Social Psychiatry and Psychiatric Epidemiology (2023) 58:153–162
https://doi.org/10.1007/s00127-022-02366-z

ORIGINAL PAPER

Using novel methodology to estimate the prevalence of mental disorders in British Columbia, Canada

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Received: 24 February 2022 / Accepted: 2 September 2022 / Published online: 16 September 2022

Abstract

Purpose A needs-based model of health systems planning uses a systematic estimate of service needs for a given population. Our objective was to derive annual prevalence estimates of specific mental disorders in the adult population of British Columbia, Canada and use a novel triangulation approach encompassing multiple data sources and stratifying these estimates by age, sex, and severity to inform Ministry partners, who commissioned this work.

Methods We performed systematic literature reviews and subsequent meta-analyses to derive an annual prevalence estimate for each mental disorder. We then generated age- and sex-specific estimates by triangulating published epidemiological studies, routinely collected province-wide health administrative data, and nationally representative health survey data sources. The age- and sex-specific estimates were further stratified by severity using the Global Burden of Disease severity distributions and published literature.

Results Anxiety disorders had the highest annual prevalence estimates (6.93%), followed by depressive disorders (6.42%). All other mental disorders had an annual prevalence of less than 1%. Prevalence estimates were consistently higher in younger age groups. Depressive disorders, anxiety disorders, and eating disorders were higher in women, while estimates for bipolar disorders, schizophrenia, and ADHD were slightly higher in men in younger age groups.

Conclusion We generated robust annual prevalence estimates stratified by age, sex, and severity using a triangulation approach. Variation by age, sex, and severity implies that these factors need to be considered when planning for mental health services. Our approach is replicable and can be used as a model for needs-based planning in other jurisdictions.

Keywords Mental disorders · Prevalence · Service planning · Age · Sex

Introduction

In Canada, one in five people are affected by a mental illness [1]. British Columbia (BC) has the highest hospitalization rate due to mental illness and substance use in Canada [2], which indicates gaps in preventative measures and treatment at the community level. The burden of mental illness costs the BC economy approximately 6.6$ billion annually [2].

One of the main barriers to providing mental health care in BC is that the service need exceeds capacity [2], leading to longer wait times that may result in higher attrition, hospitalization, and decompensation [3]. Moreover, wait times for mental health services are disproportionately distributed in the population, with longer wait times for youth and women [4, 5], impacting treatment engagement [6]. Additionally, access to a psychiatrist is often limited and prioritized to individuals with severe and complex mental illness (i.e., bipolar disorders and schizophrenia) with the expectation that less complex common mental illnesses (i.e., anxiety and depressive disorders) can be treated by family physicians [7, 8].

In 2010, the BC Ministry of Health and Ministry of Children and Family Development initiated a 10-year

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action plan to improve the quality and accessibility of mental health and substance use services and subsequently reduce the economic cost in both public and private sectors [2]. However, health resources' planning remains a complex and challenging task [9] and requires sound evidence of service demand based on estimates of how many people are affected in a given region. A needs-based planning model of service planning uses an empirical assessment of an entire population's illness burden to anticipate service needs and plans for health services organization and delivery accordingly [10]. Such a needs-based model has been successfully used to estimate treatment needs by types of services and level of severity [11] and to project future service capacity and health outcomes [12]. As service delivery and treatment needs vary by mental disorders, severity, and demographic characteristics, it is fundamental to have good estimates of how many people are affected by each mental disorder and its distribution by age, sex, and severity. Capturing these variations in the population is a crucial step in the efforts to optimize service provision.

This paper is one of three in a series estimating the annual prevalence of mental and substance use disorders in adults (15 years and older) in BC as the first step in needs-based planning, a work commissioned by the government. As part of this series, a methodological paper details the analytic approaches used to derive the results presented herein [13]. In this paper, we derived annual prevalence estimates for seven mental disorders as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5)—depressive disorders, anxiety disorders, bipolar disorders, eating disorders (i.e., anorexia nervosa and bulimia nervosa (AN/BN)), intellectual disabilities, schizophrenia spectrum disorders, and attention-deficit/hyperactivity disorder (ADHD)—for adults aged 15 years and older in BC. Using a novel triangulation approach, we combined data sources and stratified age, sex, and severity estimates for each disorder. Currently, there is no single source of data that can provide the overall prevalence, age, sex, and severity estimates needed for service planning. While epidemiological studies provide true overall prevalence estimates of disorders, administrative data and survey data provide more granular data on age and sex and utilization patterns within the local context that create a more robust assessment of service needs. As each data source has strengths and weaknesses, the triangulation of multiple data sources partially compensates for a single source's limitation, thereby strengthening the estimates. Our approach is replicable, adaptable to jurisdictions with similar data sources, and can provide timely and evidence-based estimates. Service planners and policymakers can use our model to derive estimates in their own jurisdictions as a first step to improving mental health services for their population.

Methods

Estimating annual prevalence of mental disorders

We conducted a systematic literature review of peer-reviewed population-level epidemiological studies for each of the seven mental disorders included in our study. Due to the scarcity of BC-specific data, we extended our searches to include all of Canada and international settings deemed comparable due to cultural, social, and economic similarities (i.e., United States, Western Europe, New Zealand, and Australia). The inclusion of select countries was grounded on previously published literature and meta-analysis studies on mental disorders due to their cultural similarities and comparable prevalence [14–16]. While we preferred to only use Canadian estimates, we included international estimates when there were insufficient Canadian studies for each disorder. To ensure that the international estimates were comparable, we vetted each study through a quality assessment before including them. When sufficient estimates were available by region, meta-analysis was stratified by region and estimates were compared using a forest plot**.** We excluded international estimates that were statistically significantly different from Canadian estimates**.** Details of the inclusion criteria and the quality assessment are provided in the methods' paper [13], and the list of included publications and associated study characteristics are listed in the supplemental report Tables S1-S7. The estimates of specific mental disorders from all included studies were combined for each disorder using a random-effects meta-analysis model. As most published studies were conducted before the DSM-5 release in 2013, the annual prevalence estimates for each disorder were primarily based on DSM-IV-TR (Text Revision), DSM-IV, DSM-III-R (Revised), or DSM-III. Some annual prevalence estimates were based on ICD-10, Diagnostic Interview Schedule Version III, and self-report measures (see Table S1-S7). Finally, we estimated the total number of individuals (aged 15 and older) in BC with each mental disorder using the 2016 provincial population estimates.

Estimating age- and sex-specific prevalence of mental disorders

We estimated age- and sex-specific annual prevalence for each mental disorder using methodological triangulation of multiple data sources. These sources included national population-level survey data from the Canadian Community Health Survey (CCHS) 2012 Mental Health Supplement, demographic data from the Canadian Socio-Economic

Information Management System, and health utilization data from BC's provincial health services administrative data. Data sources used for each disorder depended on availability. BC's administrative data provided the age and sex distribution of each disorder of interest across all age groups. Additionally, administrative data provide up-to-date population-level service utilization patterns as it covers all BC residents covered by provincial health insurance as this form of data is continually collected. While the administrative data only capture individuals who received services for mental health, population-level survey data present estimates for different mental disorders in a representative sample of the Canadian population, including estimates of people who did seek care. However, surveys can be subject to participation bias and may not capture individuals who are institutionalized or unable to partake in the survey. The triangulation of estimates from multiple sources compensated, to some degree, for the limitation of each source. Another advantage of triangulating multiple data sources is that it generated comprehensive age- and sex-specific estimates that reflected the whole population, considering that each data source could capture different populations. Details of data sources used for each disorder are presented in supplemental Table S8. Details of the case definition used to classify disorders in the administrative data are presented in the supplemental report. We used the combined median from all available data sources to derive age- and sex-stratified prevalence for each disorder. When only age-specific estimates were provided, we used the male:female ratio reported within the corresponding data source to stratify the age- and sex-specific prevalence. Finally, we smoothed the age- and sex-stratified prevalence distribution curve for each disorder using the R function Locally Weighted Least Squares Regression [17]. Tables S9-S15 in the supplement presents the unadjusted age- and sex-stratified prevalence from each data source and the unadjusted smoothed overall prevalence.

Adjustment of age- and sex-specific prevalence of mental disorders

To calculate the expected number of cases by age and sex for each disorder in the BC adult population, we first multiplied our age- and sex-stratified prevalence with age and sex population estimates for BC adults (15 years and older) in 2016, provided by the Population Extrapolation for Organizational Planning with Less Error [18]. To control for over- or underestimations, wee compared the total number of cases from each age- and sex-stratified distribution curve with the total number of cases expected with the annual prevalence derived through our meta-analysis. We adjusted each age- and sex-stratified distribution curve uniformly, either upwards or downwards, until the difference in the number of expected cases between the two measures was below 0.1%.

Estimating prevalence of mental disorders by severity

We used fractional severity, or health state estimates, provided by the Global Burden of Disease (GBD) study. The GBD severity fractions categorize symptom severity over a 12-month period using a standardized methodology across all disorders. The GBD severity fractions also include asymptomatic proportions which represent individuals who received a diagnosis within the past 12 months, but were not showing symptoms at a given point in time. It is essential to consider the asymptomatic proportion in service planning as these individuals still require prevention services and ongoing maintenance treatment. The majority of these severity fractions consisted of severe, moderate, mild, or asymptomatic designations. We used alternative approaches to stratify some of the disorders, as the GBD study did not include their severity fractions. As the GBD study did not include severity fractions for depressive disorders or schizophrenia spectrum disorders as a disorder group, fractions for major depressive disorder and schizophrenia were used, respectively. We established severity estimates for AN/BN by averaging the severity fractions found in the literature and adjusted the severity estimates by the expected AN:BN ratio. For intellectual disabilities, we used the one study [19] from our review that provided severity estimates for this disorder group. While some severity estimates for ADHD were found in the published literature, all were excluded as they either did not include an asymptomatic fraction or used a binary disability outcome. As such, we averaged the mild, moderate, and severe severity fractions from all mental and substance use disorders included in the GBD study to generate severity estimates for ADHD. Finally, we multiplied each age- and sex-specific prevalence by the corresponding severity estimates to stratify age- and sex-specific prevalence by severity level for each disorder.

Results

We derived estimates from multiple data sources with varying quality of evidence. First, the overall prevalence derived from the meta-analysis of epidemiological studies provided the highest quality of evidence. This was followed by age- and sex-specific estimates as they were derived from two to three sources (administrative data, survey, and epidemiological data). Finally, the severity estimates were the most limited as they were derived from a single data source (either GBD or epidemiological studies). The annual prevalence estimates for the seven mental disorders for the BC adult population (15 years and older) for 2016 are presented in Table 1 and stratified by age and sex in Fig. 1 and Table 2. Estimated number of cases by age and sex for each disorder

Table 1 Estimated annual prevalence and number of cases of mental disorder groups in BC, for 2016

Mental disorder group	Annual prevalence [estimate, CI]	Estimated cases in BC [estimate, CI]
Depressive disorders	6.4% [5.2%–7.7%]	259, 375 [210,742–312, 061]
Anxiety disorders	6.9% [3.5%–11.4%]	279, 639 [141,846–462,012]
Bipolar I and II disorders	0.93% [0.60%–1.33%]	37,690 [24,316–53,901]
Anorexia nervosa and bulimia nervosa	0.33% [0.22%–0.46%]	13,3740 [8,916–18,642]
Intellectual disabilities	0.60% [0.42%–0.81%]	24,316 [17, 21–32, 827]
Schizophrenia spectrum disorders	0.55% [0.38%–0.74%]	22,290 [15,400–29,990]
Attention-deficit/hyperactivity disorder	0.36% [0.30%–0.43%]	145,898 [121,582–174,268]

are presented in Table 3. Estimates stratified by age, sex, and severity are presented in supplemental Tables S16-S29.

Depressive disorders

We found six studies that met our inclusion criteria and provided an aggregate estimate for depressive disorders. Of these, five studies provided estimates based on the DSM-IV criteria, and one study used ICD-10. Table S1 provides details on these six studies. Using estimates from all six studies, the meta-analysis derived an annual prevalence of 6.4% (5.2%-7.7%), representing 259,375 (210,742–312,061) individuals in BC in 2016 aged 15 and older with a depressive disorder. Figure S1 presents the forest plot for this analysis.

Stratified estimates of depressive disorders by age and sex are presented in Table 2. The estimated prevalence for both men and women followed a similar pattern across age groups, with a higher prevalence overall in women. Prevalence estimates were highest among youth and young adults and gradually declined during middle age before increasing in the oldest age groups. The highest prevalence was 6.3% for men aged 1524 years and 9.9% for women aged 1519 years. Tables S16 and S17 show the estimated number of individuals with varying severities of depressive disorders in BC in 2016. The GBD estimates suggest that the majority of individuals (59%) with depressive disorders have a mild illness, followed by moderate (17%), asymptomatic (13%), and severe (10%) illness.

Anxiety disorders

While ten studies met our inclusion criteria and provided annual prevalence estimates for anxiety disorders, we present results from four studies that provided Canadian annual estimates. Two of these studies provided estimates using DSM-III-Revised criteria, one provided an estimate using DSM-III, and one provided an estimate using the World Mental Health-Composite International Diagnostic Interview. Details on these four studies are summarized in Table S2. The estimated annual prevalence of anxiety disorders was 6.9% (3.5%-11.4%), representing 279,639 (141,846–462,012) individuals in BC in 2016 aged 15 and older. The forest plot for this analysis is shown in Figure S2.

The annual prevalence estimates stratified by age and sex are presented in Table 2. The prevalence was higher for women than men across all age groups. The highest prevalence among men was 6.2% for those aged 45 to 54 years, and highest prevalence for women was for those aged 40 to 44 years at 9.2%. The GBD severity fractions were as follows: severe (11%), moderate (19%), mild (50%), and asymptomatic (20%). Tables S18 and S19 show the number of individuals with each severity level of the disorder.

Bipolar disorders

Six studies met our inclusion criteria and provided an aggregated estimate of bipolar I and bipolar II disorders. No estimates were provided for other related disorders within the spectrum. All six studies, listed in Table S3, provided estimates based on the DSM-IV criteria. The annual prevalence based on these studies was 0.93% (0.60%-1.33%). These estimates equate to 37,690 (24,316–53,901) individuals aged 15 and older in BC in 2016 with a bipolar disorder. Figure S3 shows the forest plot of this meta-analysis.

The age- and sex-specific prevalence patterns were similar for both men and women (Table 2). Prevalence estimates were highest in the younger age groups and gradually declined with age. The highest prevalence was 1.4% for men aged 15–39 years and 1.6% for women aged 15 to 19. GBD severity fractions were represented by depressive, manic, and residual states. The residual state for bipolar disorders was defined as “mild mood swings, irritability, and some difficulty with daily activities” [20]. Half of individuals with a bipolar disorder fell within the residual health state, 27% experienced a depressive health state, and 23% experienced a manic or hypomanic health state within a year. Table S20 and S21 present the number of individuals in BC with each health state.

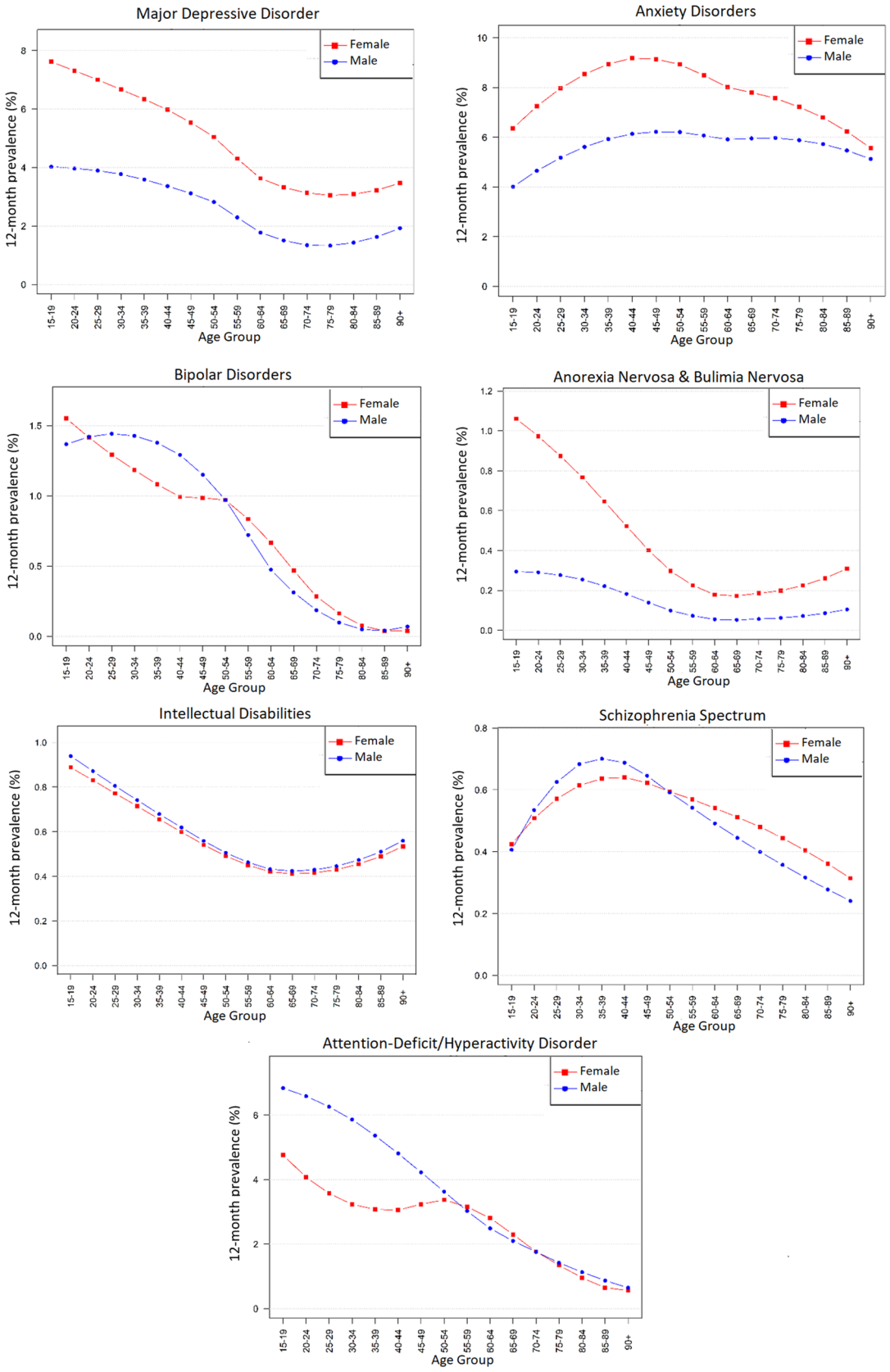

Fig. 1 Estimated 12 month prevalence of each mental disorder in BC by age and sex, for 2016

Table 2 Estimated annual prevalence of mental disorders in BC, by sex and age, for 2016

	Depressive disorder			Anxiety disorders			Bipolar I and II disorders			Anorexia nervosa and bulimia nervosa			Intellectual disabilities			Schizophrenia spectrum disorders			Attention-deficit/hyperactivity disorder		
Age	M[a]	F[b]	T[c]	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T	M	F	T
15–19	6.3	9.9	8.0	4.0	6.4	5.2	1.4	1.6	1.5	0.3	1.1	0.7	0.9	0.9	0.9	0.4	0.4	0.4	6.8	4.8	5.8
20–24	6.3	9.6	7.9	4.6	7.2	5.9	1.4	1.4	1.4	0.3	1.0	0.6	0.9	0.8	0.9	0.5	0.5	0.5	6.6	4.1	5.4
25–29	6.2	9.3	7.7	5.2	8.0	6.6	1.4	1.3	1.4	0.3	0.9	0.6	0.8	0.8	0.8	0.6	0.6	0.6	6.2	3.6	4.9
30–34	6.1	9.0	7.6	5.6	8.5	7.1	1.4	1.2	1.3	0.3	0.8	0.5	0.7	0.7	0.7	0.7	0.6	0.7	5.8	3.2	4.5
35–39	5.9	8.6	7.3	5.9	8.9	7.4	1.4	1.1	1.2	0.2	0.6	0.4	0.7	0.7	0.7	0.7	0.6	0.7	5.3	3.1	4.2
40–44	5.7	8.3	7.0	6.1	9.2	7.7	1.3	1.0	1.1	0.2	0.5	0.4	0.6	0.6	0.6	0.7	0.6	0.7	4.8	3.0	3.9
45–49	5.4	7.8	6.6	6.2	9.1	7.7	1.2	1.0	1.1	0.1	0.4	0.3	0.6	0.5	0.6	0.6	0.6	0.6	4.2	3.2	3.7
50–54	5.1	7.3	6.2	6.2	8.9	7.6	1.0	1.0	1.0	0.1	0.3	0.2	0.5	0.5	0.5	0.6	0.6	0.6	3.6	3.4	3.5
55–59	4.6	6.6	5.6	6.1	8.5	7.3	0.7	0.8	0.8	0.1	0.2	0.2	0.5	0.5	0.5	0.5	0.6	0.6	3.0	3.2	3.1
60–64	4.1	5.9	5.0	5.9	8.0	7.0	0.5	0.7	0.6	0.1	0.2	0.1	0.4	0.4	0.4	0.5	0.5	0.5	2.5	2.8	2.6
65–69	3.8	5.6	4.7	6.0	7.8	6.9	0.3	0.5	0.4	0.1	0.2	0.1	0.4	0.4	0.4	0.4	0.5	0.5	2.1	2.3	2.2
70–74	3.6	5.4	4.5	6.0	7.6	6.8	0.2	0.3	0.2	0.1	0.2	0.1	0.4	0.4	0.4	0.4	0.5	0.4	1.8	1.8	1.8
75–79	3.6	5.3	4.5	5.9	7.2	6.6	0.1	0.2	0.1	0.1	0.2	0.1	0.4	0.4	0.4	0.4	0.4	0.4	1.5	1.4	1.4
80–84	3.7	5.4	4.6	5.7	6.8	6.3	0.0	0.1	0.1	0.1	0.2	0.2	0.5	0.5	0.5	0.3	0.4	0.4	1.2	1.0	1.1
85–89	3.9	5.5	4.8	5.5	6.2	5.9	0.0	0.0	0.0	0.1	0.3	0.2	0.5	0.5	0.5	0.3	0.4	0.3	1.0	0.8	0.9
Over 90	4.2	5.8	5.3	5.1	5.6	5.4	0.1	0.0	0.0	0.1	0.3	0.2	0.6	0.5	0.5	0.2	0.3	0.3	0.8	0.6	0.6

[a]male. [b]female. [c]total

Eating disorders

Five studies met our inclusion criteria and provided aggregated estimates of AN/BN. Estimates for all other eating disorders were excluded from the analysis due to significant changes in diagnostic criteria between different DSM editions. Four of the AN/BN estimates were based on the DSM-IV criteria, while one estimate was based on the DSM-III-R criteria. These studies are listed in Table S4. The estimated annual prevalence for AN/BN was 0.33% (0.22%-0.46%), representing 13,3740 (8916–18,642) individuals aged 15 and older in BC in 2016 with either AN or BN. Figure S4 presents the forest plot of this meta-analysis.

The age- and sex-specific estimated prevalence was higher in women than men and higher in younger age groups than older age groups. The highest prevalence was 1.1% for women aged 15–19 years and 0.3% for men aged 15–34. The severity distribution was as follows: severe (14%), moderate (15%), and asymptomatic/mild (71%). Tables S22 and S23 provide the number of individuals with each severity level of AN/BN.

Intellectual disabilities

The studies included in the meta-analysis for intellectual disabilities met some but not all of our inclusion criteria as most relied on the use of administrative data to generate prevalence estimates. Additionally, methods for diagnosing disorders within this group were not standardized in the published literature. As such, the six studies that met the majority of our inclusion criteria were included in the analysis. Details of these studies are presented in Table S5. The estimated prevalence of intellectual disabilities was 0.60% (0.42%-0.81%), which represents 24,316 (17,021–32,827) individuals aged 15 and older in BC in 2016. The forest plot of the meta-analysis is presented in Figure S5.

The age- and sex-specific estimated prevalence was highest in the youngest age groups for both men and women aged 15–19 years at 0.9% and declined gradually with age (see Table 2). The increase in prevalence in the oldest age group is an artifact caused by combining estimates from CCHS and epidemiological studies. The CCHS estimates was limited to those aged 80 years or younger, while the epidemiological studies included estimates for those aged 80 years and older. As the epidemiological estimates were higher across all age groups (see Table S15), there is an apparent rise after age 80. The severity distribution was as follows: profound (2%), severe (3%), moderate (10%), and asymptomatic/mild (85%). Tables S24 and S25 in the supplemental report present the number of individuals by severity level.

Schizophrenia spectrum disorders

Three studies met our inclusion criteria and provided estimates for schizophrenia spectrum disorders. Of these studies, two provided estimates for schizophrenia and

Table 3 Estimated number of cases of mental disorders in BC, for 2016

	Intellectual disabilities			Schizophrenia spectrum disorders			Attention-deficit/hyperactivity disorder		
Age	Male	Female	Total	Male	Female	Total	Male	Female	Total
15–19	1271	1133	2404	550	542	1092	9262	6075	15,337
20–24	1490	1299	2789	914	795	1709	11,247	6360	17,607
25–29	1286	1229	2515	998	908	1906	9943	5661	15,604
30–34	1193	1186	2379	1099	1020	2119	9362	5322	14,684
35–39	1051	1027	2078	1084	997	2081	8230	4780	13,010
40–44	932	921	1853	1036	986	2022	7178	4666	11,844
45–49	902	904	1806	1042	1039	2081	6776	5375	12,151
50–54	871	881	1752	1019	1066	2085	6243	6,043	12,286
55–59	799	805	1604	936	1018	1954	5222	5634	10,856
60–64	677	672	1349	770	865	1635	3887	4481	8368
65–69	591	587	1178	620	729	1349	2927	3276	6203
70–74	427	430	857	398	497	895	1767	1848	3615
75–79	309	331	640	248	342	590	1021	1073	2094
80–84	232	262	494	156	233	389	596	599	1195
85–89	151	202	353	82	149	231	293	318	611
Over 90	80	161	241	35	95	130	116	172	288

	Depressive disorders			Anxiety disorders			Bipolar I and II disorders			Anorexia nervosa and bulimia nervosa		
Age	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
15–19	8,553	12,647	21,200	5430	8121	13,551	1851	1981	3832	399	1354	1753
20–24	10,707	15,024	25,731	7948	11,336	19,284	2427	2213	4640	497	1522	2019
25–29	9868	14,780	24,648	8268	12,682	20,950	2300	2055	4,355	441	1390	1831
30–34	9752	14,869	24,621	9021	14,159	23,180	2294	1965	4259	410	1273	1683
35–39	9096	13,507	22,603	9169	14,007	23,176	2130	1693	3823	343	1011	1354
40–44	8508	12,720	21,228	9244	14,135	23,379	1945	1527	3472	275	803	1078
45–49	8720	13,070	21,790	10,033	15,255	25,288	1856	1644	3500	224	670	894
50–54	8804	13,152	21,956	10,693	16,009	26,702	1672	1740	3412	170	533	703
55–59	7908	11,791	19,699	10,469	15,174	25,643	1245	1492	2737	125	403	528
60–64	6366	9461	15,827	9259	12,799	22,058	743	1065	1808	87	286	373
65–69	5282	7985	13,267	8298	11,109	19,407	435	666	1101	73	247	320
70–74	3613	5608	9221	5944	7830	13,774	185	293	478	57	192	249
75–79	2510	4113	6623	4079	5560	9639	68	125	193	43	153	196
80–84	1827	3097	4924	2811	3910	6721	24	44	68	35	129	164
85–89	1157	2277	3434	1616	2573	4189	12	15	27	25	108	133
Over 90	606	1739	2345	737	1681	2418	10	12	22	15	94	109

schizophreniform disorder based on DSM-III criteria, and one study provided an estimate for non-affective psychosis using DSM-III-R criteria. Additional details are listed in Table S6. The estimated annual prevalence from these studies was 0.55% (0.38–0.74%) which represents 22,290 (15,400–29,990) individuals aged 15 and older in BC. The forest plot of this meta-analysis is shown in Figure S6.

Men had slightly higher prevalence than women between ages 30 and 44, while women had higher prevalence than men starting from ages 55 to 59 and on (Table 2). Prevalence was highest in men aged 30–44 years (0.7%), and women aged 25 –59 (0.6%). Using the GBD severity fractions, acute and residual states were specified, with the acute state was defined as "hears and sees things that are not real and is afraid, confused, and sometimes violent. The person has great difficulty with communication and daily activities, and sometimes wants to harm or kill himself (or herself)" [20]. The residual state for schizophrenia was defined similarly to the acute state, excluding feelings of fear, violent behavior, and increased difficulty with communication [20]. Sixty-three percent of individuals were estimated to experience an acute state of schizophrenia, and 37% were estimated to

be in a residual state. Tables S26 and S27 show the number of individuals in BC within each health state.

Attention-deficit/hyperactivity disorder

We found five studies that met our inclusion criteria for the meta-analysis and provided annual estimates for ADHD from DSM-5, DSM-IV-TR, or DSM-IV. Additional details of these studies are provided in Table S7. The estimated annual prevalence for ADHD was 0.36% (0.30%–0.43%), which equates to 145,898 (121,582–174,268) individuals aged 15 and older in BC in 2016. The forest plot of this analysis is shown in Figure S7.

The estimated age- and sex-specific prevalence was higher in men than women and highest in youngest age groups. The highest prevalence was 4.8% for women and 6.8% for men in the 15 to 19 age group. The severity distribution was as follows: severe (14%), moderate (18%), mild (36%), and asymptomatic (33%). Tables S28 and S29 show the number of individuals with each level of severity in BC.

Discussion

We developed a systematic approach to derive timely and actionable population-level estimates stratified by age, sex, and severity using the best available evidence to support a foundational step in needs-based planning. The results presented herein are the first comprehensive annual population-level estimates of seven mental disorders in BC and their distribution by age, sex, and severity. The analytic framework presented here can be applied to other jurisdictions and health resource planning areas. With the inclusion of comparable international studies, we provided an approach that has the flexibility to overcome the limited availability of local data.

We found that the most common mental disorders were anxiety disorders (6.90%) and depressive disorders (6.40%), while the annual prevalence estimates for each of the other mental disorders included in our study were less than 1%. This was expected and consistent with most epidemiological studies [21, 22]. Our annual prevalence for schizophrenia spectrum disorders (0.55%) is comparable to the 0.40% derived through a meta-analysis from 188 different countries [23]. Our higher prevalence may be explained, because we included schizophrenia spectrum disorders) rather than only schizophrenia.

Depressive disorders, anxiety disorders, and AN/BN estimates were consistently higher in women than men across all age groups. This pattern is consistent with the current understanding of mood [24], anxiety [25], and eating disorders [26]. Estimates for bipolar disorders, schizophrenia spectrum disorders, and ADHD were slightly higher in men than women in the younger age groups. This finding is corroborated with evidence that the age of onset for schizophrenia [27] and bipolar disorders [28] tend to be earlier in males than females and that ADHD is more commonly diagnosed in young males than females [29, 30]. No sex differences were observed for intellectual disabilities.

Across most mental disorders, annual prevalence estimates were highest in younger age groups and declined consistently with age for both men and women. This is consistent with the evidence, showing that the age of onset for most mental disorders are by the age of 24 [31, 32], which has important implications for service planning and prevention. The low prevalence of lifelong psychiatric disorders in older adults, such as bipolar disorders, schizophrenia, ADHD, and intellectual disorders, may reflect the higher mortality rates in these populations from natural and unnatural causes compared to the general population [33, 34]. For instance, the years of life lost in people with mental disorders range from 1.4 to 32 years [35].

One main benefit of data triangulation is that the estimates were derived from multiple sources rather than a single data source, which improve the validity of estimates as each data source includes strengths and weaknesses and multiple sources can help compensate for shortcomings associated with a single data source. For instance, treated prevalence (derived from passively collected administrative health data) provides information on the age and sex distribution of disorders, but it is a partial picture of need and is less likely to capture individuals with a milder or sub-threshold presentation of the disorder and those experience barriers in accessing care. The inclusion of epidemiological studies and population-level cross-sectional surveys using standardized diagnostic tools administered by trained interviews help provide a more complete picture. Moreover, these data sources are continually updated. Therefore, others can efficiently use and build off our estimates or conduct the meta-analysis and the age- and sex-specific distribution with more recent data over a period that is specific to their objective.

This study has some limitations to consider. Most of the studies retrieved through our systematic reviews used older iterations of the DSM (i.e., III, III-R, and IV). Altered definitions of depressive, anxiety, eating, and bipolar disorders across the different DSM versions may have impacted the prevalence estimates. Additionally, we did not find studies that used standardized assessment tools for diagnosing intellectual disabilities in the adult population. Our data did not capture information on ethnicity, socioeconomic status, and other social determinants of health that contribute to mental health conditions and may be relevant for needs-based planning efforts. Epidemiological studies and surveys may not reach key populations, such as those that are institutionalized, homeless, in the military, or on First Nations

reserves, although mental disorders have been observed to be higher in populations who have experienced a concentration of adversities [14, 36, 37]. Future studies should capture cultural, social, and systemic factors that impact the occurrence of mental disorders, treatment, and services, for specific populations. Due to the lack of high-quality Canadian studies, we were obliged to include international and older estimates to inform Canadian estimates. This highlights a need for more funding for Canadian epidemiological studies. Additionally, it is essential to continually produce timely and local estimates of disorders to inform service planning adequately in a changing landscape. The allocation of mental health resources can be costly and inefficient if not informed by current and local demands.

Conclusion

We derived annual prevalence estimates of seven mental disorders stratified by age and sex, and severity using a novel approach. Evidence-based estimates of each disorder, with consideration to age, sex, and severity, are a fundamental first step in accurately planning mental health service to meet population needs. Our approach to needs-based planning can serve as an efficient, and actionable template for estimating needs and service planning in similar jurisdictions.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00127-022-02366-z.

Acknowledgements We would like to recognize the enormous contribution to this work made by Dr. Elliot Goldner, who conceived the project as principal investigator but sadly passed before its completion. Elliot's leadership, guidance, and passion for improving the lives of people living with mental and substance use disorders will be remembered. We would also like to acknowledge Rebecca Zappelli, Arthur Yee, and Te Su who contributed to the project's earlier phases.

Funding This work was supported by the British Columbia Ministry of Health and the Michael Smith Foundation for Health Research. The authors have no competing interest to declare.

Declarations

Conflict of interest The authors declare that they have no conflict of interest.

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