assess CVD in gender minorities, but a recent study using electronic health records identified no differences in myocardial infarction between transgender women and cisgender women (Getahun et al. 2018). The identified discrepancy between self-reported and health record data suggests that future studies should incorporate various types of data to examine CVD in gender minorities.

Misclassification and residual confounding are additional methodological concerns. For instance, the heavy drinking measure was based on sex rather than gender identity. Because participants were not asked specifically about their sex assigned at birth, there may have been some misclassification of heavy drinking for gender minority participants. The use of sex-based measures of alcohol use in gender minorities is a recognized methodological challenge in the extant literature (Gilbert et al. 2018). Moreover, not all relevant CVD risk factors (e.g., hypertension, high cholesterol, and diet quality) were assessed across all BRFSS years used in this study. In addition, although transgender women have higher rates of HIV than their cisgender counterparts (Gogia et al. 2018) and HIV is associated with greater CVD risk (Bavinger et al. 2013; Masenga et al. 2019), we were unable to include HIV in our analyses because diagnosis of HIV was not assessed in the BRFSS. The exclusion of these risk factors might potentially explain the gender identity differences in CVD prevalence we identified in the present study. In addition to the CVD risk factors measured in the present study, future work should comprehensively assess gender identity differences across established CVD risk factors such as hypertension and high cholesterol.

Conclusions

This study adds to the growing body of research that examines physical health disparities among gender minorities. Our investigation was limited by the available data since some relevant variables to gender minority health were not available in the BRFSS. Nevertheless, we found that, despite similar health behaviors, transgender women had higher rates of CVD compared to cisgender men and women. Future research should examine CVD disparities among gender minorities by measuring traditional risk factors as well as gender minority-specific risk factors. Health promotion initiatives should be implemented to address CVD risk reduction in gender minorities.

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Table 1.

Demographic characteristics, self-rated health, and healthcare access and utilization by gender identity and sex, BRFSS 2014-2017 (N=662,903)

	Cisgender Men (N=291,911)	Cisgender Women (N= 368,220)	Transgender Women (N=1,373)	Transgender Men (N=829)	Gender Nonconforming (N=570)
Demographic/clinical characteristics	Percentage				
Age [a,b,c,d,e,f]					
18-24	12.8	11.4	17.7	17.7	29.1
25-34	16.4	14.6	10.9	16.6	20.5
35-44	16.5	15.7	16.2	24.1	13.5
45-54	18.2	17.8	17.1	12.5	9.8
55-64	17.5	17.8	22.5	12.4	12.1
≥ 65	18.6	22.7	15.6	16.7	15.0
Race/ethnicity [c,e,f]					
Non-Hispanic White	67.1	67.2	58.5	53.8	53.8
Non-Hispanic Black	10.4	12.0	13.4	14.1	15.3
Hispanic	13.4	12.5	15.3	20.8	16.5
Other Race	5.4	5.7	10.0	6.0	7.9
Multi-racial	1.5	1.4	1.9	1.9	5.5
Missing	0.2	1.2	0.9	3.4	1.0
Income [a,b,c,d,e,f]					
<$15,000	7.3	10.2	17.1	16.9	16.2
$15,000-24,999	12.8	15.2	19.4	20.5	20.1
$25,000-34,999	8.8	9.2	15.2	13.7	5.3
$35,000-49,999	12.7	11.8	10.1	9.5	12.7
$50,000	47.5	39.9	28.8	24.7	34.6
Missing	10.9	13.7	9.4	14.7	11.1
Education [a,b,d,e]					
Did not graduate high school	13.3	12.2	27.2	24.5	12.3
Graduated high school	30.5	27.8	34.9	38.7	31.3
Attended college/technical school	29.3	32.7	24.6	26.1	37.1

	Cisgender Men (N=291,911)	Cisgender Women (N= 368,220)	Transgender Women (N=1,373)	Transgender Men (N=829)	Gender Nonconforming (N=570)
Graduated college/technical school	26.7	27.1	12.9	10.7	19.3
Missing	0.2	0.2	0.4	0.0	0.0
Marital status [b,c,d,e,f]					
Married/unmarried couple	58.1	53.9	53.3	43.0	40.7
Divorced	9.8	11.8	12.7	8.9	6.8
Widowed	3.4	10.3	3.7	7.3	6.7
Separated	2.1	2.7	2.6	4.8	3.2
Never married	26.2	21.0	27.4	35.3	41.5
Missing	0.4	0.3	0.3	0.7	1.1
Employment status [a,b,c,d,e,f]					
Employed or self-employed	64.8	50.5	57.5	51.0	45.5
Unemployed	5.8	5.0	9.1	8.9	8.7
Homemaker	0.4	11.4	1.8	10.2	2.8
Student	5.0	6.0	5.4	3.9	14.3
Retired	17.6	19.5	15.6	12.2	16.2
Unable to work	5.8	7.2	10.1	10.2	12.0
Missing	0.6	0.4	0.5	3.6	0.5
Self-rated health					
Self-rated health [a,b,c,d,f]					
Excellent	19.1	18.0	14.5	11.1	17.0
Very good	32.8	33.1	20.7	29.8	25.4
Good	31.6	30.9	46.5	36.6	26.9
Fair	12.0	13.2	13.5	14.6	20.8
Poor	4.2	4.6	4.7	7.7	9.9
Missing	0.3	0.2	0.1	0.2	0.0
Healthcare access and utilization					
Healthcare coverage in past year [a,b,c,d,e,f]					
Yes	87.5	90.6	82.5	77.3	86.0
No	12.0	9.1	16.1	22.1	11.4

	Cisgender Men (N=291,911)	Cisgender Women (N= 368,220)	Transgender Women (N=1,373)	Transgender Men (N=829)	Gender Nonconforming (N=570)
Missing	0.5	0.3	1.4	0.6	2.6
Healthcare delayed due to cost [a,b,d,e]					
Yes	11.0	13.2	18.4	24.3	16.1
No	88.8	86.6	81.0	75.6	83.7
Missing	0.2	0.2	0.6	0.1	0.2
Routine check-up [b,e,f]					
Within past year	66.0	75.2	69.7	68.1	64.7
1 or more years	31.7	23.4	27.8	24.2	33.1
Missing	2.3	1.4	2.5	7.7	2.2

Note. Statistical significance $p < .05$.

[a] Statistically significant difference between transgender women vs. cisgender men

[b] Statistically significant difference between transgender men vs. cisgender men

[c] Statistically significant difference between gender nonconforming participants vs. cisgender men

[d] Statistically significant difference between transgender women vs. cisgender women

[e] Statistically significant difference between transgender men vs. cisgender women

[f] Statistically significant difference between gender nonconforming participants vs. cisgender women.

Table 2.

Differences in health behaviors, metabolic risk factors, and CVD conditions between gender minorities and cisgender men, BRFSS 2014-2017 (N=294,683)

	Transgender Women (n=1,373) Reference: Cisgender Men		Transgender Men (n=829) Reference: Cisgender Men		Gender Nonconforming (n=570) Reference: Cisgender Men	
	OR (95% CI)	**AOR (95% CI)**	**OR (95% CI)**	**AOR (95% CI)**	**OR (95% CI)**	**AOR (95% CI)**
Health behaviors [a]						
Current tobacco use	1.11 (0.84-1.47)	0.82 (0.61-1.10)	1.30 (0.92-1.83)	0.97 (0.68-1.38)	0.86 (0.57-1.30)	0.67 (0.43-1.05)
Heavy drinking	0.81 (0.48-1.39)	0.80 (0.47-1.36)	1.29 (0.72-2.29)	1.27 (0.71-2.30)	1.37 (0.80-2.35)	1.40 (0.81-2.41)
Exercise in past 30 days	**0.60 (0.45-0.78)**	**0.75 (0.57-0.98)**	**0.73 (0.55-0.99)**	0.88 (0.65-1.19)	**0.52 (0.35-0.76)**	**0.58 (0.40-0.84)**
Metabolic risk factors [b]						
Overweight	0.88 (0.69-1.13)	0.89 (0.69-1.13)	0.91 (0.65-1.29)	1.07 (0.72-1.57)	0.75 (0.52-1.08)	0.84 (0.56-1.26)
Obese	0.98 (0.77-1.23)	0.89 (0.69-1.15)	1.09 (0.81-1.46)	1.08 (0.81-1.46)	1.10 (0.77-1.57)	1.00 (0.69-1.46)
Diabetes	1.24 (0.93-1.65)	1.12 (0.82-1.55)	0.96 (0.67-1.37)	0.88 (0.58-1.32)	0.82 (0.46-1.46)	0.79 (0.41-1.50)
CVD conditions [c]						
Angina/coronary heart disease	1.12 (0.81-1.57)	1.10 (0.79-1.53)	0.66 (0.39-1.10)	0.66 (0.38-1.15)	0.78 (0.32-1.93)	0.90 (0.33-2.48)
Stroke	**1.93 (1.24-3.02)**	1.62 (0.99-2.63)	1.74 (0.79-3.83)	1.55 (0.64-3.77)	1.29 (0.48-3.47)	1.11 (0.39-3.12)
Myocardial infarction	**1.52 (1.09-2.13)**	1.32 (0.95-1.85)	1.11 (0.54-2.31)	1.03 (0.44-2.42)	1.18 (0.56-2.50)	1.29 (0.53-3.13)
Any CVD	**1.47 (1.11-1.95)**	**1.38 (1.01-1.88)**	1.04 (0.63-1.73)	0.97 (0.52-1.81)	1.03 (0.56-1.91)	1.11 (0.53-2.30)

Note. Boldface denotes statistical significance $p < 0.05$; Reference group = cisgender men (n=291,911); Any CVD includes coronary heart disease, stroke, and heart attack.

[a] Adjusted model covariates included state of residence, survey year, age, race/ethnicity, income, education, marital status, employment status, and self-rated health

[b] Added healthcare coverage, delayed care, routine checkup, current tobacco use, heavy drinking, and exercise

[c] Added body mass index and diabetes.

Table 3.

Differences in health behaviors, metabolic risk factors, and CVD conditions between gender minorities and cisgender women, BRFSS 2014-2017 (N=370,992)

	Transgender Women (n=1,373) Reference: Cisgender Women		Transgender Men (n=829) Reference: Cisgender Women		Gender Nonconforming (n=570) Reference: Cisgender Women	
	OR (95% CI)	**AOR (95% CI)**	**OR (95% CI)**	**AOR (95% CI)**	**OR (95% CI)**	**AOR (95% CI)**
Health behaviors [a]						
Current tobacco use	**1.40 (1.06-1.85)**	1.10 (0.83-1.47)	**1.64 (1.17-2.31)**	1.30 (0.91-2.30)	1.09 (0.72-1.64)	0.88 (0.56-1.39)
Heavy drinking	0.93 (0.55-1.58)	1.04 (0.60-1.78)	1.47 (0.83-2.62)	1.57 (0.86-2.86)	1.56 (0.91-2.68)	1.67 (0.96-2.91)
Exercise in past 30 days	**0.71 (0.54-0.93)**	0.86 (0.65-1.13)	0.88 (0.65-1.18)	1.04 (0.77-1.41)	0.62 (0.42-0.91)	0.71 (0.49-1.03)
Metabolic risk factors [b]						
Overweight	**1.50 (1.17-1.91)**	**1.34 (1.05-1.72)**	**1.55 (1.10-2.19)**	**1.54 (1.07-2.24)**	1.27 (0.88-1.83)	1.20 (0.81-1.80)
Obese	0.97 (0.77-1.23)	0.84 (0.65-1.09)	1.08 (0.80-1.46)	0.99 (0.73-1.33)	1.10 (0.77-1.57)	0.91 (0.62-1.34)
Diabetes	**1.40 (1.05-1.86)**	**1.45 (1.05-1.99)**	1.09 (0.76-1.55)	1.07 (0.70-1.64)	0.92 (0.52-1.65)	0.98 (0.51-1.88)
CVD conditions [c]						
Angina/coronary heart disease	**1.85 (1.32-2.56)**	**1.90 (1.34-2.68)**	1.07 (0.63-1.80)	1.12 (0.64-1.97)	1.28 (0.52-3.15)	1.47 (0.53-4.09)
Stroke	**1.92 (1.23-3.00)**	**1.88 (1.16-3.03)**	1.73 (0.78-3.82)	1.80 (0.74-4.36)	1.29 (0.48-3.46)	1.30 (0.46-3.66)
Myocardial infarction	**2.92 (2.09-4.10)**	**2.98 (2.14-4.17)**	**2.14 (1.03-4.45)**	2.26 (0.98-5.22)	**2.26 (1.07-4.80)**	**2.68 (1.14-6.30)**
Any CVD	**2.09 (1.57-2.77)**	**2.24 (1.65-3.06)**	1.48 (0.89-2.46)	1.60 (0.87-2.93)	1.47 (0.80-2.72)	1.67 (0.82-3.40)

Note. Boldface denotes statistical significance $p < 0.05$; Reference group = cisgender women (n=368,220); Any CVD includes coronary heart disease, stroke, and heart attack.

[a] Adjusted model covariates included state of residence, survey year, age, race/ethnicity, income, education, marital status, employment status, and self-rated health

[b] Added healthcare coverage, delayed care, routine checkup, current tobacco use, heavy drinking, and exercise

[c] Added body mass index and diabetes.

Table 4.

Comparison of health behaviors, metabolic risk factors, and CVD conditions between gender minority participants, BRFSS 2014-2017 (N=2,772)

	Transgender Men	GNC	
	Reference: Transgender Women AOR (95% CI)	**Reference: Transgender Men AOR (95% CI)**	**Reference: Transgender Women AOR (95% CI)**
Health behaviors [a]			
Current tobacco use	1.14 (0.74-1.77)	0.70 (0.40-1.22)	0.74 (0.44-1.27)
Heavy drinking	1.81 (0.83-3.97)	0.98 (0.44-2.16)	1.63 (0.72-3.66)
Exercise in past 30 days	1.17 (0.79-1.73)	0.68 (0.41-1.14)	0.76 (0.50-1.17)
Metabolic risk factors [b]			
Overweight	1.21 (0.76-1.91)	0.76 (0.47-1.25)	0.81 (0.51-1.29)
Obese	1.17 (0.81-1.68)	0.79 (0.49-1.26)	1.06 (0.69-1.63)
Diabetes	0.82 (0.48-1.39)	0.88 (0.45-1.72)	0.72 (0.34-1.54)
CVD conditions [c]			
Angina/coronary heart disease	0.61 (0.29-1.28)	1.28 (0.60-3.15)	1.15 (0.42-3.13)
Stroke	0.80 (0.36-1.76)	0.89 (0.37-2.13)	0.67 (0.21-2.08)
Myocardial infarction	0.70 (0.36-1.37)	1.36 (0.54-3.40)	1.05 (0.49-2.24)
Any CVD	0.67 (0.38-1.18)	1.20 (0.58-2.48)	0.81 (0.39-1.65)

Note. Boldface denotes statistical significance $p < 0.05$; Any CVD includes coronary heart disease, stroke, and heart attack.

[a] Adjusted model covariates included state of residence, survey year, age, race/ethnicity, income, education, marital status, employment status, and self-rated health

[b] Added healthcare coverage, delayed care, routine checkup, current tobacco use, heavy drinking, and exercise

[c] Added body mass index and diabetes.