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Healthcare utilisation in people living with HIV: the role of substance use, mood/anxiety disorders and unsustained viral suppression – a retrospective cohort study in British Columbia, Canada, 2001–2019

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ABSTRACT

Objective People living with HIV (PLWH) are disproportionately affected by substance use disorder (SUD) and mood/anxiety disorders, which are barriers to sustained viral suppression and can contribute to increased healthcare utilisations. This study examined the impact of SUD and mood/anxiety disorders on healthcare utilisation of PLWH with sustained and unsustained viral suppression.

Design and participants This retrospective population-based cohort study used administrative data from 9757 antiretroviral-treated PLWH (83% men, median age 40 years). Eligible PLWH were≥19 years of age, followed during 2001–2019, and achieved viral suppression at least once during follow-up.

Setting This study was conducted in British Columbia, Canada.

Measurements The exposure variable consisted of eight levels and included (1) sustained suppression, (2) SUD and mood/anxiety disorder diagnoses and the interaction between (1) and (2). Outcome variables included annual counts of primary care and specialist physician visits, laboratory visits, acute care hospitalisation, day surgery episodes and hospital length of stay (LOS). Statistical count models were used to determine the effect of exposure variables on each healthcare utilisation outcome while adjusting for socioeconomic confounders.

Results In the presence of sustained suppression, having both disorders was significantly associated with over four times more acute-care hospitalisations (0.28 vs 0.05), three times longer LOS (9.1 vs 3.0 days) and almost double primary care physician (13.1 vs 6.9) and specialist (7.9 vs 4.0) visits. Overall, SUD alone was associated with increased use of all healthcare services (except day surgery). Regardless of disorder diagnoses, unsustained suppression was associated with higher healthcare utilisation (except day surgery).

Conclusion In this study, SUD, mood/anxiety disorders and unsustained suppression, when combined, resulted in the highest healthcare utilisation among PLWH. The results suggest that providing comprehensive mental health and substance use services to PLWH and addressing barriers to sustained suppression could reduce the healthcare burden within this population.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ A strength of this study is that it uses administrative health records data from a large population of people living with HIV followed over a 19-year observational span.
⇒ Financial barriers and health insurance status were controlled for in this study since it was conducted in a setting where people living with HIV have free access to antiretroviral therapy, HIV laboratory monitoring and universal healthcare coverage for essential medical services.
⇒ Instead of measuring financial healthcare costs, the study examined counts of healthcare encounters to allow for comparability of results across different settings.
⇒ A limitation of this study is the use of administrative health data, which were not collected for research purposes and may be subject to diagnostic coding errors and misclassifications.
⇒ Due to a lack of available data, we could not control for the severity, chronicity and treatment status of mood/anxiety and substance use disorders, as well as potential sociodemographic factors like ethnicity, housing stability and education.

INTRODUCTION

Improvements in antiretroviral therapy (ART) transformed HIV from a fatal disease to a chronic, manageable condition. By the 2020s, life expectancy of people living with HIV (PLWH) approached their HIV-negative counterparts'.[1] However, an excess burden

of chronic non-infectious comorbidities and socioeconomic disparities can create complex healthcare needs in PLWH.[2 3] Longitudinal reports show that since the early 2000's medical expenditure among PLWH has been on the rise and exceeding those of the general population.[2 4]

Mental health and substance use disorders (SUD) disproportionately affect PLWH.[5–7] Recent studies estimated that over 54% of PLWH in Canada and the USA have a mental health disorder diagnosis, with mood and anxiety disorders being the most prevalent.[8–10] SUD, the problematic use of alcohol and drugs, is estimated to affect over 20% of PLWH in Canada and other high-income countries.[7 10–12] In the general population, mood and anxiety disorders and SUD are associated with increased healthcare costs, especially in primary care and hospital settings.[13–15] In 2018, depression alone was estimated to increase the annual per-capita cost of Canada's healthcare by $C7232.[16] The burden of mood and anxiety disorders and SUD within the general population and the high prevalence of these disorders among PLWH call for a thorough investigation of their effects on the healthcare utilisation of PLWH. Notably, these disorders are associated with incomplete ART adherence and unsustained viral suppression (ie, undetectable viral loads (VLs)),[17] both predictors of poor health outcomes and high healthcare utilisation within this population.[18–23]

Previous studies have identified mental health and SUD as independent factors contributing to increased healthcare utilisation and high medical costs among PLWH.[24–26] However, comprehensive longitudinal research examining the separate and combined effects of these disorders while taking into account the role of sustained viral HIV control (viral suppression) is lacking. Given the findings in the literature, we hypothesise that the combined effects of mood and anxiety disorders, SUD and unsustained viral suppression may be greater than their individual effects. These factors can interact to impair treatment adherence, compromise immune function, and contribute to chronic medical conditions, consequently exacerbating health complications and increasing the need for healthcare services.[18–26] Therefore, this study examined the impact of SUD and mood and anxiety disorders (hereafter referred to as mood/anxiety disorders) on healthcare services utilisation among PLWH with sustained and unsustained viral suppression in British Columbia (BC), Canada.

METHODS

Study setting and data source

In BC, the BC Centre for Excellence in HIV/AIDS' (BC-CfE) Drug Treatment Program (DTP) provides free-of-charge ART and routine laboratory (eg, VL and CD4 cell count) monitoring to all diagnosed PLWH.[27] While delivering HIV treatment according to BC's therapeutic guidelines,[28] the DTP collects demographic, clinical and treatment data of its clients. PLWH in BC are also covered by the province's Medical Services Plan (MSP), universal health insurance fully covering medically essential services.[29]

This retrospective population-based cohort study used individual-level longitudinal data from the Comparative Outcome And Service Utilization Trends (COAST) study, consisting of linkages between BC-CfE's DTP and provincial administrative databases hosted by Population Data BC.[30] COAST contains healthcare utilisation and mortality data on all diagnosed PLWH from 1 April 1992 to 31 March 2020. HIV diagnosis was determined using a validated case-finding algorithm requiring at least one record of: (1) detectable VL, (2) ART initiation, (3) death caused by HIV/AIDS, (4) one hospitalisation with HIV as the most responsible diagnosis or within 12 months, (5) five HIV-related healthcare practitioner visits and (6) two HIV-related hospitalisation.[31]

Study population

Eligible participants were PLWH (1) 19 years and older, who (2) achieved viral suppression at least once during follow-up and (3) had more than one VL measurement in at least one of the calendar years during which they achieved viral suppression. Eligibility criteria (2) and (3) were included for analysis of sustainment of suppression among PLWH who achieved viral suppression at least once during follow-up. Viral suppression was defined as having <200 copies/mL VL.[32] The index date was the latest of the following dates: HIV seropositive status, 19th birthday or 1 January 2001. The end of the follow-up date for study participants was the earliest of the following dates: last healthcare contact, death or 31 December 2019. The death date was the end of follow-up for participants who died during follow-up.

Exposure variable

For the descriptive analysis, we had two exposure variables: (1) diagnosis status of SUD and/or mood/anxiety disorders and (2) sustainment of viral suppression (hereafter called sustained suppression), which was assessed annually from 2001 to 2019. Sustained suppression was defined as at least two VL measurements within a calendar year and having all VLs in the calendar year as <200 copies/mL,[33 34] and categorised as no, yes, only one VL measured or no VL measured. The diagnosis status of SUD and mood/anxiety disorders was categorised as (1) neither disorder, (2) only SUD, (3) only mood/anxiety disorders and (4) both disorders. Considering that interactions between SUD and mood/anxiety disorders may exacerbate their impact on health outcomes,[35 36] we used this categorical exposure variable to capture both distinct and combined effects.

For the multivariable analyses, the exposure variable was categorised as: (1) sustained suppression with neither disorder, (2) sustained suppression with only mood/anxiety disorders, (3) sustained suppression with only SUD, (4) sustained suppression with both disorders, (5) unsustained suppression with neither disorder, (6) unsustained suppression with only mood/anxiety disorders, (7)

unsustained suppression with only SUD and (8) unsustained suppression with both disorders, again to capture distinct and combined effects.

Cases of SUD and mood/anxiety disorders were identified in health administrative records using the BC Ministry of Health's case-finding algorithms that include the International Classification of Diseases (ICD) codes for these diseases (online supplemental table S1).[37 38] Note that in BC's MSP data, mood and anxiety disorders are coded under one BC-specific diagnostic code (50B), compelling combination to a single category.[37] The administrative data in COAST was not collected for research purposes. COAST consists of data from real-time encounters with specific healthcare services.[39] People engaged in care for longer are more likely to have new and pre-existing conditions documented in these databases. Hence, a 5-year lookback window was implemented for all participants to minimise misclassification bias. Per previous studies, 5 years was the optimum length for minimising bias and maximising sample size and follow-up time.[39] SUD and mood/anxiety disorder cases were annually ascertained in the lookback window,[39] ie, were regarded as present when algorithms found cases in the 5 years before the year of interest. Diagnoses were reversible, that is, defined as not present when no records related to a diagnosis appeared for 5 years.

Outcome variables

Outcomes included annual counts of primary care and specialist physician visits, laboratory visits, day surgery episodes, acute-care hospitalisations and hospital length of stay (LOS). All physician and laboratory visits were identified using the MSP billing database, which holds records of essential physician services, laboratory and diagnostic procedures.[40 41] Acute-care hospitalisations, day-surgery episodes and LOS were determined using the Discharge Abstract Database, containing hospital discharge and death records from acute-care hospitals in BC.[42] LOS was calculated as the number of inpatient days per year. For day-surgery episodes, LOS was set as 1 day.

Confounders

Potential sociodemographic confounders included age (categorical (19–29, 30–39, 40–49 and 50+ years) or continuous), gender (woman, man), receipt of income assistance (no, yes, unknown), Regional Health Authority (HA) of residency (Vancouver Coastal, Fraser, Vancouver Island, Interior, Northern and unknown) and residency in Vancouver's Downtown Eastside (DTES) (no, yes and unknown). In BC, each HA delivers healthcare services to the population within its geographic region.[43] BC's most urbanised HA is Vancouver Coastal and the most rural is Northern. DTES is a neighbourhood in Vancouver which is disproportionately affected by HIV, drug use, mental disorders and socioeconomic inequities including homelessness, poverty and crime.[44 45] Receipt of income assistance was based on records of non-ART drug dispensation under the PharmaCare Plan C, a BC-wide programme covering 100% of prescription costs for low-income residents of BC.[46] For this variable, a 5-year lookback window was selected as the optimum length after a sensitivity analysis. HIV-related potential confounders included ART initiation year (continuous; as the cohort effect) and self-reported HIV transmission group (people who inject drugs (PWID), gay, bisexual and other men who have sex with men (gbMSM), PWID/gbMSM, heterosexual/other, unknown). Index year (year of study entry), follow-up time (in years) and time between ART initiation to first viral suppression (in months) were reported for descriptive purposes. Age, receipt of income assistance, HA and residency in the DTES were time-varying variables, whereas gender, self-reported HIV transmission group and ART initiation year were time-fixed variables. Potential confounders were chosen based on data availability, literature and relevance to our outcomes of interest.[25 47–51]

Statistical analysis

Descriptive statistics (frequencies and proportions for categorical variables, medians and 25th–75th percentiles (Q1–Q3) for continuous variables) were calculated at the index date, and if time-varying, at the end of follow-up. Initially, we stratified the study population by the presence of sustained suppression and diagnosis status of SUD and/or mood/anxiety disorders. Characteristics of stratified groups were compared using χ^2 and Kruskal-Wallis tests for categorical and continuous covariates, respectively.[52] Next, we calculated the median annual counts of each type of healthcare utilisation outcome for each exposure group. Median annual counts were determined for the starting (2001), mid (2010), and ending (2019) years of the study period for illustrative purposes. Given that the sustainment of suppression was an exposure variable of interest, individuals were excluded from all outcome assessments in the years in which they did not achieve viral suppression or had fewer than two VL measurements. Counts of healthcare utilisations were reported instead of rates due to complete follow-up for the vast majority of the final study population (median follow-up time in each year was 364 days; Q1–Q3: 364–364) (online supplemental table S2). This phenomenon was likely due to the inclusion of only individuals who achieved viral suppression and had a minimum of two VL measures per year. We also compared the distribution of the number of VL measures per year for PLWH with sustained and unsustained suppression to ensure our results were not biased, as more frequent measurements in the unsustained suppression group could increase the chance of detecting unsuppressed VLs, while fewer measurements in the sustained suppression group could potentially miss unsuppressed events.

We built multivariable models to examine associations between SUD, mood/anxiety disorders and sustained suppression with each healthcare utilisation outcome. We adjusted for age category, gender, receipt of income assistance, DTES residency and ART initiation year. The self-reported HIV transmission group and HA variables were

excluded from the multivariable analysis due to substantial population overlap and multicollinearity with SUD diagnosis and DTES residency variables. For each healthcare utilisation outcome, the following models were considered for the multivariable analysis: generalised linear mixed effect negative binomial (NB), zero-inflated NB and hurdle (two-part) models.[53 54] NB models, suitable for count data, account for the overdispersion[53] and the inflated NB and hurdle models account for excessive zeros in healthcare utilisation data.[54] The NB model was selected for specialist visits, acute-care hospitalisation and LOS. The zero-inflated and the two-part (hurdle) NB models were used for primary care physician visits and laboratory visits, respectively. The selected model for each outcome was the model with the lowest Akaike Information Criterion and the smallest percentage of change between the number of zeros estimated by the model and the observed number of zeros in the outcome variable.[54] For interpretation purposes, we computed the adjusted predicted mean count with a 95% CI for each outcome using the ggpredict function (in the ggeffects R package), which holds confounding variables constant while varying the exposure variable.[55] All statistical analyses were performed using SAS V.9.4 and R V.4.0.3.

Patient and public involvement

None.

RESULTS

The final study population consisted of 9757 eligible PLWH, as shown in online supplemental figure S1. Compared with those included, PLWH excluded due to insufficient VL counts or missing information for confounding variables were more likely to be women, younger and to have never initiated ART (online supplemental table S3). The median index year was 2003 (Q1–Q3: 2001–2009), the median follow-up time was 13 years (Q1–Q3: 8–19) and the median time between ART initiation to first viral suppression was 4 months (Q1–Q3: 2–23). Our study population was 83% men, 32% gbMSM and 25% PWID (table 1). The median age increased from 40 (Q1-Q3: 33–47) years at index year to 53 (Q1–Q3: 45–60) years at the end of follow-up. At the index year, 41% of PLWH received income assistance, 52% resided in Vancouver Coastal HA and 8% were residents of the DTES. The median ART initiation was 2006 (Q1–Q3: 1998–2011). At index year, 37% of PLWH had neither disorder, and 22% had only mood/anxiety disorders.

Online supplemental tables S4 and S5 display the characteristics of PLWH with sustained and unsustained suppression stratified by the presence of SUD and mood/anxiety disorders as (1) index year and (2) end of follow-up. Among PLWH with sustained and unsustained suppression, those with both disorders or only SUD were significantly more likely to be women, younger, PWID on income assistance, residents of the Northern HA and residents of the DTES.

Table 2 displays the median annual counts of healthcare utilisations, stratified by the diagnosis status of SUD and mood/anxiety disorders in (1) 2001, (2) 2010 and (3) 2019. Annual median counts excluded zeros for all healthcare utilisation outcomes in the descriptive analyses. Online supplemental table S6 displays the number and proportion of individuals with zero and non-zero counts for each healthcare utilisation outcome in each year. Compared with PLWH with neither disorder, PLWH with both disorders or only SUD had significantly more primary care physician and specialist visits and longer LOS. For example, in 2019, PLWH with both disorders had 7 days longer median LOS (8 vs 1) and more than double the median counts of primary care physician visits (11 vs 4). We observed subtle but statistically significant differences between those with both disorders and those with only SUD, especially in recent years. For instance, in 2019, the median count of primary care physician visits for PLWH with both disorders was only one more (11 vs 10), and LOS was only 2 days longer (8 vs 6) than for PLWH with only SUD.

Table 3 displays the median annual counts of healthcare utilisations of PLWH, stratified by sustained suppression in (1) 2001, (2) 2010 and (3) 2019. Compared with PLWH with sustained suppression, PLWH with unsustained suppression consistently had significantly higher median counts of all healthcare utilisation outcomes except for acute-care hospitalisation. The most significant difference was observed for median LOS, which was 8 days longer (10 vs 2 days) in 2019. No results for day-surgery episodes were statistically significant (online supplemental tables S7–S9).

Figure 1 displays the adjusted predicted mean counts for each healthcare utilisation outcome, stratified by disorder diagnosis status and sustained suppression (see online supplemental table 9 for exact numbers). Due to a high proportion of zeros (online supplemental table S10), counts of acute-care hospitalisation were less than one. The model for LOS excluded zeros. There were subtle differences between the median number of VL measures per year for PLWH with sustained and unsustained suppression (4; Q1–Q3: 3–4 vs 5; Q1–Q3: 4–7) (online supplemental table S11).

In the presence of sustained suppression, having both disorders was significantly associated with almost double the estimated primary care physician visits (13.1 vs 6.9) (figure 1A) and specialist visits (7.9 vs 4.0) (figure 1B), over four times more acute-care hospitalisations (0.28 vs 0.05) (figure 1D) and three times longer LOS (9.1 vs 3.0 days) (figure 1F), compared with PLWH with neither disorder. Having only SUD was significantly associated with four times more acute-care hospitalisation (0.22 vs 0.05) and twice as long LOS (7.8 vs 3.0). Although having only SUD was also associated with significantly more primary care physician, specialist and laboratory visits (figure 1C), the magnitude of its association was smaller than with having both disorders. Having only mood/anxiety disorders was significantly associated with higher numbers of primary

Table 1 Clinical and sociodemographic characteristics of the overall study population

(A) Time-varying characteristics		
Categorical variables	At index year	At the end of follow-up
	n=9757	n=9757
	N (%)	N (%)
Diagnosis of SUD and mood/anxiety disorder		
Neither disorder	3610 (37)	4307 (44)
Only SUD	912 (9)	1389 (14)
Only mood/anxiety disorder	2168 (22)	2098 (22)
Both disorders	1571 (16)	1958–1962 (20)*
<5 years of medical history	1496 (15)	<5†
Achieved viral suppression		
No	4856 (50)	658 (7)
Yes	4125 (42)	8197 (84)
No VL measure	776 (8)	902 (9)
Sustained suppression		
No	5628 (58)	1162 (12)
Yes	1668 (17)	6708 (69)
Only one VL measure	1685 (17)	985 (10)
No VL measure	776 (8)	902 (9)
Age category		
19–29	1370 (14)	227 (2)
30–39	3253 (33)	1088 (11)
40–49	3214 (33)	2291 (24)
50+	1920 (20)	6151 (63)
Income assistance		
No	5419 (55)	5410 (56)
Yes	3989 (41)	4208 (43)
Unknown	349 (4)	139 (1)
Health authority		
Vancouver Coastal	5260 (54)	5042 (52)
Fraser	2059 (21)	2272 (23)
Vancouver Island	1119 (12)	1260 (13)
Interior	597 (6)	691 (7)
Northern	327 (3)	312 (3)
Unknown	395 (4)	180 (2)
Residency in the DTES		
No	8577 (88)	8894 (91)
Yes	801 (8)	700 (7)
Unknown	379 (4)	163 (2)
Continuous variables	Median (Q1-Q3)	Median (Q1-Q3)
Age (years)	40 (33–47)	53 (45–60)
(B) Time-fixed characteristics		
Categorical variables	Overall n=9757, n(%)	
Gender		
Woman	1666 (17)	
Man	8091 (83)	

Continued

Table 1 Continued

Self-reported HIV transmission group	
PWID	2434 (25)
gbMSM	3110 (32)
PWID/gbMSM	735 (8)
Heterosexual/other	987 (10)
Unknown	2491 (25)
Continuous variables	Median (Q1–Q3)
Year of ART initiation	2006 (1998–2011)
Index year	2003 (2001–2009)
Time between ART initiation to first viral suppression (months)	4 (2–23)
Follow-up time (years)	13 (8–19)

*Due to privacy concerns, small cell counts (<5) were protected by displaying a range.
†Due to data privacy, we replaced exact numbers if cells contained fewer than 5 participants.
ART, antiretroviral therapy; DTES, Downtown Eastside; gbMSM, gay, bisexual, and other men who have sex with men; PWID, people with a history of injecting drugs; Q1–Q3, 25th to 75th percentile; SUD, substance use disorder; VL, viral load.

care physician and specialist visits. However, the increases associated with having only mood/anxiety disorders were much lower than that of having only SUD. There were no significant associations between having only mood/anxiety disorders and acute-care hospitalisation and LOS. There were no significant associations between SUD, mood/anxiety disorders or unsustained suppression and day surgery episodes (figure 1E).

Regardless of disorder diagnosis, unsustained suppression was significantly associated with more primary care physician, specialist and laboratory visits, acute-care hospitalisations and longer LOS. Among those with both disorders, unsustained suppression was significantly associated with double the estimated number of acute-care hospitalisations (0.28 vs 0.55), 6 days longer LOS (15.5 vs 9.1), five more primary care physician visits (17.8 vs 13.1) and four more specialist visits (11.8 vs 7.9).

DISCUSSION

In this study, SUD (alone or combined with mood/anxiety disorders) was associated with higher counts of acute-care hospitalisations and longer LOS compared with mood/anxiety disorders alone and the absence of both disorders. SUD alone was associated with increased use of primary care and specialist physician services, acute-care hospitalisation and LOS. Although mood/anxiety disorders alone were not significantly associated with increased acute-care hospitalisation and LOS, they were associated with more frequent primary care physician and specialist visits. The associations between SUD and mood/anxiety disorders and increased healthcare utilisation were independent of sustained suppression. For all PLWH in this study, regardless of SUD and mood/anxiety disorder diagnosis, unsustained suppression was also independently associated with increased utilisation of all healthcare services (except day surgery).

Our finding that SUD alone or in combination with mood/anxiety disorders was associated with the highest number of primary care and specialist physician visits is consistent with most studies of the general population.[15 56 57] However, some research examining the effects of SUD on primary care utilisation has yielded mixed results.[58 59] For example, in a comparative study, alcohol use disorder was significantly associated with lower utilisation of outpatient healthcare services among an underserved group of PLWH but not among PLWH engaged in HIV care.[58] Similarly, another study found reduced primary care utilisation among marginalised PWID.[59] Our results may be inconsistent with these studies due to differences in populations (eg, PLWH vs PWID), outcome definitions (eg, primary care vs outpatient care) and healthcare systems. Plausibly, our study population may have higher primary care utilisation than marginalised individuals in other studies since they are engaged with HIV care and have free-of-charge access to healthcare services.[29] Additionally, several sociodemographic factors such as ethnicity, sexual orientation, education level, history of incarceration and involvement in sex work, which were controlled for in another study,[59] may contribute to the contrasting findings, as we were unable to control for these factors in our analysis. Considering that we studied SUD as a general category of disease, differences in results may also be due to variations in the type and severity of the SUD examined by other studies.

SUD was also significantly associated with increased acute-care hospitalisation and longer LOS. Our findings agree with studies of the general population and PLWH.[24 56 58 60–63] Factors contributing to this association may include chronic comorbidities and SUD-induced medical conditions common among PLWH with SUD.[15] Chronic comorbidities, such as kidney, respiratory and cardiovascular diseases, cancers and acute SUD-related

Table 2 Median annual counts of healthcare utilisations among people living with HIV in British Columbia, Canada, stratified by the diagnosis status of SUD and mood/anxiety disorders in (1) 2001, (2) 2010 and (3) 2019

		Diagnosis status of SUD and mood/anxiety disorders				
		Neither disorder n=799	Only SUD n=155	Only mood/anxiety disorder. n=563	Both disorders n=288	
2001						
Variable	Total N	Median (Q1–Q3)	Median (Q1–Q3)	Median (Q1–Q3)	Median (Q1–Q3)	P value
Primary care physician visits	1643	8 (5–13)	12 (5–27)	12 (8–19)	22 (11–44)	<0.0001
Specialist visits	1627	6 (3–13)	5 (3–12)	10 (5–19)	10 (5–22)	<0.0001
Laboratory visits	1796	6 (4–10)	8 (5–15)	7 (5–10)	8 (5–13)	<0.0001
Acute-care hospitalisation	251	1 (1–2)	1 (1–2)	1 (1–2)	1 (1–3)	0.002
LOS (days)	349	4 (1–8)	7 (2–30)	2 (1–9)	12 (3–34)	<0.0001
2010		n=2127	n=490	n=1276	n=824	
Variable	Total N	Median (Q1–Q3)	Median (Q1–Q3)	Median (Q1–Q3)	Median (Q1–Q3)	P value
Primary care physician visits	4384	5 (3–9)	10 (4–22)	8 (5-13)	14 (7–31)	<0.0001
Specialist visits	4127	4 (2–8)	6 (3-16)	6 (3-12)	9 (4-20)	<0.0001
Laboratory visits	4693	5 (4–8)	8 (5-13)	6 (4-9)	8 (5-12)	<0.0001
Acute-care hospitalisation	623	1 (1–2)	1 (1-2)	1 (1-2)	2 (1-3)	<0.0001
LOS (days)	1021	1 (1–5)	9 (3-31)	1 (1-4)	8 (3-26)	<0.0001
2019		n=3092	n=714	n=1508	n=1081	
Variable	Total N	Median (Q1–Q3)	Median (Q1–Q3)	Median (Q1–Q3)	Median (Q1–Q3)	P value
Primary care physician visits	5895	4 (3–7)	10 (4–25)	6 (3–10)	11 (5–32)	<0.0001
Specialist visits	5837	5 (2–10)	7 (3–17)	7 (4–13)	10 (5–22)	<0.0001
Laboratory visits	6361	5 (4–6)	5 (4–9)	2–235 (4–7)	6 (4–10)	<0.0001
Acute-care hospitalisation	810	1 (1–2)	1 (1–2)	1 (1–1)	1 (1–2)	<0.0001
LOS (days)	1435	1 (1–4)	6 (2–17)	1 (1–6)	8 (2–23)	<0.0001

Counts restricted to values>0 due to the presence of excess zero.
The Kruskal-Wallis test was used to compare healthcare utilisation counts across groups.
P value significance is set at 0.05.
LOS, length of stay; Q1–Q3, 25th to 75th percentile; SUD, substance use disorder.

conditions (eg, skin infections), increase the need for urgent and extensive medical care.[61 64 65] It is worth noting that PLWH with SUD were more likely to be women, receiving income assistance and DTES residents. Our results agree with other studies suggesting that among people with HIV and SUD, women and individuals with socio-economic disadvantages such as low income, housing instability, food insecurities and experiences of violence have a higher risk of hospitalisation.[25 47–51]

We did not find significant associations between mood/anxiety disorders and increased hospitalisation and LOS. Our findings contrast with prior research of the general population and a cohort study in Ontario, Canada, which found an elevated risk of hospital admission among PLWH meeting the criteria for depression in the past 4 weeks.[14 24 66–68] Some studies have identified a higher risk for hospitalisation and prolonged stays among individuals with specific types of mood/anxiety disorders, such as general anxiety and bipolar disorders.[14 24 66 67] In a study of PLWH with a more severe and chronic mental disorder (schizophrenia), individuals not adherent to psychiatric treatment were more likely to be hospitalised.[69] We measured mood/anxiety disorders as a broad category of disease, ascertained with administrative health data, over a 5-year lookback window. Therefore, the difference between our results and other studies may be due to the type, chronicity, clinical severity and the psychiatric treatment status of the disorders examined by other studies and their methods of ascertainment. In our results, episodes of day surgeries were not associated

Table 3 Median annual counts of healthcare utilisations among people living with HIV in British Columbia, Canada, stratified by sustained suppression in (1) 2001, (2) 2010 and (3) 2019

		Sustained suppression		
		No	Yes	
2001		n=518	n=1287	
Variable	Total N	Median (Q1–Q3)	Median (Q1–Q3)	P value
Primary care physician visits	1643	14 (8–23)	9 (6–16)	<0.0001
Specialist visits	1627	11 (5–19)	7 (3–14)	<0.0001
Laboratory visits	1796	9 (6–13)	6 (4–9)	<0.0001
Acute-care hospitalisation	251	1 (1–2)	1 (1–2)	0.0004
LOS (days)	349	9 (3–30)	3 (1–8)	<0.0001
2010		n=716	n=4001	
Variable	Total N	Median (Q1–Q3)	Median (Q1–Q3)	P value
Primary care physician visits	4384	10 (5–18)	7 (4–13)	<0.0001
Specialist visits	4127	7 (3–18)	5 (2–11)	<0.0001
Laboratory visits	4693	8 (5–12)	6 (4–9)	<0.0001
Acute-care hospitalisation	623	1 (1–2)	1 (1–2)	0.1669
LOS (days)	1021	8 (2–28)	2 (1–9)	<0.0001
2019		n=506	n=5889	
Variable	Total N	Median (Q1–Q3)	Median (Q1–Q3)	P value
Primary care physician visits	5895	7 (4–20)	6 (3–10)	<0.0001
Specialist visits	5837	9 (4–21)	6 (3–12)	<0.0001
Laboratory visits	6361	6 (4–9)	5 (4–7)	<0.0001
Acute-care hospitalisation	810	1 (1–3)	1 (1–2)	0.003
LOS (days)	1435	10 (3–30)	2 (1–8)	<0.0001

Note: Q1–Q3: 25th to 75th percentile Counts restricted to values>0 due to the presence of excess zeros.
Kruskal-Wallis test was used to compare healthcare utilisation counts across groups.
P value significance is set at 0.05.
LOS, length of stay.

with SUD or mood/anxiety disorder. This lack of association may be due to treatment bias in healthcare settings, where SUD-associated stigma hinders appropriate diagnoses and surgery referrals for patients with SUD.[70]

We found that independent of sustained suppression, SUD and mood/anxiety disorders contributed to higher healthcare utilisation among PLWH. While the absence of sustained suppression combined with the diagnosis of both disorders or of only SUD was associated with the highest increase in healthcare utilisation, the increase associated with these disorders was also significant in the presence of sustained suppression. Nevertheless, aligned with previous studies, unsustained suppression was associated with a consistent increase in healthcare utilisation for the entire population.[21–23] Therefore, our study highlights the importance of maintaining long-term suppression as a crucial determinant of healthcare utilisation among PLWH.

To our knowledge, this is the first population-based cohort study of ART-treated PLWH that examined the impact of SUD and mood/anxiety disorders on various healthcare utilisation outcomes in the absence and presence of sustained suppression. As a strength, this study was conducted in a universal healthcare setting where ART and HIV laboratory monitoring are accessible free of charge, and public health insurance covers all residents' medically necessary expenses. We analysed counts of healthcare encounters instead of financial costs, allowing for comparability of results across different settings. Nonetheless, this study has some limitations that must be considered. First, one limitation of this study was the inherent shortcoming of administrative health data, which was mentioned in Methods. Second, BC's single diagnostic code encompassing both mood and anxiety disorders precluded separation of these disorders in analysis. Likewise, we were not able to explore the impact of specific SUDs. As another limitation, we could not control for the severity, chronicity and the treatment status of these disorders. The episodic nature of some relapsing–remitting mood/anxiety disorders and SUD also limited our ability to identify individuals with these disorders. Third, our sustained suppression variable may have been biased by varying numbers of VL measurements per year across individuals since PLWH with fewer

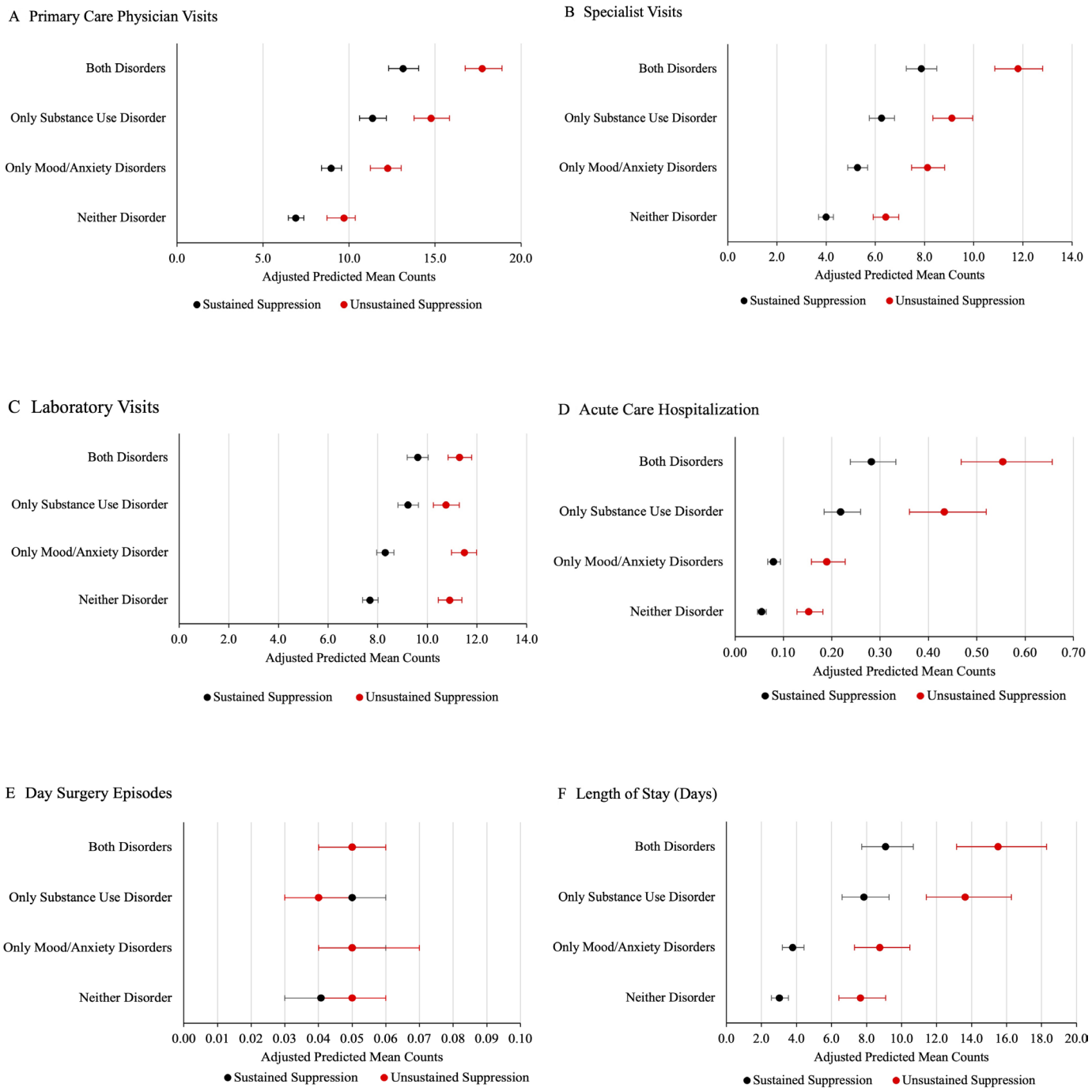

Figure 1 Adjusted predicted mean counts of healthcare utilisation outcomes with 95% CIs, stratified by diagnosis status of substance use disorder and mood/anxiety disorders and sustained suppression. Note: Each healthcare utilisation outcome was modelled separately using a single, eight-level exposure variable that combined the diagnosis status of the disorders and sustained suppression. The negative binomial model was selected for specialist visits, acute-care hospitalisation and length of stay. The zero-inflated and the two-part (hurdle) negative binomial models were used for primary care physician visits and laboratory visits, respectively. All counts were adjusted for age, gender, income assistance, residency in the Downtown Eastside and antiretroviral therapy initiation year. Length of stay restricted to values>0. Scales of the horizontal axes differ for each plot for illustration purposes.

measurements were more likely to be classified as having sustained suppression. However, we observed that the number of VL measurements per year for PLWH with sustained suppression was slightly lower than those with unsustained suppression. Lastly, we did not include other healthcare utilisation indicators, such as ambulatory and emergency department visits, due to a lack of available data. Similarly, we also could not control for potential sociodemographic confounders such as ethnicity, housing stability, education, employment, social support and food insecurity as this information was not available to us. The inability to control for these sociodemographic

factors may have reduced the generalisability of our findings and introduced potential bias in the observed associations. However, we mitigated this limitation by using income assistance and DTES residency as proxy variables for these sociodemographic factors.

CONCLUSION

In this study, SUD, mood/anxiety disorders and unsustained suppression, individually and in combination, contributed to higher healthcare utilisation. However, it is evident that independent of their effect on viral suppression, SUD and mood/anxiety disorders were associated with increased healthcare utilisation among PLWH. Hence, providing integrated care for mental health and SUD for PLWH may be an effective strategy for improving their health outcomes and reducing healthcare system burden. The observed associations between unsustained suppression and increased healthcare utilisation also re-emphasise the necessity of long-term suppression for optimising health outcomes and healthcare utilisation. Furthermore, the high proportion of women and individuals on income assistance among PLWH with SUD calls for targeted interventions and strategic resource allocation to reduce the burden of SUD among the most vulnerable groups of PLWH.

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Data availability statement Data are available upon reasonable request. Access to data provided by the Data Stewards is subject to approval but can be requested for research projects through the Data Stewards or their designated service providers. The following data sets were used in this study: BC Cancer, Pharmanet, Consolidation, Hospital Separations (Discharge Abstract Database), Mental Health, Medical Service Plan (MSP), PharmaCare, Vital Statistics (VS)-Deaths, National Ambulatory Care Reporting Systems (NARCS). You can find further information regarding these data sets by visiting the PopData project webpage at: https://my.popdata.bc.ca/project_listings/18-223/collection_approval_dates. All inferences, opinions and conclusions drawn in this publication are those of the author(s), and do not reflect the opinions or policies of the Data Steward(s).

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