Depression and Sexual Stigma Are Associated With Cardiometabolic Risk Among Sexual and Gender Minorities Living With HIV in Nigeria

Sylvia B. Adebajo, MD, PhD,[a] Ruxton Adebiyi, MSHS,[a] John Chama, MD, MPH,[a] Segun Bello, MD, PhD,[a] Uche Ononaku, NCE,[b] Abayomi Aka, LLB,[c] Shenghan Lai, MD,[d] Stefan D. Baral, MD, MPD,[e] Typhanye V. Dyer, PhD, MPH,[f] Trevor A. Crowell, MD, PhD,[g,h] Rebecca G. Nowak, PhD,[d] and Man Charurat, PhD,[d,i] for the TRUST/RV368 Study Group

Background: People living with HIV are vulnerable to cardiometabolic diseases. We assessed the prevalence of cardiometabolic risk factors (CMRF) and associations with sexual stigma and depression among sexual and gender minorities (SGM) in Abuja and Lagos, Nigeria.

Methods: The TRUST/RV368 study enrolled SGM between March 2013 and February 2020. Participants were assessed for depression, sexual stigma, and CMRF. Robust multinomial logistic regression was used to estimate adjusted odds ratio (aORs) and 95% confidence intervals (CIs) for associations of depression, sexual stigma, and other factors with increasing numbers of CMRF.

Results: Among 761 SGM, the mean age was 25.0 ± 6.0 years; 580 (76%) identified as cisgender men, 641 (84%) had ≥1 CMRF, 355 (47%) had mild–severe depression, and 405 (53%) reported moderate–high sexual stigma. Compared with individuals without depression, those with mild (aOR 8.28; 95% CI: 4.18 to 16.40) or moderate–severe depression (aOR 41.69; 95% CI: 9.60 to 181.04) were more likely to have 3–5 CMRF. Individuals with medium (aOR 3.17; 95% CI: 1.79 to 5.61) and high sexual stigma (aOR 14.42; 95% CI: 2.88 to 72.29) compared with those with low sexual stigma were more likely to have 3–5 CMRF. Participants age 25–34 years were less likely to have 3–5 CMRF (aOR 0.41; 95% CI: 0.23 to 0.73) compared with participants age younger than 25 years.

Conclusion: CMRF increased with severity of depression and sexual stigma, potentially predisposing SGM living with HIV to cardiometabolic diseases. Integrating interventions that address depression and sexual stigma in HIV care programs for SGM may improve cardiometabolic outcomes.

Key Words: sexual and gender minorities living with HIV, sexual stigma, depression, cardiometabolic diseases, syndemics, Nigeria

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Noncommunicable diseases (NCDs)[1] constitute one of the most common causes of disability globally. The World Health Organization and American Society of Endocrinology recognize cardiometabolic diseases as multifactorial disease entities characterized by insulin resistance, impaired glucose tolerance, dyslipidemia, hypertension, and central adiposity.[2–4] People with cardiometabolic diseases are twice as likely to die of coronary heart disease and three times more likely to suffer heart attacks or strokes, than those who do not have cardiometabolic diseases.[2]

A recent meta-analysis of cardiometabolic diseases among persons living with HIV (PLHIV) from low- and middle-income countries (LMICs) reported prevalence estimates of hypertension (21.2%), hypercholesterolemia (22.2%), hypertriglyceridemia (27.2%), low high-density lipoprotein (52.3%), and obesity (7.8%).[5] Although numerous systematic

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From the [a]Center for International Health Education Biosecurity, University of Maryland Baltimore, Abuja, Nigeria; [b]Institute of Human Virology, Abuja, Nigeria; [c]International Centre for Advocacy on Right to Health—ICARH, Abuja, Nigeria; [d]Institute of Human Virology, University of Maryland School of Medicine, Baltimore, MD; [e]Johns Hopkins Bloomberg School of Public Health, Baltimore, MD; [f]University of Maryland School of Public Health, College Park, MD; [g]Henry M. Jackson Foundation for the Advancement of Military Medicine, Bethesda, MD; [h]U.S. Military HIV Research Program, Walter Reed Army Institute of Research, Silver Spring, MD; and [i]Center for International Health Education Biosecurity, University of Maryland School of Medicine, Baltimore, MD.

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Correspondence to: Sylvia Adebajo, MD, PhD, Center for International Health Education Biosecurity, University of Maryland Baltimore, 129, Yakubu Gowon Way, Asokoro, Abuja, Nigeria (e-mail: SAdebajo@mgic.umaryland.edu).

reviews have reported high prevalence of cardiometabolic diseases in Nigeria ranging from 18% to 32% in the general population of persons not living with HIV,[6,7] there is a dearth of studies on cardiometabolic diseases among sexual and gender minorities (SGM), especially those living with HIV.

HIV is considered an independent risk factor for cardiovascular events.[8] The cardiometabolic effects of HIV, such as abnormal lipid and glucose metabolism, fat redistribution, chronic inflammation, and vascular endothelial dysfunction, may contribute to cardiovascular end-organ disease.[8–11] Furthermore, studies have linked antiretroviral therapy (ART) as a causal agent for cardiometabolic risk in PLHIV.[12,13]

Mental health disorders seem to be associated with increased risk of NCDs.[14] Studies in the general population of people without HIV have reported associations between depression and disease entities related to cardiometabolic risks, such as diabetes and cardiovascular disease.[15,16] This has been linked to poor dietary habits, substance use, and low physical activity among other mediators, such as delayed diagnosis of coexisting diseases resulting from neglect.[17] The cardiometabolic effects of HIV have also been linked to mental health disorders, specifically depression.[18,19] Moreover, the widespread co-occurrence of comorbidities such as NCDs with mental health disorders makes treatment of both conditions challenging with poorer prognoses.[20]

Stigma and social discrimination are known cardiovascular stressors that result in secretion of stress hormones and physiological changes.[21] Prolonged exposure to various forms of stigma, including racial,[22] sex,[23] and weight[24] stigma, can cause chronic stress, sympathetic nervous system stimulation, and other cardiovascular responses. Evidence has also shown that sexual and ethnic minorities who report discrimination have elicited a similar "cardiovascular conundrum".[25] However, the relationship between sexual stigma and cardiometabolic risk is not well elucidated.

To our knowledge, data exploring relationships between cardiometabolic risk, depression, and sexual stigma among SGM are scarce. The aim of this study was to investigate these associations in a cohort of SGM living with HIV in Nigeria.

METHODS

Population and Setting

SGM living with HIV were enrolled into the TRUST/RV368 study between March 2013 and February 2020 at two SGM-friendly community health and research center in Abuja and Lagos offering comprehensive HIV treatment and prevention services.[26,27] The cohort of 2795 SGM was recruited in Abuja (n = 2123) and Lagos (n = 672) through respondent-driven sampling, a technique extensively used and described as a recruitment strategy for hard-to-reach populations globally including Nigeria.[27–29] To be eligible for recruitment, each participant presented a valid respondent-driven sampling coupon, was assigned male sex at birth, was aged at least 16 years (for the Abuja site) or 18 years (for the Lagos site), and reported receptive or insertive anal intercourse with a male partner at least once in the 12 months before enrollment.[30] These cross-sectional analyses were restricted to SGM living with HIV with complete data on depression, sexual stigma, and cardiometabolic assessments collected across two enrollment assessments approximately two weeks apart. Only data from these enrollment visits were included in the analyses and we conducted exploratory analyses that included the enrollment period dichotomized as the median enrollment date.

Measurements

Each participant was administered a standardized questionnaire that elicited demographic, clinical, sexual stigma, and depression information by a trained interviewer, followed by physical examination to obtain weight, height, and blood pressure measurements. Nonfasting blood samples were collected and analyzed for lipid profile (cholesterol, triglycerides, and high-density lipoproteins) processed using the Reflotron Plus system. Nonfasting lipid profiles were measured for participant convenience, recognizing limited differences from fasting profiles across most parameters.[31]

Outcome Variables

The dependent variable for this study was the number of cardiometabolic risk factors (CMRF) generated by assessing five indicators: (1) body mass index (BMI) 25 kg/m^2 or greater[2,32]; (2) blood pressure greater than 120 mmHg systolic or 80 mmHg diastolic[33]; (3) total cholesterol 5.2 mmol/L or greater[34]; (4) triglycerides 1.69 mmol/L or greater[35]; and (5) high-density lipoprotein 1 mmol/L or less.[34] A score was calculated by assigning one point for each CMRF present and summed to derive a range of total scores of 0–5. CMRF was further categorized into three clinically relevant groups: 0 CMRF (no risk); 1–2 CMRF (some risk); and 3–5 CMRF (high risk). Cardiometabolic disease was defined as a cluster of three or more CMRF.[36]

Exposure Variables

Depression and sexual stigma were the primary exposure variables. Depression was assessed using the standardized 9-point Patient Health Questionnaire (PHQ-9) scaled from 0 to 3 for each question. The questions elicited the following: interest in doing things; feeling down, depressed (sad), or hopeless; feeling tired or bad about self; trouble falling or staying asleep; poor appetite or overeating; trouble concentrating on things; moving or speaking so slowly that other people could have noticed or being fidgety or restless; and thoughts of being better off dead or hurting self in some way. Based on the PHQ-9 classification, the scores derived were categorized into three groups: no depression (0–4), mild depression (5–9), and moderate–severe depression (10–27).[37] Sexual stigma was measured using a 9-item tool that assessed perceived stigma because of sexual practices as previously described.[38] The 9-item tool elicited how participants perceived the following actions were due to their same-sex sexual practices: family made discriminatory remarks; rejection from friends; refusal from police to protect them; verbally harassed; felt blackmailed; physical violence; raped; fear of

seeking health care; and fear of walking in public. Applying Rodriguez-Hart et al's interpretation of the sexual stigma tool using latent class analysis model estimation of maximum likelihood,[38,39] we grouped the sexual stigma scores into three classes based on posterior distribution probabilities: low stigma, medium stigma, and high stigma. Other covariates ascertained by self-report in this study were age, gender identity, education, marital status, and occupational status. ART use was verified from each participant's ART care cards and pharmacy order forms. Data on participants' viral load and CD4 count which were abstracted from laboratory result forms were categorized as ≥1000 copies/mL for virally unsuppressed and <200 cells/μL for severely immunocompromised and used as reference groups, respectively.

Statistical Analyses

Descriptive analyses included frequency distribution of sociodemographic and other characteristics. Associations of depression and sexual stigma with CMRF were the primary analyses. Latent class analysis was done to categorize the 9-item sexual stigma tools into three classes with best model classification of posterior distribution. Chi-squared test and Fisher exact test were used to compare the categorized variables of interest with the study outcomes. Potential confounding factors identified through literature review and variable selection for the multivariable model were based on the 20% level of significance for all independent variables in the bivariable analyses. The final multivariable model was based on effect-size estimates and collinearity considerations between independent variables. Robust multinomial logistic regression analysis was used to examine associations between CMRF, depression, and sexual stigma. Variables attaining statistical significance ($P \leq 0.05$) were reported as associated with CMRF in the multivariable analyses as odds ratio (OR) with 95% confidence interval (CI). We controlled for study site, age, marital status, gender identity, and ART in the multivariable model. Our exploratory bivariate analyses established that the enrollment period was not significantly associated with the exposure and outcome variables. All analyses were done using STATA 16 (STATA Corp, College Station, TX).

Ethics Statement

This study was approved by the institutional review boards of the University of Maryland Baltimore, MD; Walter Reed Army Institute of Research, Silver Spring, MD; and the National and Federal Capital Territory Health Research Ethics Committees, Abuja, Nigeria. All participants provided written informed consent before enrollment.

RESULTS

Study Population Characteristics

Complete data on sexual stigma, depression, and CMRF were available from 761 SGM living with HIV, of whom 402 (53%) were recruited from the Abuja site. The mean age of the participants was 25.0 ± 6.0 years, 671 (88%) were single, 273 (36%) attained tertiary education, and 449 (59%) were employed. Gender identity was reported as cisgender by 580 (76%), transgender by 98 (13%), and nonbinary by 83 (11%). There were 466 (61%) participants who identified as bisexual (Table 1).

There were no statistical differences in the sociodemographic characteristics between participants excluded and those included in the analysis (see Table S1, Supplemental Digital Content, http://links.lww.com/QAI/B971).

Clinical Conditions

Sixty-two percent of the participants were on ART, 36% were virally suppressed, and 88% had CD4 count of ≥200 cells/μL (Table 1). Nineteen percent of the participants were overweight, 37% were prehypertensive, 60% had abnormal triglycerides, and 31% had abnormal HDL. Eighty-four percent of the participants had at least 1 CMRF (95% CI: 82% to 87%). Prevalence of ≥3 CMRF was 24% (95% CI: 21% to 27%; Table 2).

Bivariable Analyses of Depression and Sexual Stigma With CMRF

Mild–severe depression was observed in 47% (95% CI: 43% to 50%) of the participants, and 53% (95% CI: 50% to 58%) represented subgroups of SGM that experienced medium–high sexual stigma. Twenty-five percent of the participants who did not have depression had 0 CMRF, whereas 49% of those who had moderate–severe depression had 1 CMRF (Table 1). Figure 1A shows that the proportion of participants with depression increased with higher CMRF.

Similarly, Table 2 shows that about a quarter (24%) of the 356 participants in the low sexual stigma class had 0 CMRF, whereas 49% of 72 participants who experienced high sexual stigma had ≥3 CMRF ($P < 0.001$). Figure 1B shows that the proportion of participants with sexual stigma increased with higher CMRF.

Other covariates significantly associated with CMRF in the bivariable analyses ($P < 0.2$) were study site, age, marital status, gender identity, and ART.

Correlates of Cardiometabolic Risk

Table 3 shows that compared with participants without depression, the odds of having 1–2 CMRF increased with severity of depression from 3.40 (95% CI: 1.88 to 6.15) with mild depression to 9.44 (95% CI: 2.27 to 39.31) with moderate–severe depression. Similarly, the odds of having 3–5 CMRF were 8.28 (95% CI: 4.18 to 16.40) with mild depression and 41.69 (95% CI: 9.60 to 181.04) with moderate–severe depression compared with those without depression. The odds of having 1–2 CMRF were also higher if participants belonged to the medium sexual stigma subgroup [adjusted odds ratio (aOR) 1.76; 95% CI: 1.10 to 2.82] compared with those in the low stigma class. Furthermore, compared with participants without sexual stigma, the odds of 3–5 CMRFs were 3.17 (95% CI: 1.79 to 5.61) among those in the medium sexual stigma class and 14.42 (95% CI: 2.88 to 72.29) in the high sexual stigma class

TABLE 1. Comparison of Covariables With CMRF Among SGM Living With HIV in Lagos and Abuja, Nigeria

Characteristics	N, %	0 CMRF n, %	1–2 CMRF n, %	3–5 CMRF n, %	*P*
Sample size	761	120 (15.8)	459 (60.3)	182 (23.9)	
Study site	761				<0.001†
Abuja ‡	402 [52.8]	91 (22.6)	241 (60.0)	70 (17.4)	
Lagos §	359 [47.2]	29 (8.1)	218 (60.7)	112 (31.2)	
Age in yr	761				<0.001†
<25	397 [52.2]	42 (10.6)	249 (62.7)	106 (26.7)	
25–34	316 [47.4]	65 (20.6)	189 (59.8)	62 (19.6)	
≥35	48 [0.4]	13 (27.1)	21 (43.7)	14 (29.2)	
Marital status	761				0.058*
Single	671 [88.2]	98 (14.6)	413 (61.5)	160 (23.9)	
Married/cohabiting	61 [8.0]	18 (29.5)	29 (47.6)	14 (22.9)	
Separated/divorced/widowed	29 [3.8]	4 (13.8)	17 (58.6)	8 (27.6)	
Gender identity	761				0.009*
Cisgender man	580 [76.2]	96 (16.6)	351 (60.5)	133 (22.9)	
Transgender woman	98 [12.9]	6 (6.1)	59 (60.2)	33 (33.7)	
Nonbinary	83 [10.9]	18 (21.7)	49 (59.0)	16 (19.3)	
Sexual orientation	761				0.004*
Homosexual	294 [38.6]	30 (10.2)	185 (62.9)	79 (26.9)	
Bisexual	466 [61.2]	90 (19.3)	273 (58.6)	103 (22.1)	
Queer	1 [0.1]	0 (0.0)	1 (100.0)	0 (0.0)	
Educational level	761				0.319*
None/primary	34 [4.4]	7 (20.6)	22 (64.7)	5 (14.7)	
Secondary	454 [59.7]	63 (13.9)	276 (60.8)	115 (25.3)	
Tertiary	273 [35.9]	50 (18.3)	161 (59.0)	182 (23.7)	
Occupational status	761				0.346†
Unemployed	312 [41.0]	42 (13.4)	193 (61.9)	77 (24.7)	
Employed	449 [59.0]	78 (17.4)	266 (59.2)	105 (23.4)	
ART	761				<0.001†
No	286 [37.6]	26 (9.1)	169 (59.1)	91 (31.8)	
Yes	475 [62.4]	94 (19.8)	290 (61.0)	91 (19.2)	
Viral load	761				0.245†
≤1000 copies/mL	274 [36.0]	41 (15.0)	158 (57.6)	75 (27.4)	
>1000 copies/mL	487 [64.0]	79 (16.2)	301 (61.8)	107 (22.0)	
CD4 count	761				0.922†
≥200	673 [88.4]	105 (15.6)	406 (60.3)	162 (24.1)	
<200	88 [11.6]	15 (17.1)	53 (60.2)	20 (22.7)	
Depression ¶	761				<0.001*
None	406 [53.4]	101 (24.9)	255 (62.8)	50 (12.3)	
Mild	227 [29.8]	17 (7.5)	141 (62.1)	69 (30.4)	
Moderate–severe	128 [16.8]	2 (1.6)	63 (49.2)	63 (49.2)	
Sexual stigma ‖	761				<0.001*
Low	356 [46.8]	86 (24.2)	221 (62.1)	49 (13.7)	
Medium	333 [43.8]	32 (9.6)	203 (61.0)	98 (29.4)	
High	72 [9.4]	2 (2.8)	35 (48.6)	35 (48.6)	

*Fisher exact test.
†χ^2 test.
‡Data collected at Abuja site only.
§Data collected at Lagos site only.
‖Stigma was determined using the Internalized Stigma of Mental Illness (ISMI-9) scale to assess the perceived and actual discrimination felt by participants because they are SGM.
¶Depression was determined using the standardized PHQ-9. N [%]–column percentage; n (%)–row percentage.

compared with those in the low stigma class. Participants at the Lagos study site had higher odds of having 1–2 CMRFs (aOR 5.30; 95% CI: 1.63 to 17.23) or 3–5 CMRFs (aOR 5.87; 95% CI: 1.59 to 21.71) compared with those at the Abuja study site. Participants age 25–34 years had lower odds of having 1–2 CMRFs (aOR 0.54; 95% CI: 0.34 to

TABLE 2. Characteristics of Indicators Assessed as CMRF Among SGM Living With HIV in Lagos and Abuja, Nigeria

Characteristics N = 761	N, %
BMI	
Underweight	162 (21.3)
Normal	452 (59.4)
Overweight	95 (12.5)
Obese	52 (6.8)
Blood pressure	
Normal	454 (59.7)
Prehypertensive	284 (37.3)
Hypertensive	23 (3.0)
Total cholesterol	
Normal	617 (81.1)
Abnormal	144 (18.9)
Triglycerides	
Normal	304 (40.0)
Abnormal	457 (60.0)
High-density lipoproteins	
Normal	524 (68.9)
Abnormal	237 (31.1)
CMRF	
0	120 (15.8)
1–2	459 (60.3)
3–5	182 (23.9)

0.86) or having 3–5 CMRFs (aOR 0.41; 95% CI: 0.23 to 0.73) compared with those age younger than 25 years.

DISCUSSION

Nearly half (47%) of SGM living with HIV in our study had depression, while 53% experienced sexual stigmatization, and 84% had at least one CMRF. The common cardiometabolic disease components in our study were prehypertension (37%), total cholesterol (19%), triglycerides (60%) and overweight/obesity (19%). Using the Adult Treatment Panel III criteria, 24% of SGM in this study had cardiometabolic disease (at least three CMRF).[36,40] This is significantly higher than the 2.1% previously reported among men living with or without HIV in a population-based study in rural South West Nigeria[41] but lower than the 27.9% reported by Oguoma et al[42] in their systematic review of hospital-based and population-based studies conducted among an older non-SGM population. The number of CMRF increased with severity of depression in our study. This may be linked to the unhealthy lifestyles adopted by persons who are depressed, which may increase the risk of CMRF. A 2014 study by Cezaretto et al[43] reported that baseline depression status predicted a lower chance of improvements in long-term cardiometabolic risks such as BMI, blood pressure, and serum cholesterol levels. A strong association between depression and CMRF was also reported in a recently published 27-year longitudinal study among older male twin veterans by Ditmars et al in 2021.[30] The Emory Health Aging Study, conducted in a young adult population (18–34 years) similar to our study's age distribution, found that moderate–severely depressed participants were unlikely to meet the ideal levels of BMI, cholesterol, and physical activity.[44]

Several studies have reported high levels of different types of stigma experienced by SGM living with HIV.[45–47] For instance, weight stigma has been linked with poor metabolic health and weight gain through metabolic and hormonal pathways like cortisol.[48,49] Weight stigma is also associated with biomarkers such as unhealthy blood pressure, C-reactive protein, HDL cholesterol, triglycerides, and glucose.[50] Studies have also reported associations between HIV stigma and NCDs, at least partially attributable to stigma-related barriers to NCD care.[51] In a systematic review, Stockton et al[51] reported that fear of disclosure, internalized shame and embarrassment, and negative past experiences with health care providers could negatively influence engagement with NCD interventions. Because stigmatization can decrease acceptability of differentiated models of care among PLHIV, it is likely to also limit access to NCD care in health care settings.[52] Two-thirds (61%) of participants who experienced medium sexual stigmatization had 1–2 CMRF. We recommend that associations between sexual stigma and CMRF are further explored among SGM populations. This is because sexual stigma, which is associated with poor mental health, may result in delayed help-seeking behavior, reduced access to health services, suboptimal treatment of CMRF, and increased risk of cardiometabolic diseases.[19] We have previously described a relationship between past

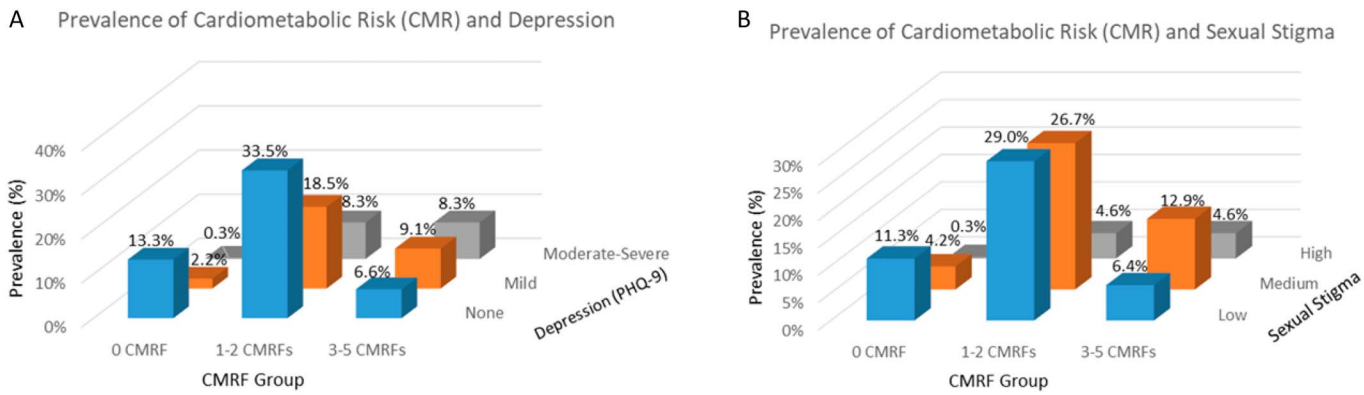

FIGURE 1. Prevalence of CMR, depression and sexual stigma.

TABLE 3. Multinomial Logistic Regression Showing Factors Associated With CMRF Among SGM Living With HIV in Lagos and Abuja, Nigeria

Characteristics	Univariable			Multivariable		
	Crude OR	95% CI	*P*	Adjusted OR	95% CI	*P*
0 CMRF	Base outcome			Base outcome		
1–2 CMRF						
Study site (Abuja)	1	—	—	1	—	—
Lagos	7.52	5.10–11.08	<0.001	5.30	1.63–17.23	**0.006**
Age in yr (<25)	1	—	—	1	—	—
25–34	2.91	2.19–3.86	<0.001	0.54	0.34–0.86	**0.010**
≥35	1.62	0.81–3.23	0.174	0.46	0.18–1.13	0.089
Marital status (single)	1	—	—	1	—	—
Married/cohabiting	1.61	0.89–2.90	0.112	0.46	0.22–1.00	0.049
Separated/divorced/widowed	4.25	1.43–12.64	0.009	1.17	0.39–3.50	0.784
Gender identity (cisgender man)	1	—	—	1	—	—
Transgender woman	9.83	4.24–22.79	<0.001	1.67	0.66–4.19	0.279
Nonbinary	2.72	1.59–4.67	<0.001	0.77	0.40–1.48	0.427
ART (no)	1	—	—	1	—	—
Yes	3.09	2.44–3.89	<0.001	2.90	0.83–10.06	0.094
Depression (none)	1	—	—	1	—	—
Mild	5.17	3.08–8.68	<0.001	3.40	1.88–6.15	**<0.001**
Moderate–severe	14.35	3.44–59.90	<0.001	9.44	2.27–39.31	**0.002**
Sexual stigma (low)	1	—	—	1	—	—
Medium	3.58	2.41–5.31	<0.001	1.76	1.10–2.82	**0.018**
High	7.58	1.75–32.88	0.007	4.58	0.97–21.57	0.054
3–5 CMRF						
Study site (Abuja)	1	—	—	1	—	—
Lagos	2.76	1.90–4.01	<0.001	5.87	1.59–21.71	**0.008**
Age in yr (<25)	1	—	—	1	—	—
25–34	0.67	0.45–0.98	0.039	0.41	0.23–0.73	**0.002**
≥35	0.99	0.48–2.01	0.966	0.87	0.28–2.70	0.808
Marital status (single)	1	—	—	1	—	—
Married/cohabiting	0.78	0.89–2.90	0.481	0.45	0.16–1.27	0.134
Separated/divorced/widowed	2.00	0.60–6.65	0.258	1.32	0.34–5.05	0.688
Gender identity (cisgender man)	1	—	—	1	—	—
Transgender woman	1.87	1.11–3.15	0.019	1.65	0.60–4.59	0.335
Nonbinary	0.77	0.42–1.43	0.406	0.52	0.22–1.19	0.121
ART (no)	1	—	—	1	—	—
Yes	0.43	0.30–0.63	<0.01	2.12	0.54–8.35	0.283
Depression (none)	1	—	—	1	—	—
Mild	3.33	1.97–5.65	<0.001	8.28	4.18–16.40	**<0.001**
Moderate–severe	22.03	5.35–90.68	<0.001	41.69	9.60–181.04	**<0.001**
Sexual stigma (low)	1	—	—	1	—	—
Medium	2.27	1.52–3.38	<0.001	3.17	1.79–5.61	**<0.001**
High	10.96	2.61–45.98	0.001	14.42	2.88–72.29	**0.001**

Bold numbers are statistically significant at $P < 0.05$.
Base outcome, referent group; CI, confidence interval; OR, odds ratio.

experiences of sexual stigma and suicidal ideation that negatively impacted the uptake of health services in the TRUST/RV368 cohort.[38,53,54] The pathways underlying relationships between depression, sexual stigma, uptake of health services, and cardiometabolic diseases should be further characterized. As reported in a systematic review by Fu et al,[55] the high prevalence of depression reported among SGM is not given the level of attention it deserves. This is particularly worrisome because of the unequivocal link with cardiometabolic risk, and the unknown but growing population of SGM with unmet mental health prevention and treatment needs. Furthermore, both can potentially lead to higher CMRF and other HIV-associated NCDs.

The life expectancy of PLHIV on ART is increasing compared with treatment-naive PLHIV.[56,57] A recent meta-analysis showed that ART independently increased the risk of

metabolic and cardiovascular diseases.[58] This was corroborated in our study with ART treatment doubling the odds of having 1–2 CMRF, although this was not statistically significant. It is worthy of note that only 62% of participants in our study were on ART partly because of the well documented interplay of individual, social, and structural barriers to access, uptake, and adherence of ART among SGM.[27,59] Nevertheless, it is possible that some of those on ART may have been newly diagnosed and not on ART for long enough to develop CMRF. We recommend further exploration of the association between ART and CMRF among SGM.

Increased risk of cardiometabolic diseases with age is well documented.[60,61] However, our study showed decreased odds of CMRF with age among SGM. Participants in our study were young (52% were ≤35 years) with lower risk of CMRFs and shorter duration of exposure to ART composed of more toxic TDF-based regimens reported to be previously associated with cardiometabolic diseases.[62,63] It is also plausible that the increased risk of cardiometabolic diseases demonstrated in the younger SGM in our study could be a reflection of increased exposure to underlying risk factors related to tobacco use, diet, illicit drug use, physical activity, and alcohol consumption poorer mental health than their older peers. Prospective studies among SGM that include qualitative and quantitative measures of CMRF are needed.

The higher odds of CMRF among SGM in Lagos compared with those in Abuja may be connected to the higher level of westernization and urbanization. Lagos is the smallest state in Nigeria surrounded by water, yet it is a megacity and the nerve-center of Nigeria characterized by its high density, high cost of living, and all the attendant challenges.[42] It is possible that SGM living with HIV in Lagos were younger, unemployed, and face higher levels of sexual stigma and discrimination, which may lead to more CMRF.[64,65] Further studies are needed to better understand the geographic epidemiology of CMRF among SGM in Nigeria.

Study Limitations

This study had a few limitations. Given the cross-sectional nature of our data, it was difficult to establish the temporal link between CMRF, depression, and sexual stigma. Some confounding factors and effect modifiers of CMRF based on the literature such as clients' history of physical activities, nutrition, family history, medical history, blood glucose, low-density lipoprotein, smoking, and more detailed information regarding alcohol and drug use were unavailable and not included in our analyses. The cross-sectional depression measurements used in these analyses may not be a true reflection of the mental status of the participants over a long period. A single depression score can only reflect the time frame it was administered and may not necessarily be representative of chronic depression, which requires successive measurements over time. For this reason, depression screening integrated into HIV services should occur at all or multiple clinic visits for optimal risk identification and service provision. This study was conducted among SGM who were assigned male sex at birth, including transgender women and cisgender men who have sex with men, but did not include any participants who were assigned female sex at birth; our findings may not be generalizable to SGM who were not represented in the study.

CONCLUSIONS

SGM living with HIV in LMICs such as Nigeria face an increased and synergistic risk of depression and sexual stigma, which predispose them to poorer health outcomes of cardiometabolic diseases. This opens opportunities for more research to investigate the mechanism and potential pathways underlying the associations observed in this study between depression, sexual stigma, and CMRF among SGM, and modifiable strategies that may be integrated into the standard of care. In our study, we found that there were high levels of sexual stigma and depression, both of which had influences on CMRF. Because these social and psychological factors often co-occur and interact with one another adversely and are dually affected by exposure to additional social and structural inequities, they may comprise a synergistic epidemic (syndemic), leading to greater disparities in health outcomes related to cardiometabolic risk and NCDs among PLHIV in LMICs, especially among SGM. Future studies would benefit from implementing a syndemic approach to inform interventions that are more targeted to abate exposure to and effects of syndemic social and structural inequities in their approach.

Implications

Although further research will be necessary to fully elucidate the associations of depression, sexual stigma, and CMRF, it is plausible that depression may have a larger impact on cardiometabolic diseases and NCDs among SGM living with HIV in Nigeria. Our findings can serve as a baseline for further research and inform early intervention efforts that aim to mitigate depression and sexual stigma, and improve help-seeking behaviors that address cardiometabolic diseases and NCDs among SGM. Health service interventions targeting NCDs, especially cardiometabolic diseases, would benefit from integration with mental health programs, and social mobilization against stigmatization may also be warranted.

REFERENCES

1. WHO. *Global Status Report on Noncommunicable Diseases 2010*. Geneva: WHO; 2011. WT 500.
2. Srivastava AK. Challenges in the treatment of cardiometabolic syndrome. *Indian J Pharmacol.* 2012;44:155–156.
3. Alberti KG, Zimmet PZ. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. *Diabet Med.* 1998;15:539–553.
4. Castro JP, El-Atat FA, McFarlane SI, et al. Cardiometabolic syndrome: pathophysiology and treatment. *Curr Hypertens Rep.* 2003;5:393–401.
5. Patel P, Rose CE, Collins PY, et al. Noncommunicable diseases among HIV-infected persons in low-income and middle-income countries: a systematic review and meta-analysis. *AIDS.* 2018;32:S5–S20.
6. Oguoma VM, Nwose EU, Richards RS. Prevalence of cardio-metabolic syndrome in Nigeria: a systematic review. *Public Health.* 2015;129:413–423.
7. Ulasi II, Ijoma CK, Onodugo OD. A community-based study of hypertension and cardio-metabolic syndrome in semi-urban and rural communities in Nigeria. *BMC Health Serv Res.* 2010;10:71.

8. Rueda S, Mitra S, Chen S, et al. Examining the associations between HIV-related stigma and health outcomes in people living with HIV/AIDS: a series of meta-analyses. *BMJ Open.* 2016;6:e011453.
9. Deeks SG, Tracy R, Douek DC. Systemic effects of inflammation on health during chronic HIV infection. *Immunity.* 2013;39:633–645.
10. Armah KA, McGinnis K, Baker J, et al. HIV status, burden of comorbid disease, and biomarkers of inflammation, altered coagulation, and monocyte activation. *Clin Infect Dis.* 2012;55:126–136.
11. Deeks SG, Phillips AN. HIV infection, antiretroviral treatment, ageing, and non-AIDS related morbidity. *BMJ.* 2009;338:a3172.
12. Martin A, Emery S. Metabolic disorders and cardiovascular consequences of HIV infection and antiretroviral therapy. *Expert Rev Clin Pharmacol.* 2009;2:381–390.
13. Ake JA, Polyak CS, Crowell TA, et al. Noninfectious comorbidity in the African cohort study. *Clin Infect Dis.* 2019;69:639–647.
14. Shao M, Lin X, Jiang D, et al. Depression and cardiovascular disease: shared molecular mechanisms and clinical implications. *Psychiatry Res.* 2020;285:112802.
15. Gelaye B, Williams MA, Lemma S, et al. Major depressive disorder and cardiometabolic disease risk among sub-Saharan African adults. *Diabetes Metab Syndr.* 2015;9:183–191.
16. Tang B, Yuan S, Xiong Y, et al. Major depressive disorder and cardiometabolic diseases: a bidirectional Mendelian randomisation study. *Diabetologia.* 2020;63:1305–1311.
17. Sartorious N. Comorbidity of mental and physical diseases: a main challenge for medicine of the 21st century. *Shanghai Arch Psychiatry.* 2013;25:68–69.
18. Mbunkah HA, Meriki HD, Kukwah AT, et al. Prevalence of metabolic syndrome in human immunodeficiency virus-infected patients from the south-west region of Cameroon, using the adult treatment panel III criteria. *Diabetol Metab Syndr.* 2014;6:92.
19. Gronholm PC, Thornicroft G, Laurens KR, et al. Mental health-related stigma and pathways to care for people at risk of psychotic disorders or experiencing first-episode psychosis: a systematic review. *Psychol Med.* 2017;47:1867–1879.
20. Javed A, Lee C, Zakaria H, et al. Reducing the stigma of mental health disorders with a focus on low- and middle-income countries. *Asian J Psychiatry.* 2021;58:102601.
21. Rozanski A, Blumenthal JA, Kaplan J. Impact of psychological factors on the pathogenesis of cardiovascular disease and implications for therapy. *Circulation.* 1999;99:2192–2217.
22. Dolezsar CM, McGrath JJ, Herzig AJM, et al. Perceived racial discrimination and hypertension: a comprehensive systematic review. *Health Psychol.* 2014;33:20–34.
23. Matheson K, Gill R, Kelly O, et al. Cortisol and cardiac reactivity in the context of sex discrimination: the moderating effects of mood and perceived control. *Open Psychol J.* 2008;1:1.
24. Major B, Eliezer D, Rieck H. The psychological weight of weight stigma. *Soc Psychol Personal Sci.* 2012;3:651–658.
25. Rosati F, Williams DP, Juster RP, et al. The cardiovascular conundrum in ethnic and sexual minorities: a potential biomarker of constant coping with discrimination. *Front Neurosci.* 2021;15:619171.
26. Nowak RG, Gravitt PE, He X, et al; TRUST Study Group. Prevalence of anal high-risk human papillomavirus infections among HIV-positive and HIV-negative men who have sex with men in Nigeria. *Sex Transm Dis.* 2016;43:243–248.
27. Charurat ME, Emmanuel B, Akolo C, et al. Uptake of treatment as prevention for HIV and continuum of care among HIV-positive men who have sex with men in Nigeria. *J Acquir Immune Defic Syndr.* 2015;68:S114–S123.
28. Baral SD, Ketende S, Schwartz S, et al. Evaluating respondent-driven sampling as an implementation tool for universal coverage of antiretroviral studies among men who have sex with men living with HIV. *J Acquir Immune Defic Syndr.* 2015;68:S107–S113.
29. Stahlman S, Johnston LG, Yah C, et al. Respondent-driven sampling as a recruitment method for men who have sex with men in southern sub-Saharan Africa: a cross-sectional analysis by wave. *Sex Transm Infect.* 2016;92:292–298.
30. Ditmars HL, Logue MW, Toomey R, et al. Associations between depression and cardiometabolic health: a 27-year longitudinal study. *Psychol Med.* 2021:1–11. doi: 10.1017/S003329172000505X.
31. Ehrlich AM. Fasting vs. nonfasting lipid profile for assessing cardiovascular risk. *Am Fam Physician.* 2019;100:72–73.
32. WHO. WHO Expert Committee on Physical Status: the Use Interpretation of, Anthropometry World Health, Organization. *Utilisation et interprétation de l' anthropométrie : rapport d' un comité OMS d' experts*; 1995.
33. Chobanian AV, Bakris GL, Black HR, et al. Seventh report of the joint national committee on prevention, detection, evaluation, and treatment of high blood pressure. *Hypertension.* 2003;42:1206–1252.
34. Information NCfB. *High Cholesterol: Overview*. Bethesda, MD: Institute for Quality and Efficiency in Health Care (IQWiG); 2017.
35. Karanchi H, Muppidi V, Wyne K. Hypertriglyceridemia. *StatPearls*. Treasure Island (FL): StatPearls Publishing; 2021.
36. Grundy SM, Cleeman JI, Daniels SR, et al. Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. *Circulation.* 2005;112:2735–2752.
37. Levis B, Benedetti A, Thombs BD. Accuracy of Patient Health Questionnaire-9 (PHQ-9) for screening to detect major depression: individual participant data meta-analysis. *BMJ.* 2019;365:l1476.
38. Rodriguez-Hart C, Musci R, Nowak RG, et al; TRUST/RV368 Study Group. Sexual stigma patterns among Nigerian men who have sex with men and their link to HIV and sexually transmitted infection prevalence. *AIDS Behav.* 2018;22:1662–1670.
39. Rodriguez-Hart C, Bradley C, German D, et al. The synergistic impact of sexual stigma and psychosocial well-being on HIV testing: a mixed-methods study among Nigerian men who have sex with men. *AIDS Behav.* 2018;22:3905–3915.
40. Grundy SM, Brewer HB, Jr, Cleeman JI, et al. Definition of metabolic syndrome: Report of the National Heart, Lung, and Blood Institute/American Heart Association conference on scientific issues related to definition. *Circulation.* 2004;109:433–438.
41. Oladapo OO, Salako L, Sodiq O, et al. A prevalence of cardiometabolic risk factors among a rural Yoruba south-western Nigerian population: a population-based survey. *Cardiovasc J Africa.* 2010;21:26–31.
42. Oguoma VM, Nwose EU, Richards RS. Prevalence of cardio-metabolic syndrome in Nigeria: a systematic review. *Public Health.* 2015;129:413–423.
43. Cezaretto A, Pakseresht M, Sharma S, et al. Influence of depression on cardiometabolic responses to a lifestyle intervention in at-risk individuals. *J Affective Disord.* 2015;174:516–521.
44. Patterson SL, Marcus M, Goetz M, et al. Abstract P192: depression and anxiety are associated with cardiovascular health in young adults. *Circulation.* 2021;143:AP192.
45. Anderson AM, Ross MW, Nyoni JE, et al. High prevalence of stigma-related abuse among a sample of men who have sex with men in Tanzania: implications for HIV prevention. *AIDS Care.* 2015;27:63–70.
46. Secor AM, Wahome E, Micheni M, et al. Depression, substance abuse and stigma among men who have sex with men in coastal Kenya. *AIDS.* 2015;29:S251–S259.
47. Tucker A, Liht J, de Swardt G, et al. Homophobic stigma, depression, self-efficacy and unprotected anal intercourse for peri-urban township men who have sex with men in Cape Town, South Africa: a cross-sectional association model. *AIDS Care.* 2014;26:882–889.
48. Tomiyama AJ, Carr D, Granberg EM, et al. How and why weight stigma drives the obesity 'epidemic' and harms health. *BMC Med.* 2018;16:123.
49. Sutin AR, Stephan Y, Luchetti M, et al. Perceived weight discrimination and C-reactive protein. *Obesity (Silver Spring).* 2014;22:1959–1961.
50. Daly M, Robinson E, Sutin AR. Does knowing hurt? Perceiving oneself as overweight predicts future physical health and well-being. *Psychol Sci.* 2017;28:872–881.
51. Stockton MA, Giger K, Nyblade L. A scoping review of the role of HIV-related stigma and discrimination in noncommunicable disease care. *PLoS One.* 2018;13:e0199602.
52. Venables E, Edwards JK, Baert S, et al. "They just come, pick and go." The acceptability of integrated medication adherence clubs for HIV and non communicable disease (NCD) patients in Kibera, Kenya. *PLoS One.* 2016;11:e0164634.
53. Crowell TA, Keshinro B, Baral SD, et al. Stigma, access to healthcare, and HIV risks among men who sell sex to men in Nigeria. *J Int AIDS Soc.* 2017;20:21489.

54. Rodriguez-Hart C, Nowak RG, Musci R, et al. Pathways from sexual stigma to incident HIV and sexually transmitted infections among Nigerian MSM. *AIDS.* 2017;31:2415–2420.
55. Fu H, Feng T, Wang T, et al. Reported prevalence of depression or depressive symptoms among men who have sex with men in China, 2004–2018: a systematic review and meta-analysis. *J Affective Disord.* 2020;277:192–203.
56. Trickey A, May MT, Vehreschild J-J, et al. Survival of HIV-positive patients starting antiretroviral therapy between 1996 and 2013: a collaborative analysis of cohort studies. *Lancet HIV.* 2017;4:e349–e356.
57. Dillon DG, Gurdasani D, Riha J, et al. Association of HIV and ART with cardiometabolic traits in sub-Saharan Africa: a systematic review and meta-analysis. *Int J Epidemiol.* 2013;42:1754–1771.
58. Dimala CA, Blencowe H, Choukem SP. The association between antiretroviral therapy and selected cardiovascular disease risk factors in sub-Saharan Africa: a systematic review and meta-analysis. *PLoS One.* 2018;13:e0201404.
59. Quinn KG, Voisin DR. ART adherence among men who have sex with men living with HIV: key challenges and opportunities. *Curr HIV/AIDS Rep.* 2020;17:290–300.
60. Wakabayashi I. Relationship between age and cardiometabolic index in Japanese men and women. *Obes Res Clin Pract.* 2018;12:372–377.
61. Hui L. Assessment of the role of ageing and non-ageing factors in death from non-communicable diseases based on a cumulative frequency model. *Scientific Rep.* 2017;7:8159.
62. Khawaja AA, Taylor KA, Lovell AO, et al. HIV antivirals affect endothelial activation and endothelial-platelet crosstalk. *Circ Res.* 2020; 127:1365–1380.
63. Bavinger C, Bendavid E, Niehaus K, et al. Risk of cardiovascular disease from antiretroviral therapy for HIV: a systematic review. *PLoS One.* 2013;8:e59551.
64. Keshinro B, Crowell TA, Nowak RG, et al. High prevalence of HIV, chlamydia and gonorrhoea among men who have sex with men and transgender women attending trusted community centres in Abuja and Lagos, Nigeria. *J Int AIDS Soc.* 2016;19:21270.
65. Nowak RG, Mitchell A, Crowell TA, et al. Individual and sexual network predictors of HIV incidence among men who have sex with men in Nigeria. *J Acquir Immune Defic Syndr.* 2019;80:444–453.