Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Annals of Epidemiology 66 (2022) 5–12

Contents lists available at ScienceDirect

Annals of Epidemiology

journal homepage: www.annalsofepidemiology.org

Original article

Sexual orientation-related disparities in health conditions that elevate COVID-19 severity

Kristine E Lynch, PhD[a,b,*], Jillian C Shipherd, PhD[c,d,e], Elise Gatsby, MPH[a], Benjamin Viernes, MPH[a,b], Scott L DuVall, PhD[a,b], John R Blosnich, PhD, MPH[f,g]

[a] VA Informatics and Computing Infrastructure (VINCI), VA Salt Lake City Health Care System, Salt Lake City, UT
[b] University of Utah School of Medicine, Department of Internal Medicine, Division of Epidemiology, Salt Lake City, UT
[c] Lesbian, Gay, Bisexual, Transgender, and Queer (LGBTQ+) Health Program, Veterans Health Administration, Washington, DC
[d] National Center for PTSD, Women's Health Sciences Division, VA Boston Healthcare System, Boston, MA
[e] Department of Psychiatry, Boston University School of Medicine, Boston, MA
[f] Suzanne Dworak-Peck School of Social Work, University of Southern California, Los Angeles, CA
[g] Center for Health Equity Research and Promotion, VA Pittsburgh Healthcare System, Pittsburgh, PA

ARTICLE INFO

Article history:
Received 8 July 2021
Revised 18 October 2021
Accepted 4 November 2021
Available online 14 November 2021

Keywords:
Administrative data or large data sets
Covid-19
Sexual orientation
Veterans/department of veterans affairs/va

ABSTRACT

Purpose: The Veterans Health Administration (VA) is the largest single integrated healthcare system in the US and is likely the largest healthcare provider for people with minoritized sexual orientations (e.g., gay, lesbian, bisexual). The purpose of this study was to use electronic health record (EHR) data to replicate self-reported survey findings from the general US population and assess whether sexual orientation is associated with diagnosed physical health conditions that may elevate risk of COVID-19 severity among veterans who utilize the VA.

Methods: A retrospective analysis of VA EHR data from January 10, 1999–January 07, 2019 analyzed in 2021. Veterans with minoritized sexual orientations were included if they had documentation of a minoritized sexual orientation within clinical notes identified via natural language processing. Veterans without minoritized sexual orientation documentation comprised the comparison group. Adjusted prevalence and prevalence ratios (aPR) were calculated overall and by race/ethnicity while accounting for differences in distributions of sex assigned at birth, age, calendar year of first VA visit, volumes of healthcare utilization, and VA priority group.

Results: Data from 108,401 veterans with minoritized sexual orientation and 6,511,698 controls were analyzed. After adjustment, veterans with minoritized sexual orientations had a statistically significant elevated prevalence of 10 of the 11 conditions. Amongst the highest disparities observed were COPD (aPR:1.24 [95% confidence interval:1.23–1.26]), asthma (1.22 [1.20–1.24]), and stroke (1.26 [1.24–1.28]).

Conclusions: Findings largely corroborated patterns among the general US population. Further research is needed to determine if these disparities translate to poorer COVID-19 outcomes for individuals with minoritized sexual orientation.

Introduction

A concordance of evidence about sexual orientation-related health disparities has developed in the decade following the 2011 National Academy of Medicine report about the health of lesbian, gay, bisexual, and transgender (LGBT) populations [1]. Health risk behaviors (e.g., smoking, [2] substance use [3]) and social stressors (e.g., violence, [4] homelessness [5]) are well-documented amongst

Abbreviations and acronyms: aPR, adjusted prevalence ratio; BRFSS, behavioral risk factor surveillance system; CDW, corporate data warehouse; CKD, chronic kidney disease; COPD, chronic obstructive pulmonary disease; COVID-19, coronavirus disease; EHR, electronic health record; ICD, international classification of disease; LGBT, lesbian, gay, bisexual, transgender; NLP, natural language processing; OMOP, observational medical outcomes partnership; PR, prevalence ratio; VA, veterans health administration.

Conflict of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

* Corresponding author. VA Informatics and Computing Infrastructure (VINCI), VA Salt Lake City Health Care System, 500 Foothill Drive, Salt Lake City, UT 84148, Tel: 801-582-1565 ext 1913.

E-mail address: Kristine.Lynch@va.gov (K.E. Lynch).

https://doi.org/10.1016/j.annepidem.2021.11.006
1047-2797/

key health determinants for people who have minoritized sexual orientations. However, disparities in health outcomes such as diagnosed medical conditions are still developing in the literature due to lags in availability of sexual orientation fields in electronic health record (EHR) data [6].

Differences in diagnosed physical health conditions for individuals with minoritized sexual orientations have gained increased urgency in the wake of the coronavirus disease (COVID-19) pandemic [7,8] Several diagnosed medical conditions increase severity of COVID-19 symptoms, vulnerability to complications, and mortality [9,10] For example, hospitalizations are three times higher for those with type I or type II diabetes [11] and intensive care admissions are similarly higher among those with clinically active asthma [12] Although not yet wholly understood, routinely collected healthcare data have enabled research on the impact of preexisting conditions on COVID-19 among certain marginalized populations, such as racial and ethnic minority groups [13,14]. Similar research is non-existent for individuals with minoritized sexual orientations owing to the lack of data on sexual orientation in healthcare environments, including COVID-19 tracking systems [8,15,16].

Heretofore, most knowledge about physical health profiles of minoritized sexual orientation groups typically relies on self-reported survey data. For example, individuals with minoritized sexual orientations are more likely to report acute respiratory illnesses and asthma than their heterosexual peers [17–20] Data from the National Health and Nutrition Examination Survey indicated greater risk profiles for cardiovascular disease among people with minoritized sexual orientations, especially women [21,22]. Most recently, Heslin and Hall used data from the Centers for Disease Control and Prevention Behavioral Risk Factor Surveillance System (BRFSS), finding consistent sexual orientation differences in ten physical health conditions that may worsen COVID-19 severity and increase risk of death: asthma, cancer, heart disease, chronic obstructive pulmonary disease (COPD), diabetes, hypertension, kidney disease, stroke, obesity, and smoking. Although self-reported survey data, such as BRFSS, advanced the field on health outcomes among the sexual minority community, some evidence is equivocal. For instance, a study of the Nurses' Health Study detected greater prevalence of type II diabetes among women with minoritized sexual orientations than heterosexual women, [23] other studies of survey data failed to detect sexual orientation-related differences in self-reported diagnoses of diabetes [24–26]. Additionally, questions remain about the accuracy of estimating disease prevalence given differing levels of agreement between self-report and medical record data [27–29].

Replication studies using routinely collected EHR data to determine objective provider diagnosis can clarify disparities, specifically for health outcomes. The purpose of this study was to replicate the recent Morbidity and Mortality Weekly Report [7] about sexual orientation differences in COVID-19-related medical comorbidities using data from the Veterans Health Administration (VA). We hypothesized that disparities in diagnosed physical health conditions are significantly influenced by sexual orientation.

Methods

Data source and study population

We used EHR data from VA that had been transformed into the Observational Medical Outcomes Partnership (OMOP) common data model [30]. The VA OMOP data are sourced from the VA Corporate Data Warehouse (CDW), [31] a data repository that receives nightly updates from VA's EHR platform Veterans Health Information Systems and Technology Infrastructure. The CDW contains clinical data from inpatient, outpatient, and emergency settings as well as services provided externally but paid for by VA.

The study cohort for the present analysis considered veterans who enrolled in VA after fiscal year 1999 and had documentation in their EHR indicating a minoritized sexual orientation at any point in time between October 1, 1999 and July 1, 2019; the former date marks the beginning of the VA EHR and the latter the date of data extraction. Data were analyzed in 2021. Documentation in this context consisted of records in both unstructured clinical notes, extracted via natural language processing (NLP), and, to a much lesser extent, structured administrative coding indicating a minoritized sexual orientation (e.g., ICD10 code Z72.52: high risk homosexual behavior). Details of the NLP extraction process are described elsewhere [32,33]. A comparison group of veterans without minoritized sexual orientation documentation who enrolled in VA between October 1, 1999 and July 1, 2019 was selected as a proxy for heterosexual veterans (hereinafter referred to as veterans with non-minoritized sexual orientation). This study was reviewed and approved by the University of Utah Institutional Review Board.

Measures

All physical health conditions presented by Heslin and Hall [7] were analyzed in the present study including asthma, cancer (excluding skin cancer and benign tumors), heart disease, COPD, type I diabetes, type II diabetes, hypertension, chronic kidney disease (CKD), obesity, smoking, and stroke. With the exception of obesity and smoking, each condition was defined using International Classification of Disease (ICD) Clinical Modification 9th and 10th Revision diagnosis codes and operationalized as a binary variable (ever/never according to VA data). Diabetes was assessed separately for type I and type II; gestational diabetes was excluded. Diagnoses were extracted from inpatient, outpatient, emergency, and community settings paid for by VA. Obesity was defined as body mass index of $\geq$30 kg/m^2 calculated from the average height across time and most recent weight measurements (weight [kg]/height [m] [2]). Smoking status was defined using Health Factor data [34]. Within the EHR, clinicians are prompted by clinical reminders called Health Factors to ask veterans about a variety of domains including tobacco use and smoking behavior. Reponses are input locally and can be accessed through the CDW and categorized by researchers. Smoking was categorized as current or not current according to most recent Health Factor data.

Statistical analysis

To evaluate disparities in the prevalence of physical health conditions between veterans with minoritized sexual orientations and veterans with non-minoritized sexual orientations, we calculated adjusted prevalence and prevalence ratios with corresponding 95% confidence intervals for each of the eleven health conditions overall and stratified by race/ethnicity. Race and ethnicity were combined and categorized to align with Heslin and Hall's groupings [7] as non-Hispanic Black, non-Hispanic White, non-Hispanic other (including non-Hispanic Asian, non-Hispanic American Indian/Alaskan Native, non-Hispanic Pacific Islander/Native Hawaiian), and Hispanic. Additionally, because the VA patient population has a majority of individuals assigned male sex at birth, the analyses were repeated and stratified by data in the birth sex field. Initial adjusted analyses included age at first VA visit, year of first VA visit, and sex assigned at birth (male or female).

Unlike Heslin and Hall, sexual orientation identity was not measured via self-report but rather defined by documentation within VA health records. Our previous research showed documentation is not immediate upon entering VA and the majority of documentation occurs in mental health settings [35]. Thus, volume and type

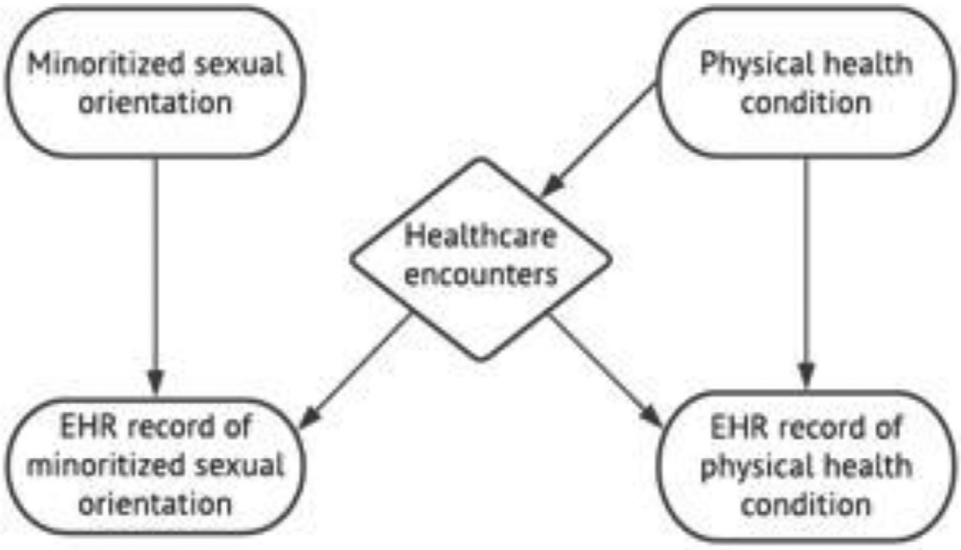

Fig. 1. Directed Acyclic Graph showing the potential of confounding by healthcare utilization.

of healthcare visits can potentially confound the relationship between sexual orientation and outcomes [36]. To address the possibility that the two groups differed systematically with respect to healthcare utilization (Fig. 1) we calculated adjusted prevalence ratios (aPRs) accounting for the number of primary care and mental health encounters, each as a separate categorical variable (0, 1–9, 10+) in the model. Due to similar potential effects on utilization and morbidity, we investigated the impact of further adjusting for VA priority group. All veterans are assigned to one of eight enrollment priority groups after applying to receive VA health care. The allocation is based on a variety of factors including service-connected disability level, income, and history of military service. Veterans were categorized as no service-connected disability (priority groups seven and eight), low income (priority group five), low/moderate disability (priority groups two, three, and six), or high disability (priority groups one and four). Groupings were selected based on prior VA research [37].

All estimates were calculated using logistic regression with the margins and nonlinear combination of estimators (nlcom) postestimation commands using Stata version 15. Individuals missing data on ethnicity, race (except when ethnicity was recorded as Hispanic), sex assigned at birth, year of birth, or had year of birth inconsistent with a plausible age (<18 or >115) were excluded.

Results

Of the 8312,455 million veterans who enrolled in VA after 10/01/1999, 115,911 had documentation indicating a minoritized sexual orientation, of which 108,401 (93%) were eligible for analysis based on non-missing covariate data. There were 8196,544 veterans with non-minoritized sexual orientation of which 6511,698 (80%) were eligible for further analysis. The primary reason for exclusion in both cohorts was missing data on race/ethnicity. The majority of veterans were White non-Hispanic (76.6%), followed by Black non-Hispanic (14.4%), Hispanic (6.4%), and Other non-Hispanic (2.5%). Those with minoritized sexual orientations were significantly more likely to have been assigned female at birth compared to those without minoritized sexual orientations (31.6% vs. 6.9%). Additionally, the minoritized sexual orientation cohort was significantly younger than those without minoritized sexual orientations and started in VA care at younger ages (41 vs. 54 years of age, respectively). See Table 1 for complete comparison of study groups.

Minoritized sexual orientation differences - overall

Among the 6511,698 veterans with non-minoritized sexual orientations, the median number of physical health conditions (out of eleven) recorded in the EHR was 2 (interquartile range:1–4), whereas the median number of conditions recorded among veterans with minoritized sexual orientations was 3 (interquartile range: 1–5). For unadjusted prevalence, among all individuals with minoritized sexual orientations, regardless of race/ethnicity, the five most frequent conditions were hypertension (57.6%), heart disease (54.1%), obesity (41.0%), COPD (30.8%), and cancer (27.1%). Similar ranking was observed among individuals with non-minoritized sexual orientations with slight differences (63.3% hypertension, 60.8% heart disease, 35.9% obesity, 28.7% type II diabetes, and 25.9% cancer). For everyone, stroke was the least frequent condition (8.7% among those with minoritized sexual orientation and 6.9% among those with non-minoritized sexual orientations) followed by type I diabetes (8.4% and 8.1%).

In the initial adjusted analyses accounting for sex, age, and year, except for obesity, individuals with minoritized sexual orientations were 11%–75% more likely to experience each of the conditions (Table 2, aPR1). Accounting for healthcare utilization reduced the magnitude of differences, but the patterns largely persisted except for obesity. After accounting for healthcare utilization, the prevalence of obesity was 8% lower among veterans with minoritized sexual orientations than veterans with non-minoritized sexual orientations (aPR2 = 0.92, 95% CI= 0.91–0.93). Results were virtually unchanged when priority group was added to the models (Table 2, aPR3).

Minoritized sexual orientation differences – among race and ethnicity

Overall, when stratified by race/ethnicity, there was some variation in the differences observed in the overall analysis (Table 2). The sexual orientation differences in outcomes in the overall analysis that were also observed among racial and ethnic groups included asthma, cancer, COPD, CKD, smoking, and stroke. For example, among individuals who were Black non-Hispanic, those with minoritized sexual orientations were almost 50% more likely to be

Table 1
Characteristics of study sample by sexual orientation category

	Total	Non-minoritized sexual orientation	Minoritized sexual orientation
	6,620,099	6,511,698	108,401
Demographics			
Sex assigned at birth			
Female	482,776 (7.3%)	448,531 (6.9%)	34,245 (31.6%)
Male	6,137,323 (92.7%)	6,063,167 (93.1%)	74,156 (68.4%)
Age at first VHA visit			
Mean (SD)	53.874 (17.887)	54.071 (17.859)	41.992 (15.410)
Age group at first VHA visit			
18–29	966,948 (14.6%)	934,860 (14.4%)	32,088 (29.6%)
30–39	627,353 (9.5%)	608,876 (9.4%)	18,477 (17.0%)
40–49	864,298 (13.1%)	842,507 (12.9%)	21,791 (20.1%)
50–59	1304,882 (19.7%)	1284,387 (19.7%)	20,495 (18.9%)
60–69	1514,985 (22.9%)	1504,278 (23.1%)	10,707 (9.9%)
70–79	905,073 (13.7%)	901,466 (13.8%)	3607 (3.3%)
80+	436,560 (6.6%)	435,324 (6.7%)	1236 (1.1%)
Year of first visit			
1999–2005	2,613,300 (39.5%)	2,568,386 (39.4%)	44,914 (41.4%)
2006–2010	1,814,010 (27.4%)	1,782,176 (27.4%)	31,834 (29.4%)
2011–2015	1,773,516 (26.8%)	1,746,470 (26.8%)	27,046 (24.9%)
2016–2019	419,273 (6.3%)	414,666 (6.4%)	4607 (4.2%)
Race/Ethnicity			
Black non-Hispanic	954,611 (14.4%)	931,826 (14.3%)	22,785 (21.0%)
White non-Hispanic	5,072,729 (76.6%)	5,000,851 (76.8%)	71,878 (66.3%)
Other non-Hispanic	167,648 (2.5%)	164,681 (2.5%)	2967 (2.7%)
Hispanic or Latino	425,111 (6.4%)	414,340 (6.4%)	10,771 (9.9%)
Mental health visits			
0	3,165,206 (47.8%)	3,157,905 (48.5%)	7301 (6.7%)
1–9	1,614,953 (24.4%)	1,600,145 (24.6%)	14,808 (13.7%)
10+	1,839,940 (27.8%)	1,753,648 (26.9%)	86,292 (79.6%)
Primary care visits			
0	351,412 (5.3%)	350,070 (5.4%)	1342 (1.2%)
1–9	2,032,429 (30.7%)	2,014,616 (30.9%)	17,813 (16.4%)
10+	4,236,258 (64.0%)	4,147,012 (63.7%)	89,246 (82.3%)
Priority group (group numbers)			
High Disability (1, 4)	2174,975 (32.9%)	2117,638 (32.5%)	57,337 (52.9%)
Low/moderate disability (2, 3, 6)	1,380,394 (20.9%)	1,357,549 (20.8%)	22,845 (21.1%)
Low Income (5)	1,486,369 (22.5%)	1,470,530 (22.6%)	15,839 (14.6%)
No Disability (7, 8)	1,578,361 (23.8%)	1,565,981 (24.0%)	12,380 (11.4%)

VHA = veteran health administration; SD = standard deviation.

a current smoker than those with non-minoritized sexual orientations (aPR1 = 1.48, 95% CI = 1.44–1.51). Adjusting for healthcare utilization narrowed these disparities slightly, but significant differences between sexual orientation groups remained within each racial/ethnic category.

Varied findings emerged for heart disease, type I and type II diabetes, hypertension, and obesity. In adjusted analyses, there were no significant differences in prevalence of type II diabetes between veterans with minoritized sexual orientation and non-minoritized sexual orientations among Black non-Hispanic, Other race, non-Hispanic, or Hispanic veterans (Table 2). However, among White non-Hispanic veterans with minoritized sexual orientations, a 5% greater prevalence of type II diabetes was observed compared with White non-Hispanic veterans with non-minoritized sexual orientations (aPR3 = 1.05, 95% CI = 1.04–1.07). Similarly, the overall sexual orientation differences observed for type I diabetes appeared to be driven by Other non-Hispanic (aPR3 = 1.26, 95% CI = 1.11–1.41

Minoritized sexual orientation differences – among sex assigned at birth

In analyses stratified by sex assigned at birth, conditions were consistently more frequent for veterans with minoritized sexual orientations than non-minoritized veterans assigned female at birth (Fig. 2). Specifically, smoking and COPD were 1.4 and 1.3 times higher, respectively, among those assigned female at birth with minoritized sexual orientations compared to 1.1 and 1.2 for those assigned male at birth. Obesity, in particular, stood out because minoritized sexual orientation had a negative association with obesity for veterans assigned male at birth (aPR = 0.88, 95% CI = 0.87–0.88), but a null association for veterans assigned female at birth (aPR = 0.99, 95% CI = 0.97–1.00).

Discussion

Using nationwide EHR data from the VA, we found veterans with minoritized sexual orientations were disproportionally burdened by many physical health conditions. This is the first study to empirically describe the physical health of veterans with minoritized sexual orientations using EHR data. Greater prevalence of health conditions among people with minoritized sexual orientations is a logical epidemiologic sequela given the large literature documenting greater prevalence of both health risk behaviors and minority stress among individuals with minoritized sexual orientations than non-minoritized identities [1]. These disparities in medical conditions convey new urgency because of their relation with COVID-19 severity [9].

Consistent with findings from Heslin and Hall, with the exception of obesity, the unadjusted prevalence estimates of conditions were greater among veterans with minoritized sexual orientations than among veterans with non-minoritized sexual orientations. Heslin and Hall reported obesity rates 10%–20% higher in individuals with minoritized sexual orientations. While, obesity rates were lower among veterans assigned male at birth and minoritized sexual orientations, for veterans assigned female at birth, obesity was positively associated with minoritized sexual orientation iden-

Table 2
Adjusted prevalence and adjusted prevalence ratios (aPRs) of underlying health conditions among veterans with minoritized sexual orientations and non-minoritized sexual orientations by race/ethnicity

	All	Black, non-Hispanic	White, non-Hispanic	Other, non-Hispanic	Hispanic
Sample n (row%)	6,620,099 (100)	954,611 (14.4)	5,072,729 (76.6)	167,648 (2.5)	425,111 (6.4)
Minoritized	108,401 (100)	22,785 (21.0)	71,878 (66.3)	2967 (2.7)	10,771 (9.9)
Non-minoritized	6,511,698 (100)	931,826 (14.3)	5,000,851 (76.8)	164,681 (2.5)	414,340 (6.4)
Adjusted Prevalence (95% CI)					
Asthma					
Minoritized	11.79 (11.62, 11.96)	13.39 (12.29, 13.78)	11.16 (10.96, 11.37)	13.98 (12.82, 15.15)	14.18 (13.57, 14.79)
Non-minoritized	7.41 (7.39, 7.43)	8.84 (8.78, 8.90)	7.01 (6.99, 7.04)	8.50 (8.36, 8.63)	8.48 (8.40, 8.57)
aPR1	1.59 (1.56, 1.61)	1.51 (1.46, 1.55)	1.59 (1.56, 1.62)	1.64 (1.50 1.78)	1.67 (1.59, 1.74)
aPR2	1.22 (1.20, 1.23)	1.23 (1.20, 1.27)	1.20 (1.17, 1.22)	1.21 (1.10, 1.32)	1.25 (1.19, 1.32)
aPR3	1.22 (1.20, 1.24)	1.24 (1.20, 1.28)	1.20 (1.17, 1.22)	1.21 (1.11, 1.32)	1.26 (1.20, 1.32)
Cancer					
Minoritized	34.49 (34.20, 34.78)	31.15 (30.97, 32.21)	35.86 (35.49, 36.22)	26.40 (24.79, 28.02)	26.42 (25.61, 27.23)
Non-minoritized	25.85 (25.82, 25.88)	24.40 (24.32, 24.48)	27.00 (26.96, 27.04)	17.62 (17.44, 17.79)	18.52 (18.41, 18.63)
aPR1	1.33 (1.32, 1.35)	1.29 (1.26, 1.32)	1.32 (1.31, 1.34)	1.49 (1.40, 1.59)	1.42 (1.38, 1.47)
aPR2	1.14 (1.13, 1.15)	1.14 (1.11, 1.16)	1.13 (1.12, 1.14)	1.20 (1.13, 1.28)	1.17 (1.13, 1.21)
aPR3	1.14 (1.13, 1.15)	1.14 (1.11, 1.16)	1.13 (1.12, 1.14)	1.20 (1.13, 1.28)	1.17 (1.13, 1.21)
Heart disease					
Minoritized	67.34 (61.25, 67.55)	69,72 (69.22, 70.22)	70.10 (69.84, 70.35)	56.46 (55.04, 57.88)	51.89 (51.11, 52.64)
Non-minoritized	60.65 (60.62, 60.68)	65.46 (65.38, 65.55)	62.85 (62.82, 62.89)	48.24 (48.04, 48.43)	44.42 (44.30, 44.54)
aPR1	1.11 (1.10,1.12)	1.06 (1.05, 1.07)	1.11 (1.11, 1.11)	1.17 (1.14, 1.20)	1.17 (1.15, 1.19)
aPR2	1.02 (1.01,1.02)	0.98 (0.97, 0.99)	1.02 (1.01, 1.02)	1.02 (1.00, 1.06)	1.04 (1.01, 1.05)
aPR3	1.02 (1.01, 1.02)	0.98 (0.97, 0.99)	1.02 (1.01, 1.02)	1.03 (1.00, 1.06)	1.03 (1.01, 1.05)
COPD					
Minoritized	36.29 (35.99, 36.57)	29.74 (29.14, 30.34)	39.05 (38.69, 39.40)	26.75 (25.15, 28.35)	21.87 (21.10, 22.64)
Non-minoritized	22.66 (22.63, 22.69)	17.96 (17.88, 18.03)	24.61 (24.57, 24.64)	14.94 (14.78, 15.11)	12.96 (12.86, 13.06)
aPR1	1.60 (1.58, 1.61)	1.65 (1.62, 1.69)	1.58 (1.57, 1.60)	1.79 (1.68, 1.89)	1.68 (1.62, 1.74)
aPR2	1.26 (1.25, 1.28)	1.33 (1.30, 1.36)	1.23 (1.22, 1.25)	1.31 (1.22, 1.39)	1.27 (1.22, 1.33)
aPR3	1.24 (1.23, 1.26)	1.32 (1.29, 1.35)	1.21 (1.20, 1.22)	1.29 (1.21, 1.38)	1.27 (1.22, 1.32)
Diabetes, Type 1					
Minoritized	11.07 (10.87, 11.28)	10.97 (10.52, 11.43)	10.95 (10.70, 11.20)	11.06 (0.98, 12.32)	11.53 (10.89, 12.17)
Non-minoritized	8.09 (8.07, 7.8.11)	8.92 (8.87, 8.98)	7.99 (7.97, 8.01)	6.80 (6.66, 6.91)	7.97 (7.89, 8.05)
aPR1	1.36 (1.34, 1.39)	1.22 (1.17, 1.28)	1.37 (1.33, 1.40)	1.62 (1.44, 1.81)	1.44 (1.36, 1.53)
aPR2	1.09 (1.07, 1.11)	1.07 (1.03, 1.11)	1.08 (1.05, 1.10)	1.27 (1.12, 1.42)	1.18 (1.12, 1.25)
aPR3	1.09 (1.07, 1.11)	1.08 (1.03, 1.12)	1.07 (1.05, 1.10)	1.26 (1.11, 1.41)	1.18 (1.12, 1.25)
Diabetes, Type 2					
Minoritized	34.67 (34.38, 34.97)	35.61 (34.97, 36.26)	34.61 (34.24, 34.97)	34.99 (33.25, 36.73)	27.57 (27.45, 27.69)
Non-minoritized	28.65 (28.62, 28.69)	31.80 (31.71, 31.89)	28.16 (28.12, 28.20)	28.42 (28.21, 28.62)	33.62 (32.75, 34.48)
aPR1	1.21 (1.19, 1.22)	1.11 (1.09, 1.14)	1.22 (1.21, 1.24)	1.23 (1.17, 1.29)	1.21 (1.19, 1.25)
aPR2	1.04 (1.03, 1.05)	1.00 (0.98, 1.02)	1.05 (1.04, 1.07)	1.04 (0.99, 1.10)	1.04 (1.02, 1.07)
aPR3	1.05 (1.03, 1.06)	1.02 (0.99, 1.03)	1.05 (1.04, 1.07)	1.04 (0.99, 1.10)	1.05 (1.02, 1.08)
Hypertension					
Minoritized	69.98 (69.76, 63.21)	69.72 (69.22, 70.22)	71.83 (71.56, 72.10)	61.71 (60.25, 63.16)	56.63 (55.85, 57.41)
Non-minoritized	63.18 (63.15, 63.21)	65.46 (65.38, 65.55)	64.22 (64.18, 64.25)	53.61 (53.41, 53.82)	49.48 (49.35, 49.60)
aPR1	1.11 (1.10, 1.12)	1.07 (1.05, 1.07)	1.11 (1.11, 1.12)	1.15 (1.12, 1.18)	1.14 (1.12, 1.16)
aPR2	0.99 (0.99, 1.00)	0.98 (0.97, 0.99)	1.01 (1.00, 1.01)	1.00 (0.97, 1.03)	1.00 (0.98, 1.02)
aPR3	0.99 (0.99, 1.00)	0.98 (0.97, 0.99)	1.01 (1.00, 1.01)	1.00 (0.97, 1.03)	1.00 (0.98, 1.02)
CKD					
Minoritized	20.69 (20.41, 20.97)	22.54 (21.93, 23.16)	20.85 (20.51, 21.19)	19.06 (17.45, 20.68)	14.88 (14.15, 15.61)
Non-minoritized	13.95 (13.91, 13.97)	16.27 (16.19, 16.34)	13.96 (13.93, 13.99)	10.92 (10.77, 11.06)	9.79 (9.79, 9.88)
aPR1	1.48 (1.46, 1.50)	1.38 (1.34, 1.42)	1.49 (1.46, 1.51)	1.74 (1.59, 1.89)	1.51 (1.44, 1.59)
aPR2	1.21 (1.19, 1.23)	1.22 (1.18, 1.26)	1.21 (1.19, 1.23)	1.39 (1.27, 1.52)	1.25 (1.19, 1.32)
aPR3	1.20 (1.19, 1.23)	1.22 (1.18, 1.26)	1.20 (1.18, 1.22)	1.38 (1.26, 1.52)	1.25 (1.18,1.31)
Obesity					
Minoritized	35.98 (35.71, 36.25)	37.30 (36.70, 37.90)	35.74 (35.41, 36.07)	35.07 (33.42, 36.72)	41.43 (40.53, 42.33)
Non-minoritized	35.98 (35.94, 36.02)	41.28 (41.18, 41.38)	34.62 (34.58, 34.66)	32.36 (32.14, 32.58)	41.74 (41.59, 41.89)
aPR1	1.00 (0.99, 1.00)	0.90 (0.88, 0.92)	1.03 (1.02, 1.04)	1.08 (1.03, 1.13)	0.99 (0.97, 1.01)
aPR2	0.92 (0.91, 0.93)	0.86 (0.85, 0.87)	0.94 (0.93, 0.95)	0.94 (0.88, 0.98)	0.89 (0.87, 0.92)
aPR3	0.93 (0.92, 0.93)	0.87 (0.86, 0.89)	0.95 (0.94, 0.96)	0.93 (0.88, 0.98)	0.90 (0.88, 0.92)
Smoker					
Minoritized	23.82 (23.58, 24.05)	28.54 (27.94, 29.14)	23.48 (23.20, 23.76)	22.14 (20.66, 12.61)	17.15 (16.42, 17.88)
Non-minoritized	18.14 (16.11, 18.16)	19.27 (19.19, 19.35)	18.42 (18.38, 18.45)	16.43 (16.25, 16.60)	12.89 (12.79, 12.99)
aPR1	1.31 (1.29, 1.32)	1.48 (1.44, 1.51)	1.27 (1.25, 1.29)	1.35 (1.25, 1.43)	1.33 (1.27, 1.39)
aPR2	1.18 (1.17, 1.19)	1.35 (1.32, 1.38)	1.13 (1.12, 1.14)	1.20 (1.12, 1.28)	1.24 (1.19, 1.30)
aPR3	1.14 (1.13, 1.16)	1.30 (1.27, 1.33)	1.10 (1.09, 1.11)	1.17 (1.09, 1.25)	1.21 (1.16, 1.27)
Stroke					
Minoritized	12.05 (11.82, 12.27)	11.46 (10.98, 11.94)	12.30 (12.03, 12.57)	9.22 (8.00, 10.44)	10.18 (9.56, 10.80)
Non-minoritized	6.88 (6.86, 6.90)	7.14 (7.09, 7.19)	7.06 (7.03, 7.08)	4.90 (4.79, 5.00)	5.00 (4.94, 5.07)
aPR1	1.75 (1.71, 1.78)	1.65 (1.53, 1.67)	1.74 (1.70, 1.78)	1.88 (1.63, 2.13)	2.03 (1.90, 2.15)
aPR2	1.28 (1.25, 1.30)	1.29 (1.23, 1.34)	1.25 (1.22, 1.28)	1.30 (1.12, 1.48)	1.51 (1.41, 1.60)
aPR3	1.26 (1.24, 1.28)	1.27 (1.22, 1.33)	1.23 (1.20, 1.26)	1.29 (1.11, 1.47)	1.49 (1.39, 1.59)

aPR = adjusted prevalence ratios; aPR1 = adjusted for sex assigned at birth, age and year of first VHA encounter; aPR2 = adjusted for sex assigned at birth, age and year of first VHA encounter, primary care visits, mental health visits; aPR3 = adjusted for sex assigned at birth, age and year of first VHA encounter, primary care visits, mental health visits, VA priority group.

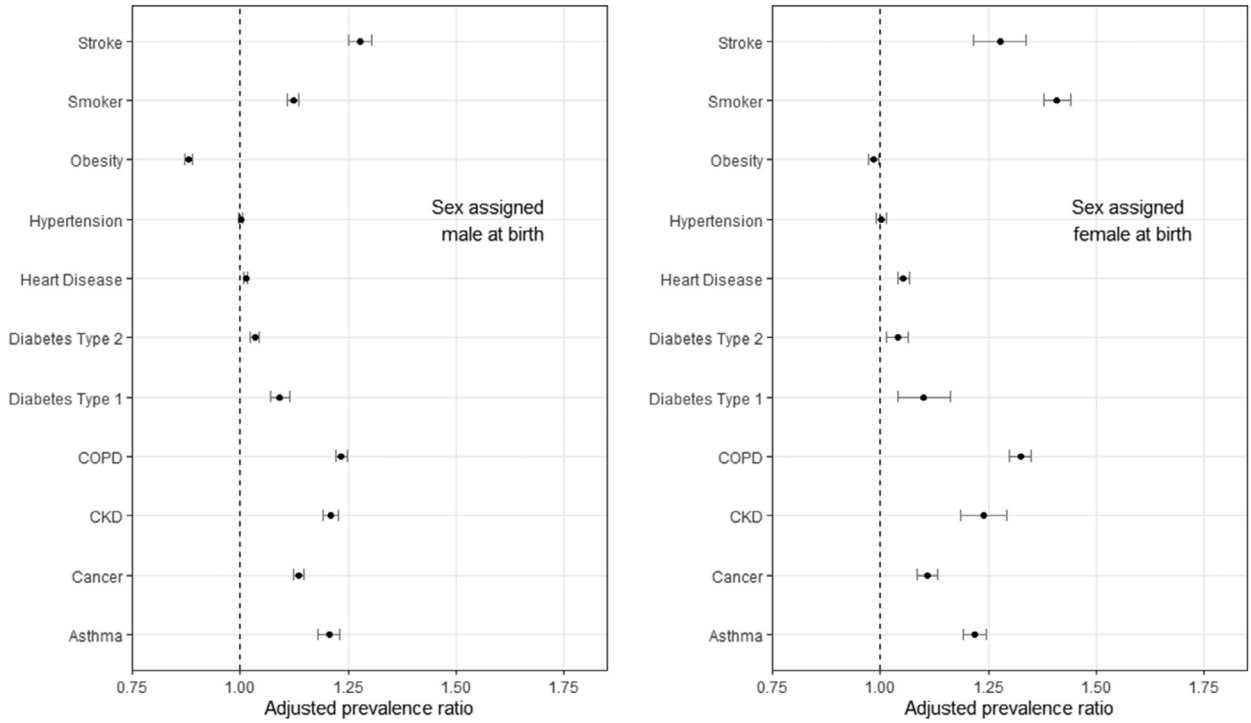

Fig. 2. Adjusted prevalence ratios of physical health conditions among veterans with minoritized sexual orientations and non-minoritized sexual orientations stratified by birth sex.

tity. Aggregating results can mask important differences that have been revealed in prior BRFSS evaluations [25,38,39] as well other population-based survey studies [40] finding lower odds of obesity among gay men [24].

Although we largely replicated the methods of Heslin and Hall and had similar overall findings, the prevalence of physician-diagnosed conditions in the present results were much larger than those of the BRFSS self-reported data. For instance, adjusted prevalence of cancer and heart disease among veterans with minoritized sexual orientations was considerably greater (34.4% and 67.3%,) than Heslin and Hall's findings (9.2% and 8.0%). There are several possible explanations for these differences. First, the present study consisted of individuals who were engaged with a healthcare system and is consequently comprised of patients with poorer health status than the general population [41]. Second, although the demographic profile of the VA is shifting younger and more diverse, historically veterans tend to be older and have worse health status and more health risk behaviors than their civilian counterparts [42,43]. Population prevalence differences notwithstanding, these clinical data from a nationwide healthcare system aligned with the overall population disparity patterns of self-report data from a national survey.

The COVID-19 pandemic has amplified the stakes of these conditions and there has been increasing attention to disparity research. The present study focused on medical conditions as risk factors for COVID-19 severity, however we did not evaluate COVID-19 infection itself. The processing of clinical notes used to identify the cohorts in the present analysis concluded in 2019, prior to the pandemic. Although we could have expanded the cohort to include 2020 notes, we would likely have underestimated the number of sexual minority individuals for two important reasons. First, although documentation of sexual orientation exists in clinical notes and can be extracted via NLP, it is rarely captured in the first year of VA engagement [35]. Second, it is possible many veterans who sought VA care or vaccination during the COVID-19 pandemic might have never used VA medical services prior to 2020. Thus, a subgroup of veterans may exist in 2020 data that have not had sufficient opportunity to have their sexual orientation documented in notes. Without documentation, sexual orientation is unobservable as there are no alternative methods for identifying veterans with minoritized sexual orientations in VA. This emphasizes the urgency of integrating sexual orientation (and gender identity) data collection into VA clinical workflows.

Empirically describing potential COVID-19 risk factors among subgroups is especially important for healthcare systems to better understand patient needs. In the context of the health disparities framework proposed by Kilborne et al., [44] these results raise important questions for future research into factors driving these disparities and proposing and testing solutions to overcome them. For instance, we found similarly high rates of hypertension and type II diabetes between sexual orientation groups, but whether disease management is similar between groups is unclear. Uncontrolled diabetes is an established risk factor for both ischemic and hemorrhagic stroke, [45] while sustained hypertension is a leading cause of impaired glomerular filtration and CKD [46]. Among the largest disparities observed in this study were stroke (aPR = 1.26) and CKD (aPR = 1.20). Recent research on asthma supports that notion that COVID-19 severity is more strongly related to current disease status (active vs. inactive) rather than simply disease history (ever/never) [12]. Future research is therefore warranted to understand differential disease control between sexual orientation groups. Preventing disease from developing and adequately treating disease for those in whom it has manifested are realistic goals for any healthcare system and should not be impacted by a patient's minority identity.

The data presented in this study are not without limitations. For the present study sexual orientation was extracted from clinical notes and outcomes were extracted from administrative coding. Ideally, sexual orientation was self-reported by patients and subsequently recorded in their EHR by a clinician, but we cannot confirm this sequence had occurred for all patients. Providers may document based on their assumptions or interpretations, both

which may not align with patient's self-identified sexual orientation. EHRs are not subject to the same degree of recall bias as survey data, yet there are other possible sources of bias that should be considered. First, the degree and context in which a patient interacts with a healthcare system can impact both the volume and type of information that are recorded in EHRs and subsequently available to researchers – a term coined by Goldstein and colleagues as informed presence bias, [36] a type of ascertainment bias specific to EHR data. To mitigate the extent to which this type of bias could distort estimated prevalence ratios, we simultaneously adjusted for the number of mental health and primary care visits. However, residual confounding could remain, which could potentially overestimate the true association between sexual orientation and health outcomes. Second, the selection process used to identify patients for this analysis could have impacted the findings. Specifically, we were only able to assess the prevalence of physical health conditions among veterans with minoritized sexual orientations who used VA services. As such, results may not be generalizable to all veterans with minoritized sexual orientations. Related, veterans with minoritized sexual orientations who did not disclose this information to a VA provider or if the provider did not document the disclosure would have been erroneously included in the non-minoritized sexual orientation group. While possible, veterans with minoritized sexual orientations have reported less need for confidentiality and more willingness to disclose sexual orientation to VA providers since the repeal of Don't Ask Don't Tell, a policy that barred gay military members from serving openly and the addition of a VA policy in 2014 [47] assuring affirming care at VA [48] Therefore, we do not believe this type of misclassification would have significantly affected our findings. Lastly, physical health conditions were defined by ICD codes which also has limitations. Using administrative data for research is common, yet the accuracy is variable across diseases, healthcare settings, and calendar time [49,50]. However, such errors, if present, would likely be nondifferential and bias results towards a null association.

Conclusions

The present study of EHR data largely corroborates findings from a recent study of self-report survey data showing sexual orientation-related disparities in medical diagnoses associated with higher risk for COVID-19 severity and mortality. Further research is needed to determine if disparities in these conditions, which can antagonize COVID-19 symptoms, result in poorer outcomes for individuals with minoritized sexual orientations.

Acknowledgments

This work was supported using resources and facilities at the VA Salt Lake City Health Care System and the VA Informatics and Computing Infrastructure (VINCI), VA HSR RES 13–457.

Submission declaration

This work described has not been published previously, nor is it under consideration for publication elsewhere.

Disclaimer

The views expressed in this article are those of the authors and do not represent the views of the U.S. Department of Veterans Affairs.

References

[1] Medicine Institute of. The health of lesbian, gay, bisexual, and transgender people: building a foundation for better understanding. Washington, DC: National Academies Press; 2011.
[2] Lee JG, Griffin GK, Melvin CL. Tobacco use among sexual minorities in the USA, 1987 to May 2007: a systematic review. Tob Control 2009;18(4):275–82.
[3] Green KE, Feinstein BA. Substance use in lesbian, gay, and bisexual populations: an update on empirical research and implications for treatment. Psyhol Addict Behav 2012;26(2):265.
[4] Rothman EF, Exner D, Baughman AL. The prevalence of sexual assault against people who identify as gay, lesbian, or bisexual in the United States: a systematic review. Trauma Violence Abuse 2011;12(2):55–66.
[5] Ecker J, Aubry T, Sylvestre J. A review of the literature on LGBTQ adults who experience homelessness. J Homosex 2019;66(3):297–323.
[6] Lau F, Antonio M, Davison K, Queen R, Devor A, et al. A rapid review of gender, sex, and sexual orientation documentation in electronic health records. J Am Med Inform Assoc 2020;27(11):1774–83.
[7] Heslin KC, Hall JE. Sexual orientation disparities in risk factors for adverse COVID-19–related outcomes, by race/ethnicity—Behavioral Risk Factor Surveillance System, United States, 2017–2019. MMWR Morb Mortal Wkly Rep 2021;70(5):149.
[8] Cahill S, Grasso C, Keuroghlian A, Sciortino C, Mayer K. Sexual and gender minority health in the COVID-19 pandemic: why data collection and combatting discrimination matter now more than ever. Am J Public Health 2020;110(9):1360–1.
[9] COVID-19 Response Team CDC, Chow N, Fleming-Dutra K, et al. Preliminary estimates of the prevalence of selected underlying health conditions among patients with coronavirus disease 2019—United States, February 12–March 28, 2020. MMWR Morb Mortal Wkly Rep 2020;69(13):382–6.
[10] Zhou Y, Yang Q, Chi J, et al. Comorbidities and the risk of severe or fatal outcomes associated with coronavirus disease 2019: a systematic review and meta-analysis. Int J Infect Dis 2020;99:47–56.
[11] Gregory JM, Slaughter JC, Duffus SH, et al. COVID-19 severity is tripled in the diabetes community: a prospective analysis of the pandemic's impact in type 1 and type 2 diabetes. Diabetes Care 2021;44(2):526–32.
[12] Huang BZ, Chen Z, Sidell MA, et al. Asthma disease severity, COPD, and COVID-19 severity in a large multiethnic population. J Allergy Clin Immunol Pract 2021;9(10):3621–8 e3622.
[13] Price-Haywood EG, Burton J, Fort D, et al. Hospitalization and mortality among black patients and white patients with Covid-19. N Engl J Med 2020;382(26):2534–43.
[14] Gu T, Mack JA, Salvatore M, et al. Characteristics associated with racial/ethnic disparities in COVID-19 outcomes in an academic health care system. JAMA Netw Open 2020;3(10):e2025197.
[15] Cahill SR. Still in the dark regarding the public health impact of COVID-19 on sexual and gender minorities. Am J Public Health 2021;111(9):1606–9.
[16] Bowleg L, Landers S. The needs for COVID-19 LGBTQ-specific data. Am J Public Health 2021;111(9):1604–5.
[17] Blosnich J, Jarrett T, Horn K. Disparities in smoking and acute respiratory illnesses among sexual minority young adults. Lung 2010;188(5):401–7.
[18] Blosnich JR, Lee JG, Bossarte R, et al. Asthma disparities and within-group differences in a national, probability sample of same-sex partnered adults. Am J Public Health 2013;103(9):e83–7.
[19] Veldhuis CB, George M, Everett BG, et al.. The association of asthma, sexual identity, and inhaled substance use among us adolescents, 18. Ann Am Thorac Soc; 2021. p. 273–80.
[20] Heck JE, Jacobson JS. Asthma diagnosis among individuals in same-sex relationships. J Asthma 2006;43(8):579–84.
[21] Farmer GW, Bucholz KK, Flick LH, et al. CVD risk among men participating in the National Health and Nutrition Examination Survey (NHANES) from 2001 to 2010: differences by sexual minority status. J Epidemiol Community Health 2013;67(9):772–8.
[22] Farmer GW, Jabson JM, Bucholz KK, et al. A population-based study of cardiovascular disease risk in sexual-minority women. Am J Public Health 2013;103(10):1845–50.
[23] Corliss HL, VanKim NA, Jun H-J, et al. Risk of type 2 diabetes among lesbian, bisexual, and heterosexual women: findings from the Nurses' Health Study II. Diabetes Care 2018;41(7):1448–54.
[24] Blosnich JR, Farmer GW, Lee JG, et al. Health inequalities among sexual minority adults: evidence from ten US states, 2010. Am J Prev Med 2014;46(4):337–49.
[25] Conron KJ, Mimiaga MJ, Landers SJ. A population-based study of sexual orientation identity and gender differences in adult health. Am J Public Health 2010;100(10):1953–60.
[26] Fredriksen-Goldsen KI, Kim H-J, Barkan SE, et al. Health disparities among lesbian, gay, and bisexual older adults: results from a population-based study. Am J Prev Med 2013;103(10):1802–9.
[27] Machlin S, Cohen J, Elixhauser A, et al. Sensitivity of household reported medical conditions in the medical expenditure panel survey. Med Care 2009:618–25.
[28] Martin LM, Leff M, Calonge N, et al. Validation of self-reported chronic conditions and health services in a managed care population. Am J Prev Med 2000;18(3):215–18.
[29] Okura Y, Urban LH, Mahoney DW, et al. Agreement between self-report questionnaires and medical record data was substantial for diabetes, hypertension, myocardial infarction and stroke but not for heart failure. J Clin Epidemiol 2004;57(10):1096–103.
[30] Lynch KE, Deppen SA, DuVall SL, et al. Incrementally transforming electronic medical records into the observational medical outcomes partnership common data model: a multidimensional quality assurance approach. Appl Clin Inform 2019;10(5):794–803.

[31] Fihn SD, Francis J, Clancy C, et al. Insights from advanced analytics at the Veterans Health Administration. Health Aff 2014;33(7):1203–11.
[32] Lynch KE, Alba P, Patterson OV, et al. The utility of clinical notes for sexual minority health research. Am J Prev Med 2020;59(5):755–63.
[33] Lynch KE, Alba P, Viernes B, et al. Using enriched samples for semi-automated vocabulary expansion to identify rare events in clinical text: sexual orientation as a use case. Stud Health Technol Inform 2019;264:1532–3.
[34] McGinnis KA, Brandt CA, Skanderson M, et al. Validating smoking data from the Veteran's Affairs Health Factors dataset, an electronic data source. Nicotine Tob Res 2011;13(12):1233–9.
[35] Lynch KE, Viernes B, Schliep KC, et al. Variation in sexual orientation documentation in a national electronic health record system. LGBT Health 2021;8(3):201–8.
[36] Goldstein BA, Bhavsar NA, Phelan M, et al. Controlling for informed presence bias due to the number of health encounters in an electronic health record. Am J Epidemiol 2016;184(11):847–55.
[37] Ferguson JM, Jacobs J, Yefimova M, et al. Virtual care expansion in the Veteran Health Administration during the COVID-19 pandemic: clinical services and patient characteristics associated with utilization. J AM Med Inform Assoc 2021;28(3):453–62.
[38] Azagba S, Shan L, Latham K. Overweight and obesity among sexual minority adults in the United States. Int J Environ Res Public Health 2019;16(10):1828.
[39] Blosnich J, Foynes MM, Shipherd JC. Health disparities among sexual minority women veterans. J Womens Health (Larchmt) 2013;22(7):631–6.
[40] Boehmer U, Bowen DJ, Bauer GR. Overweight and obesity in sexual-minority women: evidence from population-based data. Am J Public Health 2007;97(6):1134–40.
[41] Weiskopf NG, Bakken S, Hripcsak G, et al. A data quality assessment guideline for electronic health record data reuse. EGEMS (Wash. DC) 2017;5(1):14.
[42] Agha Z, Lofgren RP, VanRuiswyk JV, et al. Are patients at Veterans Affairs medical centers sicker? A comparative analysis of health status and medical resource use. Arch Intern Med 2000;160(21):3252–7.
[43] Schult TM, Schmunk SK, Marzolf JR, et al. The health status of veteran employees compared to civilian employees in Veterans Health Administration. Mil Med 2019;184(7–8):e218–24.
[44] Kilbourne AM, Switzer G, Hyman K, et al. Advancing health disparities research within the health care system: a conceptual framework. Am J Public Health 2006;96(12):2113–21.
[45] Chen R, Ovbiagele B, Feng W. Diabetes and stroke: epidemiology, pathophysiology, pharmaceuticals and outcomes. Am J Med Sci 2016;351(4):380–6.
[46] Garofalo C, Borrelli S, Pacilio M, et al. Hypertension and prehypertension and prediction of development of decreased estimated GFR in the general population: a meta-analysis of cohort studies. Am J Kidney Dis 2016;67(1):89–97.
[47] Mattocks KM, Sullivan JC, Bertrand C, et al. Perceived stigma, discrimination, and disclosure of sexual orientation of sexual orientation among a sample of lesbian veterans receiving care in the Department of Veterans Affairs. LGBT. Health 2001;2(2):147–53.
[48] U.S. Department of Veterans Affairs: Provision of health care for Veterans who identify as lesbian, gay or bisexual 2021. Available at https://www.va.gov/vhapublications/ViewPublication.asp?pub_ID=5438 Accessed October 17.
[49] O'Malley KJ, Cook KF, Price MD, et al. Measuring diagnoses: ICD code accuracy. Health Serv Res 2005;40(5):1620–39 Pt 2.
[50] Yoon J, Chow A. Comparing chronic condition rates using ICD-9 and ICD-10 in VA patients FY2014–2016. BMC Health Serv Res 2017;17(1):572.