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Emergency department use for mental and substance use disorders: Analysis of population-based, linked administrative data in British Columbia, Canada

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Emergency department use for mental and substance use disorders: Analysis of population-based, linked administrative data in British Columbia, Canada

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Abstract

Objectives: Tracking emergency department (ED) visits for mental and substance use disorders (MSUDs) and understanding the characteristics of people accessing EDs for MSUD is important for improving healthcare systems. In the context of the overdose crisis, ED visits for MSUD may have increased, but changes over time have not been explored in British Columbia (BC), Canada.

Methods and setting: Linked administrative data comprised of ED records and physician billings were used to capture all MSUD ED visits for all people age 15+ in BC. Patient characteristics (sex/gender, age, location of residence, income, treated disorders, and comorbidities) and previous outpatient service use for all ED visits by visit diagnosis, and for all people, by number of MSUD ED visits in 2017/8, were described.

Population: All people age ≤15 with MSUD ED visits during the study period.

Measures: Examined all claims with a service location in the ED or corresponding to fee items billed only in the ED. These were then stratified based on demographic, clinical, and health service use characteristics.

Results: 72,363 individuals made 134,063 MSUD ED visits in 2017/8. MSUD ED visits were evenly distributed by sex/gender. MSUD ED visits have increased since 2010. The most common diagnoses in 2017/8 were substance use, anxiety, and depression. People with more frequent visits were more likely to be male, ages 25-44, on public prescription drug plans for income assistance and psychiatric medications, and living in lower income neighbourhoods. They used more community-based primary care and psychiatry services but had lower continuity of primary care.

Conclusions: MSUD ED visits are substantial and growing in BC. Although substance use largely accounts for increasing rates over time, visits for anxiety and other conditions are also increasing. ED visits are disproportionately distributed across populations, signaling a need to expand and better target services for underserved groups**.**

Key words: mental disorders, substance use disorders, emergency services, emergency department visits, ambulatory care, administrative data

2

Article Summary
Strengths and limitations of this study

- Combination of the National Ambulatory Care Reporting System and BC's Medical Services Plan now permits comprehensive analysis of ED visits.
- For the first time ever, mental and substance use disorder-related emergency department visits for people ages ≥15, patient characteristics, and changes in visit rates over time, are comprehensively described in British Columbia (BC), Canada.
- This study is preliminary and descriptive, and cannot confirm causal drivers of ED visits.
- Only one diagnosis is consistently recorded in the data, even if concurrent disorders are managed during the visits.

Declarations

Background

Accurately tracking emergency department (ED) visits related to mental and substance use disorders (MSUD) and understanding the characteristics of people with MSUD ED visits is important for service planning and improving healthcare systems. EDs provide highly accessible acute care [1,2] and in many cases act as an entry point for referral to other, community-based services [1]. However, unscheduled visits to care providers with little knowledge of the patient's history may limit effective patient management [1,2]. Thus, a detailed picture of who uses the ED for MSUD-related needs and an understanding of changing ED use over time is important to plan healthcare delivery, especially in the context of public health emergencies such as the ongoing overdose crisis.

In the United States, a survey of ED visits found that alcohol use disorder accounted for the greatest increase in MSUD visits between 2006 and 2015, followed by mood disorders, and anxiety disorders [3]. Over a similar time period, anxiety disorders and substance use disorders accounted for the greatest increase in MSUD ED visits in Ontario [4]. In Australia, MSUD ED visit increases were also largely driven by substance use disorders, which included alcohol use, followed by anxiety disorders and mood disorders [5]. However, Canadian research examining trends in MSUD ED visits over time outside of Ontario is limited by the fact data from the National Ambulatory Care Reposting System data is available for only a subset of EDs, and comparable data has not been available over time. Consequently, most studies focus only on people with frequent ED visits, and are cross-sectional [6–13]. MSUD ED visits have not been examined in British Columbia (BC). This information gains additional importance within the context of the overdose crisis which has disproportionately impacted BC [14,15].

The purpose of the present study is to for the first time ever 1) comprehensively describe all MSUD ED visits for people ages 15 and older in the province of BC in 2017/8, 2) describe patient characteristics by number of ED visits in 2017/8, and 3) explore changes in MSUD ED visit rates over time by disorder group (2007/8 to 2017/8).

Methods

Data

We used de-identified data holdings from the BC Ministry of Health linked [16] and made accessible through Population Data BC. Two data sources capture ED visits in BC: the National Ambulatory Care Reporting System (NACRS) [17] and BC's Medical Services Plan (MSP) payment information [18]. NACRS was developed by the Canadian Institute for Health Information to collect data on ED and other ambulatory visits. BC began reporting to NACRS in 2012 and only a subset of EDs are captured (30 of 108 hospitals providing ED care in 2017/8). MSP data captures fee-for-service payments made to physicians, and encounter claims if submitted for services provided by physicians who are paid through Alternative Payment Plans. All EDs not reporting to NACRS are captured within the MSP data; thus, we have complete data for the entire province.

We used patient registry data [19], as well as information from hospitalizations captured through the Discharge Abstract Database to describe the demographic and clinical characteristics of people with MSUD ED visits [20]. We obtained population estimates used as denominators to construct rates of ED visits from BC Statistics [21].

4

Study population

We examined all people age 15+ with MSUD ED visits (diagnosis codes listed in Appendix 1) during the study period.

Patient and public involvement

Neither patients nor the public were involved in the design, conduct, reporting, or dissemination plans of this research.

Setting

The province of BC had a population of approximately 5 million people in 2018 [22]. Five geographic health authorities (Fraser, Vancouver Coastal, Interior, Northern, and Island) are responsible for planning and delivering healthcare services within their geographic areas. Most physician services (including primary care and psychiatry) are paid fee-for-service directly by the provincial health insurance plan (MSP). A public health emergency was declared in BC on April 14, 2016 in response to the opioid overdose epidemic.

Measures

MSUD ED visits: We identified MSP claims with a service location in the ED or corresponding to fee items billed only in the ED (Appendix 1). We also extracted all ED visits to BC facilities recorded in NACRS data. To ensure visits were not double counted across sources or when multiple MSP claims were submitted for a single patient, we retained only one ED record per patient per day. Where multiple records contained different diagnoses, we retained records for MSUD.

Demographic characteristics: Age was obtained from BC's MSP registration file. Sex is collected at time of MSP registration. The field is labeled "Gender" on the registration form but only the binary options "M" and "F" are provided. It is not possible to distinguish sex at birth, legal sex, and gender based on this information, so we labelled this "sex/gender." Health Authority was determined based on patient residential address, not location of service use. Neighbourhood income quintile was determined based on census enumeration area of residence, assigned using the Postal Code Conversion File Plus (PCCF+) [23,24].

Clinical characteristics: We classified MSUD ED visits based on disorder groupings (Appendix 2). We also examined all other MSUD services in 2017/8. Patients with two outpatient visits or one hospitalization (within a 365-day period) for the disorders listed in Appendix 2 were considered to have been treated for the disorder [25].

The Charlson-Deyo Comorbidity Index categorizes diagnosis codes based on 17 weighted categories [26,27]. We presented both the Index's average weight and the percentage of people with no identified comorbidities based on both outpatient and inpatient service use.

Health services use: For all ED visits, we explored if people had an outpatient visit (service location office, home, or long-term care facility) with a primary care physician with an MSUD diagnosis code on the same day as the ED visit or in the preceding 30 days. We excluded visits for Opioid Agonist Treatment (OAT, fee codes 00039 and 15039). We also determined the percentage of ED visits that subsequently resulted in hospitalization. We identified involuntary

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hospitalizations under BC's Mental Health Act as those in which the patient was apprehended and admitted by police and/or if forms 4, 10, 20 or 21 were on the patient's record.

For all people seen in the ED, we examined outpatient service use in the 365 days preceding their first ED visit in 2017/8. We counted the number of primary care visits occurring in the previous year (total, for MSUD, and for OAT) and report the percentage of people with no visits. We calculated continuity of care over this period using the Continuity of Care Index (COCI). The COCI identifies the number of primary care physicians providing service to a patient and the percentage of care provided by each physician. The index ranges from 0 (all visits to different physicians/no visit) to 1 (all visits with one physician). In BC, primary care physicians can bill a $100 fee for people with Axis 1 conditions of sufficient severity to interfere with activities of daily living. The fee requires doctors to conduct a comprehensive review of the patient's history, assess the patient, and develop a treatment and management plan [28]. We examined the proportion of people with a primary care mental health planning fee billed on their behalf in the 365 days preceding the ED visit as a marker of active management in primary care. We also examined number of outpatient visits (excluding visits with a hospital, day surgery, or ED service location code) with a psychiatrist in the preceding year and the percentage of people with no psychiatrist visits.

Analysis

Our intention was to describe the volume of services within the system and the nature of the presenting population and so we chose to report both visit-level and patient-level information using data from 2017/18. We first describe patient characteristics associated with each ED visit, stratified by the MSUD diagnosis associated with the visit. We report numbers and percentages or means and standard deviations, as appropriate, and calculated the rate of ED visits per 1,000 population by health authority and income quintile.

Next, we describe the characteristics of people by number of ED visits in 2017/8. In this analysis the unit of analysis is the individual patient. We report numbers and percentages or means and standard deviations as appropriate.

Finally, we present ED visits per 1,000 population from 2007/8 to 2017/8, stratified by disorders presenting to ED. Only visits captured in MSP data were considered in examining trends over time as NACRS data in BC were not available before 2012. We also note that BC fee-for-service data uses a code "50B" in addition to standard ICD9 codes for anxiety and depression. For this reason, it is not possible to distinguish mood and anxiety disorders in all cases. In plotting rates over time, we present this code separately for clarity.

Ethics approval

This study was approved by the University of British Columbia, Providence Health Care Research Institute, and Simon Fraser University research ethics boards (REB number H17-00506). All inferences, opinions and conclusions drawn in this article are those of the authors, and do not reflect the opinions or policies of the data stewards.

Results

6

We observed 134,063 ED visits in 2017/8 across 72,363 people in BC. In total, 35.7% of visits were for mood or anxiety disorders, 36.7% for substance use disorders, 7.6% for schizophrenia spectrum disorders, 5.4% for post-traumatic stress disorder (PTSD) and adjustment disorders, and 14.6% for other mental disorders (e.g. attention deficit/hyperactivity disorder [ADHD], eating disorders, intellectual disability, neurocognitive disorder, and personality disorders) (Table 1). We observed more visits for substance use and schizophrenia among men and more visits for mood or anxiety and for PTSD and adjustment disorders among women. More visits for other mental disorders, which include organic neurocognitive disorders, were among people age 65+.

Total visit rates were higher in the Northern and Interior Health Authorities, whereas Fraser and Vancouver Coastal Health Authorities saw higher visit rates for schizophrenia spectrum disorders (Table 1). Pronounced gradients by neighbourhood income were observed across all disorders. Rates of MSUD ED visits for people living in low-income neighbourhoods were more than double rates for people living in high-income neighbourhoods. Visits for people with substance use and schizophrenia spectrum disorders were especially high among people living in the lowest income neighbourhoods relative to the other disorders. The Charlson-Deyo index, a measure of physical comorbidities, was similar across all groups except other disorders, which also has an older age distribution.

We found that 26.6% of ED visits were preceded by a primary care visit for mental health or substance use within 30 days, and 6.1% of ED visits occurred on the same day as a separate primary care visit (Table 1). Across all disorders, approximately 22.6% of ED visits were followed by a hospital admission, of which 54% were involuntary admissions under BC's Mental Health Act. The percentage hospitalized was highest for schizophrenia spectrum and lowest for substance use disorders (for both voluntary, and involuntary hospitalizations).

Rates of MSUD ED visits are increasing over time, and are largely driven by substance use, though visits for anxiety also increased notably (Figure 1). Higher percentages of people with frequent ED visits are male (Table 2). The percentage of people living in the lowest income quintile increased with number of ED visits, as did the percentage of people with drug coverage under public Pharmacare. The percentage of people with substance use disorders and the percentage of people with two or more treated disorders increased with number of ED visits, but the Charlson-Deyo index of comorbidities was similar.

People with more ED visits also had higher mean outpatient primary care service use, but lower continuity of care with primary care providers (Table 2). People with more ED visits also had higher mean outpatient psychiatrist visits, though overall 78.4% of people with one or more ED visits did not have an outpatient psychiatrist visit in the preceding year.

Discussion

We observe that roughly 1.5% of British Columbians ages ≥15 (*n* = 4,118,960) used an emergency department for MSUD in 2017/8. As anticipated, ED visits for substance use are increasing as has been observed elsewhere [3–5], likely signalling the overdose epidemic is contributing to increasing ED visit rates for substance use [29,30]. Unmet healthcare needs, especially a lack of accessible, community-based specialist care, may also be driving these visits [31]. Additionally, people who use drugs often experience stigmatizing attitudes and inferior care in hospital settings and may consequently delay seeking treatment [32] until the severity

7

of their symptoms require medical attention at which point, they present to the ED [2,32–34]. Increasing rates of visits for substance use in particular, likely indicate the need for linkages to other relevant treatments and services, such as intensive case management [35–37].

Visits for anxiety are also increasing as observed elsewhere [3–5]. Increased substance use, especially within the context of the ongoing overdose crisis, may be contributing to increasing rates of ED visits for anxiety. High rates of comorbidity between substance use and anxiety within clinical and population samples are well established [38]. Symptoms of both substance use and substance use withdrawal can mimic anxiety symptoms [38,39] and may be treated as anxiety. Others have noted that the prevalence of anxiety disorders has remained stable, while the prevalence of psychological distress is increasing, which may indicate psychological distress is being treated as anxiety [40].

We found people with more frequent ED visits also have higher use of outpatient services, indicating that existing community-based services are not meeting people's healthcare needs. Pronounced income gradients reflect the association between socioeconomic status and mental illness but may also suggest that EDs play a particularly important role as an access point for people living with low incomes (as indicated by low-income neighbourhoods and receiving drug coverage under public Pharmacare). This is consistent with patterns observed in cross-provincial Canadian data [41] and elsewhere [2,6,34,42,43]. The fact that people with more frequent visits had lower continuity of care may suggest gaps in coordination and integration of outpatient services, corroborating previous research [9,44–46].

In the context of COVID-19, the ability to track MSUD service use, and highlight potential gaps, gains additional significance. Our methods may be useful to other researchers seeking to track changing patterns of ED service use.

Limitations

This study relied on administrative data and is preliminary and descriptive, and thus, subject to several important limitations. Trends in diagnoses over time are based on MSP data only. The subset of facilities where fee-for-service claims are not submitted may differ in disorders seen and possibly also in changes over time. Only one diagnosis is consistently recorded in fee-for-service and NACRS data, even if concurrent disorders are managed during the visits. We cannot confirm causal drivers of increasing rates of ED visits for substance use and anxiety.

Conclusion

The use of ED services for mental and substance use disorders is substantial and growing in BC. While substance use largely accounts for increasing rates over time, visits for anxiety and other conditions are also increasing. Findings signal a need to strengthen and target community healthcare services for potentially underserved groups and an opportunity to triage people with MSUD to appropriate care.

8

Availability of data and material: Linked, de-identified data holdings from the BC Ministry of Health linked and made accessible through Population Data BC were used for analysis. We are not permitted to share the research extract used in this analysis with other researchers, but all data are available through Population Data BC. All inferences, opinions and conclusions drawn in this article are those of the authors, and do not reflect the opinions or policies of the data stewards.

Figure caption
Figure 1. Rates of emergency department visits for mental and substance use disorders over time by diagnosis assigned to visit (physician claims only)

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13

Table 1. Emergency department visits for mental and substance use disorders in British Columbia (2017/8) by individual characteristics and discharge diagnosis

	Mood and Anxiety		Substance Use		Schizophrenia spectrum		PTSD and adjustment		Other Mental		Total	
Total Visits, n (%)	47,881	(35.7%)	49,164	(36.7%)	10,219	(7.6%)	7,236	(5.4%)	19,563	(14.6%)	134,063	(100.0%)
Sex												
Female	26,775	(55.9%)	15,865	(32.3%)	3,585	(35.1%)	3,896	(53.8%)	9,720	(49.7%)	59,841	(44.6%)
Male	21,106	(44.1%)	33,299	(67.7%)	6,634	(64.9%)	3,340	(46.2%)	9,838	(50.3%)	74,217	(55.4%)
Unknown	0		0		0		0		5		5	
Age												
15-24	12,430	(26.0%)	7,582	(15.4%)	1,526	(14.9%)	2,183	(30.2%)	3,019	(15.4%)	26,740	(19.9%)
25-44	17,740	(37.1%)	22,142	(45.0%)	4,899	(47.9%)	2,596	(35.9%)	5,076	(25.9%)	52,453	(39.1%)
45-64	11,922	(24.9%)	16,328	(33.2%)	3,069	(30.0%)	1,734	(24.0%)	3,790	(19.4%)	36,843	(27.5%)
65+	5,789	(12.1%)	3,112	(6.3%)	725	(7.1%)	723	(10.0%)	7,678	(39.2%)	18,027	(13.4%)
Health Authority (rate per 1,000 population)												
Interior	8,684	(13.3)	10,124	(15.5)	918	(1.4)	1,435	(2.2)	2,683	(4.1)	23,844	(36.5)
Fraser	18,948	(12.6)	16,812	(11.2)	4,759	(3.2)	2,665	(1.8)	7,518	(5.0)	50,702	(33.7)
Vancouver Coastal	7,479	(7.2)	11,252	(10.8)	3,019	(2.9)	997	(1.0)	4,740	(4.5)	27,487	(26.4)
Vancouver Island	8,412	(12.2)	7,219	(10.5)	1,045	(1.5)	1,275	(1.9)	3,613	(5.2)	21,564	(31.3)
Northern	4,315	(18.9)	3,638	(16.0)	457	(2.0)	862	(3.8)	989	(4.3)	10,261	(45.1)
Missing HA	43		119		21				20		205	
Income quintile (rate per 1,000 population)												
Q1 (lowest)	13,113	(14.7)	17,818	(20.0)	3,972	(4.5)	2,122	(2.4)	5,979	(6.7)	43,004	(48.2)
Q2	10,048	(13.2)	10,124	(13.3)	2,185	(2.9)	1,619	(2.1)	3,995	(5.2)	27,971	(36.7)
Q3	8,988	(11.3)	7,732	(9.8)	1,602	(2.0)	1,277	(1.6)	3,536	(4.5)	23,135	(29.2)
Q4	8,237	(10.0)	6,992	(8.5)	1,251	(1.5)	1,155	(1.4)	3,130	(3.8)	20,765	(25.1)
Q5 (highest)	6,786	(8.0)	4,944	(5.8)	985	(1.2)	907	(1.1)	2,539	(3.0)	16,161	(19.1)
Missing Income	709		1,554		224		156		384		3,027	
Comorbidities												
Charlson-Deyo weighted index (mean, SD)	0.7	± 1.5	0.8	± 1.7	0.7	± 1.5	0.7	± 1.5	1.7	± 2.4	0.9	± 1.8

14

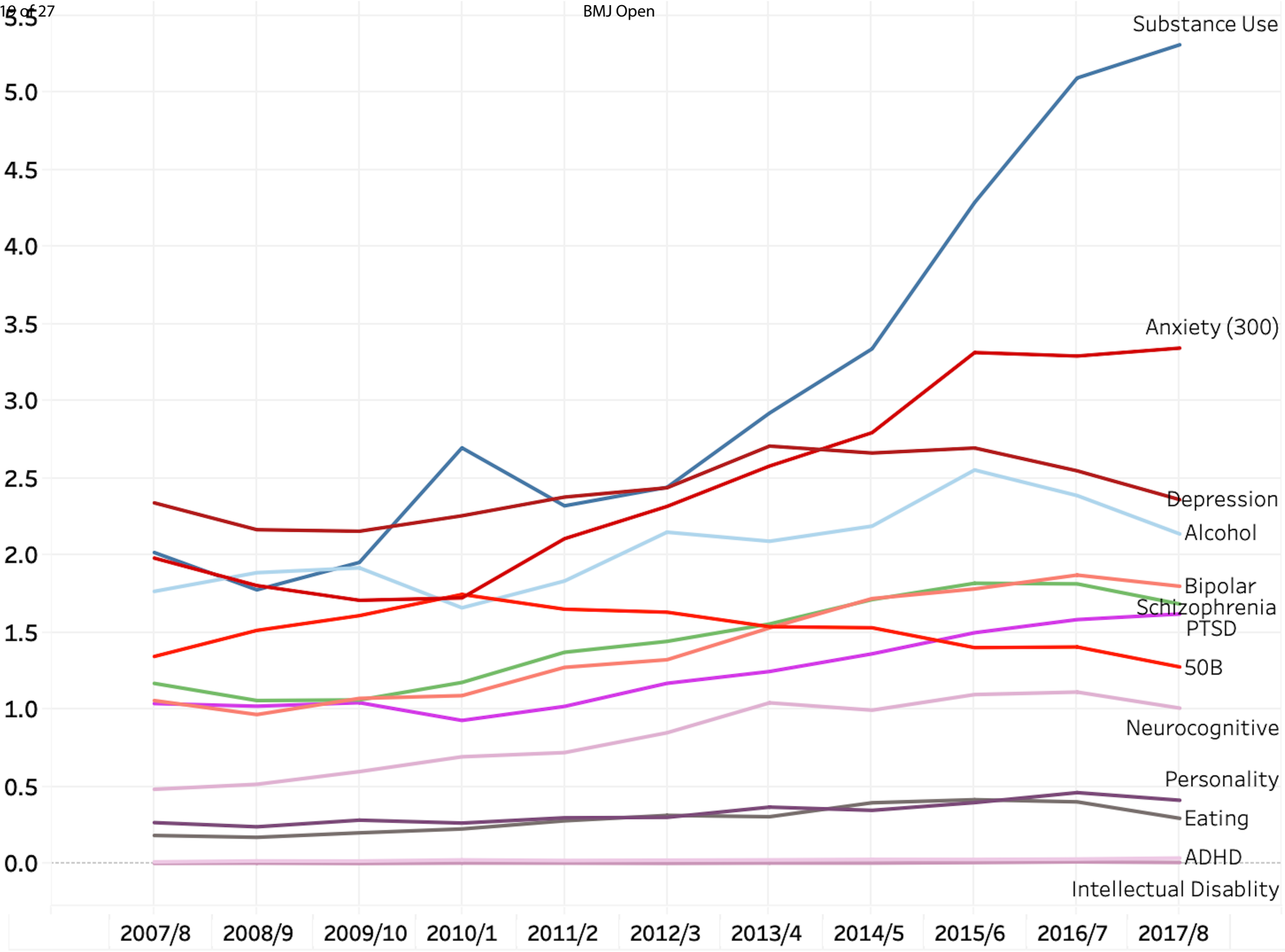|												
No Charlson-Deyo diagnoses	33,139	(69.2%)	32,239	(65.6%)	6,558	(64.2%)	5,084	(70.3%)	8,253	(42.2%)	85,273	(63.6%)
Service use before and after ED												
MSUD primary care visit within preceding 30 days	13,764	(28.7%)	13,387	(27.2%)	2,226	(21.8%)	1,695	(23.4%)	4,554	(23.3%)	35,626	(26.6%)
MSUD primary care visit on same day as ED visit	3,252	(6.8%)	2,890	(5.9%)	520	(5.1%)	384	(5.3%)	1,172	(6.0%)	8,218	(6.1%)
Hospital admission on same or next day	10,188	(21.3%)	6,428	(13.1%)	4,531	(44.3%)	1,474	(20.4%)	7,634	(39.0%)	30,255	(22.6%)
Involuntary admission on same or next day	6,464	(13.5%)	2,093	(4.3%)	3,767	(36.9%)	749	(10.4%)	3,239	(16.6%)	16,312	(12.2%)

15

Table 2. Individual characteristics by number of MSUD ED visits 2017/8. N(%) except where indicated.

	1 ED visit		2-5 ED visits		6-11 ED visits		12+ ED visits		All people	
Total	50,107	(69.2%)	19,353	(26.7%)	2,138	(3.0%)	765	(1.1%)	72,363	(100.0%)
Sex										
Female	24,958	(49.8%)	8,851	(45.7%)	834	(39.0%)	268	(35.0%)	34,911	(48.2%)
Male	25,149	(50.2%)	10,502	(54.3%)	1,304	(61.0%)	497	(65.0%)	37,450	(51.8%)
Age										
15_24	11,169	(22.3%)	4,326	(22.4%)	377	(17.6%)	105	(13.7%)	15,977	(22.1%)
25_44	16,625	(33.2%)	7,486	(38.7%)	981	(45.9%)	373	(48.8%)	25,465	(35.2%)
45_64	12,337	(24.6%)	5,073	(26.2%)	639	(29.9%)	253	(33.1%)	18,302	(25.3%)
65+	9,976	(19.9%)	2,468	(12.8%)	141	(6.6%)	34	(4.4%)	12,619	(17.4%)
Health Authority										
Interior	8,797	(17.6%)	2,884	(14.9%)	257	(12.0%)	198	(25.9%)	12,136	(16.8%)
Fraser	17,801	(35.5%)	7,706	(39.8%)	926	(43.3%)	266	(34.8%)	26,699	(36.9%)
Vancouver Coastal	10,005	(20.0%)	3,916	(20.2%)	481	(22.5%)	175	(22.9%)	14,577	(20.1%)
Vancouver Island	8,969	(17.9%)	3,245	(16.8%)	324	(15.2%)	88	(11.5%)	12,626	(17.4%)
Northern	4,409	(8.8%)	1,577	(8.1%)	147	(6.9%)	38	(5.0%)	6,171	(8.5%)
Missing	126	(0.3%)	25	(0.1%)		(0.0%)		(0.0%)	154	(0.2%)
Rurality										
Metropolitan	30,734	(61.3%)	12,286	(63.5%)	1,456	(68.1%)	587	(76.7%)	45,063	(62.3%)
Small urban	11,648	(23.2%)	4,385	(22.7%)	449	(21.0%)	110	(14.4%)	16,592	(22.9%)
Rural/remote	7,595	(15.2%)	2,655	(13.7%)	229	(10.7%)	68	(8.9%)	10,547	(14.6%)
Unknown	39	(0.1%)	7	(0.0%)		(0.0%)		(0.0%)	47	(0.1%)
Neighbourhood income quintile										
Q1 (lowest)	13,794	(27.5%)	6,158	(31.8%)	797	(37.3%)	306	(40.0%)	21,055	(29.1%)
Q2	10,377	(20.7%)	3,994	(20.6%)	449	(21.0%)	162	(21.2%)	14,982	(20.7%)
Q3	9,273	(18.5%)	3,403	(17.6%)	345	(16.1%)	111	(14.5%)	13,132	(18.1%)
Q4	8,610	(17.2%)	3,029	(15.7%)	282	(13.2%)	93	(12.2%)	12,014	(16.6%)
Q5 (highest)	7,088	(14.1%)	2,341	(12.1%)	202	(9.4%)	69	(9.0%)	9,700	(13.4%)
Missing	965	(1.9%)	428	(2.2%)	63	(2.9%)	24	(3.1%)	1,480	(2.0%)
Prescription drug plan (BC Pharmacare)										

16

Plan C (income assistance)	9,939	(19.8%)	7,012	(36.2%)	1,232	(57.6%)	494	(64.6%)	18,677	(25.8%)
Plan G (psychiatric medications))	4,234	(8.4%)	3,543	(18.3%)	476	(22.3%)	168	(22.0%)	8,421	(11.6%
Treated disorders										
Mood and anxiety	20,611	(41.1%)	12,804	(66.2%)	1,632	(76.3%)	493	(64.4%)	35,540	(49.1%)
Substance use	9,102	(18.2%)	9,423	(48.7%)	1,642	(76.8%)	680	(88.9%)	20,847	(28.8%)
Schizophrenia spectrum	3,159	(6.3%)	4,331	(22.4%)	899	(42.0%)	281	(36.7%)	8,670	(12.0%)
PTSD and adjustment	3,439	(6.9%)	3,177	(16.4%)	529	(24.7%)	219	(28.6%)	7,364	(10.2%)
Other	7,085	(14.1%)	4,427	(22.9%)	849	(39.7%)	304	(39.7%)	12,665	(17.5%)
Two or more treated disorders	10,058	(20.1%)	10,517	(54.3%)	1,755	(82.1%)	561	(73.3%)	22,891	(31.6%)
Physical comorbidities										
Charlson-Deyo weighted index (mean, SD)	0.9	± 1.8	0.8	± 1.7	0.9	± 1.7	1.0	± 1.8	0.9	± 1.8
No Charlson-Deyo diagnoses	32,815	(65.5%)	12,716	(65.7%)	1,261	(59.0%)	435	(56.9%)	47,227	(65.3%)
Outpatient service use (in 365 days preceding first ED visit in 2017/8)										
Primary care visits, excluding OAT (mean, SD)	8.2	±9.0	8.8	± 9.7	9.6	± 10.5	9.9	± 11.9	8.4	± 9.3
No primary care visits (N, %)	6,761	(13.5%)	2,588	(13.4%)	282	(13.2%)	107	(14.0%)	9,738	(13.5%)
MSUD primary care visits, excluding methadone (mean, SD)	1.8	± 3.5	2.8	± 4.3	3.7	± 5.3	4.1	± 6.1	2.1	± 3.9
No MSUD primary care visit (N, %)	26,511	(52.9%)	7,762	(40.1%)	660	(30.9%)	239	(31.2%)	35,172	(48.6%)
OAT visits (mean, SD)	1.1	± 7.2	1.8	± 8.8	2.5	± 10.2	3.5	± 11.8	1.4	± 7.9
No OAT visits (N, %)	48,370	(96.5%)	18,187	(94.0%)	1,943	(90.9%)	592	(77.4%)	69,092	(95.5%)
Continuity of care index (mean, SD)	0.43	± 0.38	0.41	± 0.37	0.36	± 0.35	0.36	± 0.35	0.42	± 0.38
Primary care management fee billed	3,400	(6.8%)	1,704	(8.8%)	204	(9.5%)	69	(9.0%)	5,377	(7.4%)
Outpatient psychiatrist visits (mean, SD)	1.1	± 4.4	2.2	± 6.1	3.8	± 8.5	3.5	± 9.2	1.5	± 5.2
No outpatient psychiatrist visit (N, %)	41,704	(83.2%)	13,345	(69.0%)	1,176	(55.0%)	477	(62.4%)	56,702	(78.4%)

*The categories "missing" and "male" were combined in this table so as not to disclose cell sizes with fewer than five individuals

17

Appendix 1. List of fee codes included in identification of ED visits using Medical Services Plan
Payment data

FEE ITEM	DESCRIPTION
1811	LEVEL I EMERGENCY CARE - DAY
1812	01812 LEVEL II EMERGENCY CARE - DAY
1813	01813 LEVEL III EMERGENCY CARE - DAY
1821	01821 LEVEL I EMERGENCY CARE - EVENING
1822	01822 LEVEL II EMERGENCY CARE - EVENING
1823	01823 LEVEL III EMERGENCY CARE - EVENING
1831	01831 LEVEL I EMERGENCY CARE - NIGHT
1832	01832 LEVEL II EMERGENCY CARE - NIGHT
1833	01833 LEVEL III EMERGENCY CARE - NIGHT
1841	01841 LEVEL I EMERGENCY CARE - SAT, SUN, OR STAT HOL
1842	01841 LEVEL I EMERGENCY CARE - SAT, SUN, OR STAT HOL
1843	01841 LEVEL I EMERGENCY CARE - SAT, SUN, OR STAT HOL
96801	96801 APB-LEVEL I EMERGENCY CARE DAY
96802	96802 APB - LEVEL 2 EMERGENCY CARE - DAY
96803	96803 APB - LEVEL 3 EMERGENCY CARE - DAY
96804	96804 APB- LEVEL 4 EMERGENCY CARE - DAY
96805	96805 APB - LEVEL 5 EMERGENCY CARE - DAY
96811	96811 APB-LEVEL I EMERGENCY CARE - EVENING
96812	96812 APB - LEVEL 2 EMERGENCY CARE - EVENING
96813	96813 APP - LEVEL 3 EMERGENCY CARE - EVENING
96814	96814 APB - LEVEL 4 EMERGENCY CARE - EVENING
96815	96815 APB - LEVEL 5 EMERGENCY CARE - EVENING
96821	96821 APB - LEVEL 1 EMERGENCY CARE - NIGHT
96822	96822 APB - LEVEL 2 EMERGENCY CARE - NIGHT
96823	96823 APB -LEVEL 3 EMERGENCY CARE - NIGHT
96824	96824 APB - LEVEL 4 EMERGENCY CARE - NIGHT
96825	96825 APB - LEVEL 5 EMERGENCY CARE - NIGHT
36347	36347 NP - VISIT, EMERGENCY (BETWEEN 0800 AND 1800 HRS)
36440	36440 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 50-59)
36441	36441 NP - EMERGENCY DEPARTMENT VISIT (AGE 50-59)
36447	36447 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 2-19)
36448	36448 NP - EMERGENCY DEPARTMENT VISIT (AGE 2-19)
36601	36601 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 0-1)
36602	36602 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 2-59)
36603	36603 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 60-69)
36604	36604 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 70-79)
36605	36605 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 80+)
36606	36606 NP - VISIT IN EMERGENCY DEPARTMENT (AGE 0-1)
36607	36607 NP - VISIT IN EMERGENCY DEPARTMENT (AGE 2-59)
36608	NP - VISIT IN EMERGENCY DEPARTMENT (AGE 60-69)

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| 36609 | NP - VISIT IN EMERGENCY DEPARTMENT (AGE 70-79) |
| 36610 | NP - VISIT IN EMERGENCY DEPARTMENT (AGE 80+) |

Appendix 2. Disorder groupings and associated diagnosis codes

	ICD-9 codes (MSP claims)	ICD-10 codes (Hospital Discharge Data)	NACRS Codes
Mood and anxiety			
Depressive disorders	311	F32, F33, F34.1	F329
Anxiety disorders	300	F40, F41	F419
Anxiety/depression (code unique to MSP)	50B		
Bipolar and related disorders	296	F30, F31, F34 (excluding F34.1), F38, F29	F319
Substance use			
Substance use	292, 304, 305	F11, F12, F13, F14, F15, F16, F17, F18, F19	F119, T401, F129, T407, F159, F149, 1405, F169, 1409, 1406, F180, F199, F139, T424, T439
Alcohol	291, 303	F10	F100, F103, T510
Schizophrenia spectrum	295, 297, 298	F20, F21, F22, F23, F24, F25, F28, F29	F209, F239
Post-traumatic stress and adjustment disorder	308, 309	F43	
Other mental disorders			
Neurocognitive	290, 293, 294	F01, F03, F04, F05, F06, F09	F03, F059
Personality disorders	301	F60, F61, F62	F489, F609
Eating	307.1, 307.5	F50	F509
ADHD	314	F90	
Intellectual disability	317, 318, 319	F71, F71, F72, F73, F78, F79	

The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found		RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included.	Page 1
				RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract.	Page 2
				RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Page 1-2
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported			Page 4
Objectives	3	State specific objectives, including any prespecified hypotheses			Page 4
Methods					
Study Design	4	Present key elements of study design early in the paper			Page 4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection			Page 5

Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case		RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	Page 5 Page 5 Page 4 (Reference: Data Linkage Process on Page 11)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.		RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Page 19, 20
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group			Page 4, 5

Bias	9	Describe any efforts to address potential sources of bias			N/A
Study size	10	Explain how the study size was arrived at			N/A
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why			Page 5, 6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses			Page 6
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population.	Page 4

				RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	Page 4 (Reference: Data Linkage Process, on Page 11)
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram		RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	Page 5, 6,
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)			Page 6, 7, 14–17
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure			Page 6

			category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures			
Main results	16		(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period			N/A
Other analyses	17		Report other analyses done— e.g., analyses of subgroups and interactions, and sensitivity analyses			N/A
Discussion						
Key results	18		Summarise key results with reference to study objectives			Page 7, 8
Limitations	19		Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Page 8
Interpretation	20		Give a cautious overall interpretation of results considering objectives,			Page 7, 8

		limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			
Generalisability	21	Discuss the generalisability (external validity) of the study results			N/A
Other Information					
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*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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Emergency department use for mental and substance use disorders: Descriptive analysis of population-based, linked administrative data in British Columbia, Canada

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Emergency department use for mental and substance use disorders: Descriptive analysis of population-based, linked administrative data in British Columbia, Canada

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1

Abstract

Objectives: Information on emergency department (ED) visits for mental and substance use disorders (MSUDs) is important for planning services but has not been explored in British Columbia (BC), Canada. We describe all MSUD ED visits for people ages 15 and older in the province of BC in 2017/8 and document trends in MSUD ED visits between 2007/8 and 2017/8 by disorder group.

Design: Population-based linked administrative data comprised of ED records and physician billings capturing all MSUD ED visits in BC.

Setting: BC is Canada's westernmost province with a population of approximately 5 million. Permanent residents receive first-dollar coverage for all medically necessary services provided by licensed physicians or in hospital, including emergency department services.

Population: All people age >15 with MSUD ED visits during the study period.

Measures: All claims with a service location in the ED or corresponding to fee items billed only in the ED were examined alongside ED visits reported through a national reporting system. Patient characteristics (sex/gender, age, location of residence, income, treated disorders, and comorbidities) and previous outpatient service use for all ED visits by visit diagnosis are also described.

Results: A total of 72,363 people made 134,063 visits to the ED in 2017/8 for needs related to MSUD. MSUD ED visits have increased since 2010, particularly visits for substance use and anxiety disorders. People with more frequent visits were more likely to be male, on public prescription drug plans for income assistance, prescribed psychiatric medications, and living in lower income neighbourhoods. They used more community-based primary care and psychiatry services and had lower continuity of primary care.

Conclusions: MSUD ED visits are substantial and growing in BC. Findings underscore a need to strengthen and target community healthcare services and to adequately resource and support emergency departments to manage growing patient populations.

Key words: mental disorders, substance use disorders, emergency services, emergency department visits, ambulatory care, administrative data

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Article Summary

Strengths and limitations of this study

- Mental and substance use disorder-related emergency department visits for people ages ≥15, patient characteristics, and changes in visit rates over time, are comprehensively described
- Emergency department visits related to mental health and substance use are increasing over time, which must guide service planning.
- Combining emergency department records and physician claims data now permits comprehensive analysis of ED visits.
- This study is preliminary and descriptive and cannot confirm causal drivers of ED visits.
- Only one diagnosis is consistently recorded in the data, even if concurrent disorders are managed during the visits.

Declarations

Conflicts of Interest: The authors have no relevant financial or non-financial interests to disclose. Drs. Ruth Lavergne receives salary support from a Tier II Canada Research Chair in Primary Care and Joseph Puyat receive salary support from a Michael Smith Foundation for Health Research Scholar Award.

3

Background

Accurately tracking emergency department (ED) visits related to mental and substance use disorders (MSUD) and understanding the characteristics of people with MSUD ED visits is important for service planning and improving healthcare systems. EDs provide highly accessible acute care [1,2] and in many cases act as an entry point for referral to other, community-based services [1]. However, unscheduled visits to care providers with little knowledge of the patient's history may limit effective patient management [1,2]. Thus, a detailed picture of who uses the ED for MSUD-related needs and an understanding of changing ED use over time is important to plan healthcare delivery.

Internationally, literature points to increasing ED visits across varied populations and contexts [3–8]. In the United States, ED visits by adults with MSUD increased by over 30% between 2006 and 2015, primarily due to alcohol use disorder, followed by mood and anxiety disorders [7]. These findings extend earlier observation of increasing trends between 1992 and 2001 [8]. Similarly in Australia, MSUD ED visits increased between 2004/5 and 2016/7, driven largely by psychoactive substance use, followed by anxiety and mood disorders [3]. In other settings findings differ in terms of what is driving ED use and/or the direction of changes in rates of ED use. Increases between 1988 and 2014 in Taiwan were driven by visits related to trauma and stressor-related disorders, depressive disorders, and suicide attempts [5]. In contrast, in Denmark, the number of MSUD ED visits decreased from 1985 to 2012 [6].

Where data are available, research in Canada appears to coincide with patterns observed in the US, with upward trends primarily reflecting increases in anxiety disorders and substance use disorders [9]. However, Canadian research is limited by the fact that only a subset of ED data is collected by the national reporting system, and comparable data has not been available over time in all provinces. While many studies have examined the characteristics of people with MSUD ED visits cross-sectionally or within specific hospitals or service delivery organizations [10–15] fewer have used population-based data and examined trends over time [9,16].

Given the variability in trends between jurisdictions within the published literature, there is value in additional localized studies. Currently, the characteristics of people visiting emergency departments for MSUD and trends in MSUD ED visits have not been examined in British Columbia (BC), Canada's westernmost province. This information gains added importance within the context of the overdose crisis which has disproportionately impacted BC [17,18]. Our research aims to address this gap, and for the first time ever: 1) comprehensively describe all MSUD ED visits for people ages 15 and older in the province of BC, 2) describe patient and service use characteristics by number of ED visits in 2017/8, and 3) explore changes in MSUD ED visit rates over time by disorder group (2007/8 to 2017/8).

Methods
Data

We used de-identified data holdings from the BC Ministry of Health linked and made accessible through Population Data BC [19]. Two data sources capture ED visits in BC: the National Ambulatory Care Reporting System (NACRS) [20] and BC's Medical Services Plan (MSP) payment information [21]. NACRS was developed by the Canadian Institute for Health Information to collect data on ED and other ambulatory visits. BC began reporting to NACRS in

4

2012 and only a subset of EDs are captured (30 of 108 BC hospitals providing ED care in 2017/8). MSP data captures fee-for-service payments made to physicians. All EDs not reporting to NACRS are captured within the MSP data; thus, we have complete data for the entire province.

We used patient registry data [22], as well as information from hospitalizations captured through the Discharge Abstract Database [23] to describe the demographic and clinical characteristics of people with MSUD ED visits. We obtained population estimates used as denominators to construct rates of ED visits from BC Statistics [24].

Study population

We examined all people ages 15+ with MSUD ED visits (diagnosis codes listed in Appendix 1) during the study period.

Setting

The province of BC had a population of approximately 5 million people in 2018 [25]. Five geographic health authorities (Fraser, Vancouver Coastal, Interior, Northern, and Island) are responsible for planning and delivering healthcare service. The provincial health insurance program (MSP) covers all permanent residents, except for a small percentage of the population covered under federal health insurance programs. BC residents insured under MSP receive first-dollar coverage for all medically necessary services provided by licensed physicians or in hospital, including emergency department services.

Measures

MSUD ED visits: We identified MSP claims with a service location in the ED or corresponding to fee items billed only in the ED (Appendix 1). We also extracted all ED visits to BC facilities recorded in NACRS data. To ensure visits were not double counted across sources or when multiple MSP claims were submitted for a single patient, we retained only one ED record per patient per day [26]. Where multiple records contained different diagnoses, we retained records for MSUD. Operational definitions for frequent MSUD ED visits vary [12,27]. We examined individual characteristics and outpatient service use based on the following groups for annual visits, ranging from one per year to one per month, on average: 1 ED visit, 2-5 ED visits, 6-11 ED visits, and 12+ ED visits.

Demographic characteristics: Age was obtained from BC's MSP registration file. Sex is collected at time of MSP registration. The field is labeled "Gender" on the registration form but only the binary options "M" and "F" are provided. It is not possible to distinguish sex at birth, legal sex, and gender based on this information, so we labelled this "sex/gender." Health Authority was determined based on patient residential address, not location of service use. Neighbourhood income quintile was determined based on census enumeration area of residence, assigned using the Postal Code Conversion File Plus (PCCF+) [28,29].

Clinical characteristics: We classified MSUD ED visits based on disorder groupings (Appendix 2). We also examined all other MSUD services in 2017/8. Patients with two outpatient visits or one hospitalization (within a 365-day period) for the disorders listed in Appendix 2 were considered to have been treated for the disorder [30]. We used this case definition as it has been validated by previous studies [31,32] and most closely aligned with

5

expected prevalence [30]. A minimum of two outpatient visits was used to be inclusive of physician consultation without ongoing care. The use of one outpatient visit overestimated the prevalence when compared to the expected prevalence for each disorder [30].

In BC, diagnostic codes for substance use disorders do not include the fifth digit, and thus it is difficult to differentiate between substances, with the exception of alcohol. We created a combined substance use disorders group (including alcohol use) within tables, but plot alcohol and other substance use separately over time in Figure 1.

The Charlson-Deyo Comorbidity Index categorizes diagnosis codes based on 17 weighted categories [33,34]. We presented both the Index's average weight and the percentage of people with no identified comorbidities based on both outpatient and inpatient service use.

Health services use: For all ED visits, we explored if people had an outpatient visit (service location office, home, or long-term care facility) with a primary care physician with an MSUD diagnosis code on the same day as the ED visit or in the preceding 30 days. We excluded visits for Opioid Agonist Treatment (OAT, fee codes 00039 and 15039). We also determined the percentage of ED visits that subsequently resulted in hospitalization. We identified involuntary hospitalizations under BC's Mental Health Act as those in which the patient was apprehended and admitted by police and/or if forms 4, 10, 20 or 21 were on the patient's record.

For all people seen in the ED, we examined outpatient service use in the 365 days preceding their first ED visit in 2017/8. We counted the number of primary care visits occurring in the previous year (total, for MSUD, and for OAT) and report the percentage of people with no visits. We calculated continuity of care over this period using the Continuity of Care Index (COCI). The COCI identifies the number of primary care physicians providing service to a patient and the percentage of care provided by each physician. The index ranges from 0 (all visits to different physicians/no visit) to 1 (all visits with one physician). In BC, primary care physicians can bill a $100 fee for people with Axis 1 conditions of sufficient severity to interfere with activities of daily living. The fee requires doctors to conduct a comprehensive review of the patient's history, assess the patient, and develop a treatment and management plan [35]. We examined the proportion of people with a primary care mental health planning fee billed on their behalf in the 365 days preceding the ED visit as a marker of active management in primary care. We also examined number of outpatient visits (excluding visits with a hospital, day surgery, or ED service location code) with a psychiatrist in the preceding year and the percentage of people with no psychiatrist visits.

Analysis

Our intention was to describe the volume of services within the system and the nature of the presenting population and so we chose to report both visit-level and patient-level information using data from 2017/18. We first describe patient characteristics associated with each ED visit, stratified by the MSUD diagnosis associated with the visit. We report numbers and percentages or means and standard deviations, as appropriate, and calculated the rate of ED visits per 1,000 population by health authority and income quintile.

Next, we describe the characteristics of people by number of ED visits in 2017/8. In this analysis the unit of analysis is the individual patient. We report numbers and percentages or means and standard deviations, as appropriate.

6

Finally, we present ED visits per 1,000 population from 2007/8 to 2017/8, stratified by disorders presenting to ED. Only visits captured in MSP data were considered in examining trends over time as NACRS data in BC were not available before 2012. We also note that BC fee-for-service data uses a code "50B" in addition to standard ICD9 codes for anxiety and depression. For this reason, it is not possible to distinguish mood and anxiety disorders in all cases. In plotting rates over time, we present this code separately for clarity.

Ethics approval

This study was approved by the University of British Columbia, Providence Health Care Research Institute, and Simon Fraser University research ethics boards (REB number H17-00506). All inferences, opinions and conclusions drawn in this article are those of the authors, and do not reflect the opinions or policies of the data stewards.

Patient and public involvement

Neither patients nor the public were involved in the design, conduct, reporting, or dissemination plans of this research.

Results

We observed 134,063 ED visits for MSUDs in 2017/8 across 72,363 people in BC. This means roughly 1.5% of British Columbians ages 15 and older (*n* = 4,118,960) used an emergency department for MSUD in 2017/8. In total, 35.7% of visits were for mood or anxiety disorders, 36.7% for substance use disorders, 7.6% for schizophrenia spectrum disorders, 5.4% for post-traumatic stress disorder (PTSD) and adjustment disorders, and 14.6% for other mental disorders (e.g., attention-deficit/hyperactivity disorder [ADHD], eating disorders, intellectual disability, neurocognitive disorder, and personality disorders) (Table 1). More than half of visits for substance use and schizophrenia were among people recorded as male (67.7% and 64.9%, respectively), and more than half of visits for mood or anxiety and for PTSD and adjustment disorders were among people recorded as female (55.9% and 53.8%, respectively). More visits for other mental disorders, which include organic neurocognitive disorders, were among people aged 65+ (39.2%).

Total visit rates were higher in the Northern and Interior Health Authorities (45.1 and 36.5 per 1,000 population), whereas Fraser and Vancouver Coastal Health Authorities saw higher visit rates for schizophrenia spectrum disorders (3.2 and 2.9 per 1,000 population) (Table 1). Pronounced gradients by neighbourhood income were observed across all disorders. Rates of MSUD ED visits for people living in low-income neighbourhoods were more than double rates for people living in high-income neighbourhoods (48.2 versus 19.1 per 1,000 population). Visits for people with substance use and schizophrenia spectrum disorders were especially high among people living in the lowest income neighbourhoods relative to the other disorders. The Charlson-Deyo index, a measure of physical comorbidities, was similar across all groups except other disorders, which also had an older age distribution.

We found that 26.6% of ED visits were preceded by a primary care visit for mental health or substance use within 30 days, and 6.1% of ED visits occurred on the same day as a separate primary care visit (Table 1). Across all disorders, approximately 22.6% of ED visits were followed by a hospital admission, of which more than half were involuntary admissions under

7

BC's Mental Health Act. The percentage of people hospitalized was highest for schizophrenia spectrum disorders and lowest for substance use disorders for both total and involuntary hospitalizations.

Rates of MSUD ED visits are increasing over time, and changes are largely driven by visits for substance use disorders, though visits for anxiety disorders also increased notably (Figure 1). The percentage of people who are recorded as male, who live in metropolitan areas and in the lowest income neighbourhoods, and who have drug coverage under public Pharmacare (a marker of low-income status) all evidenced an increasing number of ED visits in 2017/8 (Table 2). The percentage of people treated for each disorder group and two or more disorders also increased with number of ED visits. Among people with 12 or more ED visits, 88.9% had been treated for a substance use disorder. The Charlson-Deyo index of comorbidities was similar regardless of the number of ED visits. People with more ED visits also had higher mean outpatient primary care service use (all visits for MSUD and for OAT) but lower continuity of care with primary care providers (Table 2). People with more ED visits also had higher mean outpatient psychiatrist visits, though overall 78.4% of people with one or more ED visits and 62.4% of people with 12+ ED visits did not have an outpatient psychiatrist visit in the preceding year.

Discussion

As expected, based on international literature, rates of ED visits for MSUD are substantial and growing, with roughly 1.5% of British Columbians ages 15 and older visiting an emergency department for MSUD in 2017/8. The upward trend in ED visits largely reflects the impact of substance use and anxiety disorders as has been observed in other studies [3,7,9]. High rates of comorbidity between substance use and anxiety disorders within clinical and population samples are well established [36]. Symptoms of both substance use and substance use withdrawal can mimic anxiety symptoms [36,37] and may be treated as anxiety. Others have proposed psychological distress, which has been increasing, is being treated as anxiety [38]. Self-medication for anxiety disorders may also be driving ED visits for substance use disorders [39].

Pronounced income gradients reflect the association between socioeconomic status and mental illness but may also suggest that EDs play a particularly important role as an access point for people living with low incomes (as indicated by low-income neighbourhoods and receiving drug coverage under public Pharmacare). This is consistent with patterns observed in cross-provincial Canadian data [40] and elsewhere [2,10,41,42]. We also observed regional variations in ED use that is likely due to differences in healthcare infrastructure and service provision. Northern Health, the least populous and geographically the largest region, saw the highest rate for ED use per 1,000 population. Meanwhile, Vancouver Coastal, the region with the highest concentration of specialist services, had the lowest rate.

A recent report released by the BC Ministry of Mental Health and Addiction [43] echoed and renewed calls to action [44,45] to improve MSUD services in BC. Our results are not surprising but add to the urgency of strengthening systems for MSUD service delivery. We found people with more frequent ED visits have higher use of outpatient services, indicating that existing community-based services are not meeting people's healthcare needs. Roughly a quarter of people had a MSUD primary care visit within 30 days preceding their MSUD ED visit,

8

suggesting people are seeking out care in the community but are unable to access care that mitigates the need for ED services. The fact that people with more frequent visits had lower continuity of care may suggest gaps in coordination and integration of outpatient services, corroborating previous research [46–49]. This may also suggest primary care providers do not currently have the capacity to deliver care to help circumvent MSUD-related ED use. At the same time, well over half of people who visited the ED multiple times in the year did not have any outpatient psychiatrist visits in the year preceding their ED visit, reflecting ongoing issues accessing specialist care in the community [50]. Improved integration and collaboration between primary care and specialist MSUD services could potentially address this issue [51,52], but this has not been widely adopted in BC. Indeed, decreasing MSUD ED visits in Denmark coincided with the establishment of outpatient psychiatry clinics and specialist outreach teams [6]. Alongside more integrated and collaborative treatment models, service planning efforts should focus on expanding community-based specialist care, for example, through telepsychiatry including rapid access to virtual care [53,54]. Provision of telepsychiatry may also help reduce ED visits as observed in BC's more rural health regions by addressing regional inequities (i.e., access to specialist care) [53].

Strengths and Limitations

This study uses province-wide population-based data to, for the first time, comprehensively describe ED use for MSUDs. In the context of COVID-19, the ability to track MSUD service use, and highlight potential gaps, gains additional significance. Our methods may be useful to other researchers seeking to track changing patterns of ED service use. At the same time, it is preliminary and descriptive, and thus, subject to several important limitations. Trends in diagnoses over time are based on MSP data only. The subset of facilities where fee-for-service claims are not submitted may differ in disorders seen and possibly also in changes over time. Only one diagnosis is consistently recorded in fee-for-service and NACRS data, even if concurrent disorders are managed during the visits. This may lead to under-detection of substance use disorders in particular, as has been observed in validation studies [55]. People with certain mental disorders (e.g., schizophrenia) and substance use disorders are at high risk of experiencing violence [56,57] and may also seek out ED services accordingly. These visits are not likely to capture the underlying MSUD and thus will not be recorded in our data. Similarly, visits for self-injurious behaviours due to substance use [58] do not likely capture the underlying substance use disorder. We cannot confirm causal drivers of increasing rates of ED visits for substance use disorders and anxiety disorders.

Conclusion

The use of ED services for MSUD is substantial and growing in BC. While substance use disorders largely accounts for increasing rates over time, visits for anxiety disorders and other conditions are also increasing. Findings underscore the urgent need to strengthen and target community healthcare services for people who remain poorly served, and to adequately resource and support emergency departments to manage growing and changing patient populations.

Figure caption
Figure 1. Rates of emergency department visits for mental and substance use disorders over time by diagnosis assigned to visit (physician claims only).

10

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15

Table 1. Emergency department visits for mental and substance use disorders in British Columbia (2017/8) by individual characteristics and discharge diagnosis.

	Mood and Anxiety		Substance Use		Schizophrenia spectrum		PTSD and adjustment		Other Mental		Total	
Total Visits, n (%)	47,881	(35.7%)	49,164	(36.7%)	10,219	(7.6%)	7,236	(5.4%)	19,563	(14.6%)	134,063	(100.0%)
Sex												
Female	26,775	(55.9%)	15,865	(32.3%)	3,585	(35.1%)	3,896	(53.8%)	9,720	(49.7%)	59,841	(44.6%)
Male	21,106	(44.1%)	33,299	(67.7%)	6,634	(64.9%)	3,340	(46.2%)	9,838	(50.3%)	74,217	(55.4%)
Unknown	0		0		0		0		5		5	
Age												
15-24	12,430	(26.0%)	7,582	(15.4%)	1,526	(14.9%)	2,183	(30.2%)	3,019	(15.4%)	26,740	(19.9%)
25-44	17,740	(37.1%)	22,142	(45.0%)	4,899	(47.9%)	2,596	(35.9%)	5,076	(25.9%)	52,453	(39.1%)
45-64	11,922	(24.9%)	16,328	(33.2%)	3,069	(30.0%)	1,734	(24.0%)	3,790	(19.4%)	36,843	(27.5%)
65+	5,789	(12.1%)	3,112	(6.3%)	725	(7.1%)	723	(10.0%)	7,678	(39.2%)	18,027	(13.4%)
Health Authority (rate per 1,000 population)												
Interior	8,684	(13.3)	10,124	(15.5)	918	(1.4)	1,435	(2.2)	2,683	(4.1)	23,844	(36.5)
Fraser	18,948	(12.6)	16,812	(11.2)	4,759	(3.2)	2,665	(1.8)	7,518	(5.0)	50,702	(33.7)
Vancouver Coastal	7,479	(7.2)	11,252	(10.8)	3,019	(2.9)	997	(1.0)	4,740	(4.5)	27,487	(26.4)
Vancouver Island	8,412	(12.2)	7,219	(10.5)	1,045	(1.5)	1,275	(1.9)	3,613	(5.2)	21,564	(31.3)
Northern	4,315	(18.9)	3,638	(16.0)	457	(2.0)	862	(3.8)	989	(4.3)	10,261	(45.1)
Missing HA	43		119		21				20		205	
Income quintile (rate per 1,000 population)												
Q1 (lowest)	13,113	(14.7)	17,818	(20.0)	3,972	(4.5)	2,122	(2.4)	5,979	(6.7)	43,004	(48.2)
Q2	10,048	(13.2)	10,124	(13.3)	2,185	(2.9)	1,619	(2.1)	3,995	(5.2)	27,971	(36.7)
Q3	8,988	(11.3)	7,732	(9.8)	1,602	(2.0)	1,277	(1.6)	3,536	(4.5)	23,135	(29.2)
Q4	8,237	(10.0)	6,992	(8.5)	1,251	(1.5)	1,155	(1.4)	3,130	(3.8)	20,765	(25.1)
Q5 (highest)	6,786	(8.0)	4,944	(5.8)	985	(1.2)	907	(1.1)	2,539	(3.0)	16,161	(19.1)
Missing Income	709		1,554		224		156		384		3,027	
Comorbidities												
Charlson-Deyo weighted index (mean, SD)	0.7	± 1.5	0.8	± 1.7	0.7	± 1.5	0.7	± 1.5	1.7	± 2.4	0.9	± 1.8

16

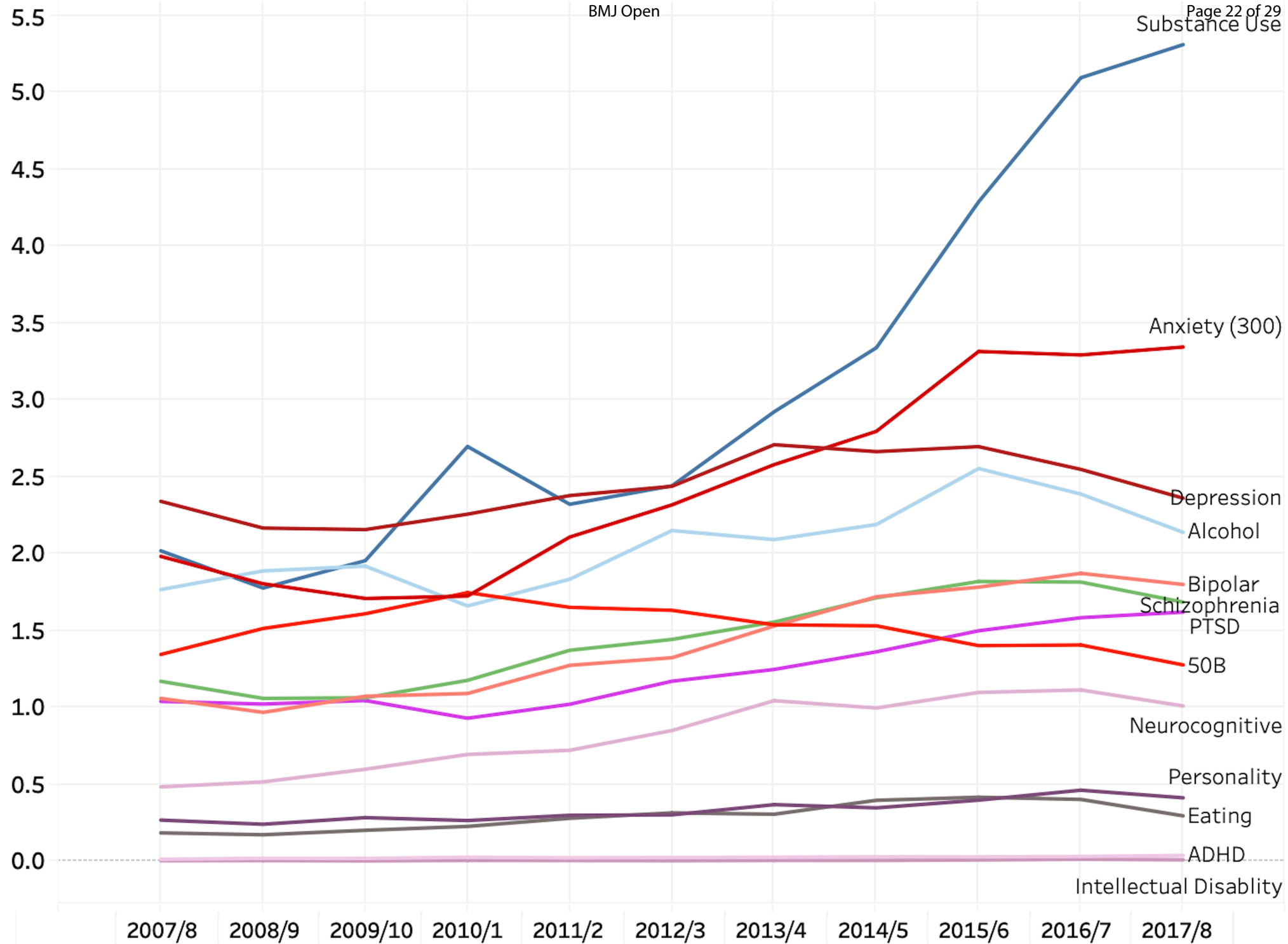|												
No Charlson-Deyo diagnoses	33,139	(69.2%)	32,239	(65.6%)	6,558	(64.2%)	5,084	(70.3%)	8,253	(42.2%)	85,273	(63.6%)
Service use before and after ED												
MSUD primary care visit within preceding 30 days	13,764	(28.7%)	13,387	(27.2%)	2,226	(21.8%)	1,695	(23.4%)	4,554	(23.3%)	35,626	(26.6%)
MSUD primary care visit on same day as ED visit	3,252	(6.8%)	2,890	(5.9%)	520	(5.1%)	384	(5.3%)	1,172	(6.0%)	8,218	(6.1%)
Hospital admission on same or next day	10,188	(21.3%)	6,428	(13.1%)	4,531	(44.3%)	1,474	(20.4%)	7,634	(39.0%)	30,255	(22.6%)
Involuntary admission on same or next day	6,464	(13.5%)	2,093	(4.3%)	3,767	(36.9%)	749	(10.4%)	3,239	(16.6%)	16,312	(12.2%)

17

Table 2. Individual characteristics and outpatient service use by number of MSUD ED visits 2017/8. N(%) except where indicated.

	1 ED visit		2-5 ED visits		6-11 ED visits		12+ ED visits		All people	
Total	50,107	(69.2%)	19,353	(26.7%)	2,138	(3.0%)	765	(1.1%)	72,363	(100.0%)
Sex										
Female	24,958	(49.8%)	8,851	(45.7%)	834	(39.0%)	268	(35.0%)	34,911	(48.2%)
Male	25,149	(50.2%)	10,502	(54.3%)	1,304	(61.0%)	497	(65.0%)	37,450	(51.8%)
Age										
15_24	11,169	(22.3%)	4,326	(22.4%)	377	(17.6%)	105	(13.7%)	15,977	(22.1%)
25_44	16,625	(33.2%)	7,486	(38.7%)	981	(45.9%)	373	(48.8%)	25,465	(35.2%)
45_64	12,337	(24.6%)	5,073	(26.2%)	639	(29.9%)	253	(33.1%)	18,302	(25.3%)
65+	9,976	(19.9%)	2,468	(12.8%)	141	(6.6%)	34	(4.4%)	12,619	(17.4%)
Health Authority										
Interior	8,797	(17.6%)	2,884	(14.9%)	257	(12.0%)	198	(25.9%)	12,136	(16.8%)
Fraser	17,801	(35.5%)	7,706	(39.8%)	926	(43.3%)	266	(34.8%)	26,699	(36.9%)
Vancouver Coastal	10,005	(20.0%)	3,916	(20.2%)	481	(22.5%)	175	(22.9%)	14,577	(20.1%)
Vancouver Island	8,969	(17.9%)	3,245	(16.8%)	324	(15.2%)	88	(11.5%)	12,626	(17.4%)
Northern	4,409	(8.8%)	1,577	(8.1%)	147	(6.9%)	38	(5.0%)	6,171	(8.5%)
Missing	126	(0.3%)	25	(0.1%)		(0.0%)		(0.0%)	154	(0.2%)
Rurality										
Metropolitan	30,734	(61.3%)	12,286	(63.5%)	1,456	(68.1%)	587	(76.7%)	45,063	(62.3%)
Small urban	11,648	(23.2%)	4,385	(22.7%)	449	(21.0%)	110	(14.4%)	16,592	(22.9%)
Rural/remote	7,595	(15.2%)	2,655	(13.7%)	229	(10.7%)	68	(8.9%)	10,547	(14.6%)
Unknown	39	(0.1%)	7	(0.0%)		(0.0%)		(0.0%)	47	(0.1%)
Neighbourhood income quintile										
Q1 (lowest)	13,794	(27.5%)	6,158	(31.8%)	797	(37.3%)	306	(40.0%)	21,055	(29.1%)
Q2	10,377	(20.7%)	3,994	(20.6%)	449	(21.0%)	162	(21.2%)	14,982	(20.7%)
Q3	9,273	(18.5%)	3,403	(17.6%)	345	(16.1%)	111	(14.5%)	13,132	(18.1%)
Q4	8,610	(17.2%)	3,029	(15.7%)	282	(13.2%)	93	(12.2%)	12,014	(16.6%)
Q5 (highest)	7,088	(14.1%)	2,341	(12.1%)	202	(9.4%)	69	(9.0%)	9,700	(13.4%)
Missing	965	(1.9%)	428	(2.2%)	63	(2.9%)	24	(3.1%)	1,480	(2.0%)
Prescription drug plan (BC Pharmacare)										

18

Plan C (income assistance)	9,939	(19.8%)	7,012	(36.2%)	1,232	(57.6%)	494	(64.6%)	18,677	(25.8%)
Plan G (psychiatric medications))	4,234	(8.4%)	3,543	(18.3%)	476	(22.3%)	168	(22.0%)	8,421	(11.6%)
Treated disorders										
Mood and anxiety	20,611	(41.1%)	12,804	(66.2%)	1,632	(76.3%)	493	(64.4%)	35,540	(49.1%)
Substance use	9,102	(18.2%)	9,423	(48.7%)	1,642	(76.8%)	680	(88.9%)	20,847	(28.8%)
Schizophrenia spectrum	3,159	(6.3%)	4,331	(22.4%)	899	(42.0%)	281	(36.7%)	8,670	(12.0%)
PTSD and adjustment	3,439	(6.9%)	3,177	(16.4%)	529	(24.7%)	219	(28.6%)	7,364	(10.2%)
Other	7,085	(14.1%)	4,427	(22.9%)	849	(39.7%)	304	(39.7%)	12,665	(17.5%)
Two or more treated MSUDs	10,058	(20.1%)	10,517	(54.3%)	1,755	(82.1%)	561	(73.3%)	22,891	(31.6%)
Physical comorbidities										
Charlson-Deyo weighted index (mean, SD)	0.9	± 1.8	0.8	± 1.7	0.9	± 1.7	1.0	± 1.8	0.9	± 1.8
No Charlson-Deyo diagnoses	32,815	(65.5%)	12,716	(65.7%)	1,261	(59.0%)	435	(56.9%)	47,227	(65.3%)
Outpatient service use (in 365 days preceding first ED visit in 2017/8)										
Primary care visits, excluding OAT (mean, SD)	8.2	±9.0	8.8	± 9.7	9.6	± 10.5	9.9	± 11.9	8.4	± 9.3
No primary care visits (N, %)	6,761	(13.5%)	2,588	(13.4%)	282	(13.2%)	107	(14.0%)	9,738	(13.5%)
MSUD primary care visits, excluding methadone (mean, SD)	1.8	± 3.5	2.8	± 4.3	3.7	± 5.3	4.1	± 6.1	2.1	± 3.9
No MSUD primary care visit (N, %)	26,511	(52.9%)	7,762	(40.1%)	660	(30.9%)	239	(31.2%)	35,172	(48.6%)
OAT visits (mean, SD)	1.1	± 7.2	1.8	± 8.8	2.5	± 10.2	3.5	± 11.8	1.4	± 7.9
No OAT visits (N, %)	48,370	(96.5%)	18,187	(94.0%)	1,943	(90.9%)	592	(77.4%)	69,092	(95.5%)
Continuity of care index (mean, SD)	0.43	± 0.38	0.41	± 0.37	0.36	± 0.35	0.36	± 0.35	0.42	± 0.38
Primary care management fee billed	3,400	(6.8%)	1,704	(8.8%)	204	(9.5%)	69	(9.0%)	5,377	(7.4%)
Outpatient psychiatrist visits (mean, SD)	1.1	± 4.4	2.2	± 6.1	3.8	± 8.5	3.5	± 9.2	1.5	± 5.2
No outpatient psychiatrist visit (N, %)	41,704	(83.2%)	13,345	(69.0%)	1,176	(55.0%)	477	(62.4%)	56,702	(78.4%)

*The categories "missing" and "male" were combined in this table so as not to disclose cell sizes with fewer than five individuals

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Appendix 1. List of fee codes included in identification of ED visits using Medical Services Plan Payment data

FEE ITEM	DESCRIPTION
1811	LEVEL I EMERGENCY CARE - DAY
1812	01812 LEVEL II EMERGENCY CARE - DAY
1813	01813 LEVEL III EMERGENCY CARE - DAY
1821	01821 LEVEL I EMERGENCY CARE - EVENING
1822	01822 LEVEL II EMERGENCY CARE - EVENING
1823	01823 LEVEL III EMERGENCY CARE - EVENING
1831	01831 LEVEL I EMERGENCY CARE - NIGHT
1832	01832 LEVEL II EMERGENCY CARE - NIGHT
1833	01833 LEVEL III EMERGENCY CARE - NIGHT
1841	01841 LEVEL I EMERGENCY CARE - SAT, SUN, OR STAT HOL
1842	01841 LEVEL I EMERGENCY CARE - SAT, SUN, OR STAT HOL
1843	01841 LEVEL I EMERGENCY CARE - SAT, SUN, OR STAT HOL
96801	96801 APB-LEVEL I EMERGENCY CARE DAY
96802	96802 APB - LEVEL 2 EMERGENCY CARE - DAY
96803	96803 APB - LEVEL 3 EMERGENCY CARE - DAY
96804	96804 APB- LEVEL 4 EMERGENCY CARE - DAY
96805	96805 APB - LEVEL 5 EMERGENCY CARE - DAY
96811	96811 APB-LEVEL I EMERGENCY CARE - EVENING
96812	96812 APB - LEVEL 2 EMERGENCY CARE - EVENING
96813	96813 APP - LEVEL 3 EMERGENCY CARE - EVENING
96814	96814 APB - LEVEL 4 EMERGENCY CARE - EVENING
96815	96815 APB - LEVEL 5 EMERGENCY CARE - EVENING
96821	96821 APB - LEVEL 1 EMERGENCY CARE - NIGHT
96822	96822 APB - LEVEL 2 EMERGENCY CARE - NIGHT
96823	96823 APB -LEVEL 3 EMERGENCY CARE - NIGHT
96824	96824 APB - LEVEL 4 EMERGENCY CARE - NIGHT
96825	96825 APB - LEVEL 5 EMERGENCY CARE - NIGHT
36347	36347 NP - VISIT, EMERGENCY (BETWEEN 0800 AND 1800 HRS)
36440	36440 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 50-59)
36441	36441 NP - EMERGENCY DEPARTMENT VISIT (AGE 50-59)
36447	36447 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 2-19)
36448	36448 NP - EMERGENCY DEPARTMENT VISIT (AGE 2-19)
36601	36601 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 0-1)
36602	36602 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 2-59)
36603	36603 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 60-69)
36604	36604 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 70-79)
36605	36605 NP - SIMPLE/FASTRACK VISIT IN EMERGENCY (AGE 80+)
36606	36606 NP - VISIT IN EMERGENCY DEPARTMENT (AGE 0-1)
36607	36607 NP - VISIT IN EMERGENCY DEPARTMENT (AGE 2-59)
36608	NP - VISIT IN EMERGENCY DEPARTMENT (AGE 60-69)

36609   NP - VISIT IN EMERGENCY DEPARTMENT (AGE 70-79)

36610   NP - VISIT IN EMERGENCY DEPARTMENT (AGE 80+)

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Appendix 2. Disorder groupings and associated diagnosis codes

	ICD-9 codes (MSP claims)	ICD-10 codes (Hospital Discharge Data)	NACRS Codes
Mood and anxiety			
Depressive disorders	311	F32, F33, F34.1	F329
Anxiety disorders	300	F40, F41	F419
Anxiety/depression (code unique to MSP)	50B		
Bipolar and related disorders	296	F30, F31, F34 (excluding F34.1), F38, F29	F319
Substance use			
Substance use	292, 304, 305	F11, F12, F13, F14, F15, F16, F17, F18, F19	F119, T401, F129, T407, F159, F149, 1405, F169, 1409, 1406, F180, F199, F139, T424, T439
Alcohol	291, 303	F10	F100, F103, T510
Schizophrenia spectrum	295, 297, 298	F20, F21, F22, F23, F24, F25, F28, F29	F209, F239
Post-traumatic stress and adjustment disorder	308, 309	F43	
Other mental disorders			
Neurocognitive	290, 293, 294	F01, F03, F04, F05, F06, F09	F03, F059
Personality disorders	301	F60, F61, F62	F489, F609
Eating	307.1, 307.5	F50	F509
ADHD	314	F90	
Intellectual disability	317, 318, 319	F71, F71, F72, F73, F78, F79	

The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found		RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included.	Page 1
				RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract.	Page 2
				RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Page 1-2
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported			Page 4
Objectives	3	State specific objectives, including any prespecified hypotheses			Page 4
Methods					
Study Design	4	Present key elements of study design early in the paper			Page 4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection			Page 5

Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed *Case-control study* - For matched studies, give matching criteria and the number of controls per case		RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number of individuals with linked data at each stage.	Page 5 Page 5 Page 4 (Reference: Data Linkage Process on Page 11)
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.		RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Page 19, 20
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group			Page 4, 5

Bias	9	Describe any efforts to address potential sources of bias			N/A
Study size	10	Explain how the study size was arrived at			N/A
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why			Page 5, 6
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions (c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses			Page 6
Data access and cleaning methods		..		RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population.	Page 4

				RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	Page 4 (Reference: Data Linkage Process, on Page 11)
Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram		RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	Page 5, 6,
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)			Page 6, 7, 14–17
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure			Page 6

			category, or summary measures of exposure *Cross-sectional study* - Report numbers of outcome events or summary measures		
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period			N/A
Other analyses	17	Report other analyses done— e.g., analyses of subgroups and interactions, and sensitivity analyses			N/A
Discussion					
Key results	18	Summarise key results with reference to study objectives			Page 7, 8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias		RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over time, as they pertain to the study being reported.	Page 8
Interpretation	20	Give a cautious overall interpretation of results considering objectives,			Page 7, 8

		limitations, multiplicity of analyses, results from similar studies, and other relevant evidence			
Generalisability	21	Discuss the generalisability (external validity) of the study results			N/A
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based			Page 3
Accessibility of protocol, raw data, and programming code		..		RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	Page 9

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

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