A Novel Population-Based Health Index for Mental Disorder

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Abstract

Introduction: A novel population-based health index was identified, in addition to calculation of the rates of psychiatric disorder in a random sample from a large urban center.

Methods: With use of the regional population as a sampling frame, 685,684 individuals (45.8% male) were selected randomly, with physician billing visit and cost data from 1994 to 2009 grouped on the basis of the presence or absence of a psychiatric disorder. The prevalence of psychiatric disorder was described and the groups were further analyzed in terms of somatic and biomedical disorders with the profile of depression highlighted.

Results: In the sample (45.8% male), the annual prevalence of psychiatric disorder from 1994 to 2009 was found to increase in 3 age strata (children, 5.3%; adults, 4.4%; and geriatric subjects, 6.2%). Depressive disorders as a group provided an example of the population profile. The cumulative rate of psychiatric disorder was 53% over 16 fiscal years. In comparison with the group without psychiatric disorder, the median cost of physical (biomedical/somatic) disorders was 2.9 times higher for the group with any International Classification of Diseases psychiatric disorder.

Discussion: The arithmetic ratio of median somatic and biomedical health costs, comparing groups with and without psychiatric disorders, was presented as a novel population health index that holds the potential to directly measure the impact of promotion and prevention programs associated with psychiatric disorders.

Introduction

A recent population study identified psychiatric disorder to have reached epidemic proportions.[1] The 2010 national Canadian Index of Wellbeing report[2,3] identified depression as "The Silent Epidemic." In relationship to actual health care costs, this proposition is untenable and, for every nation, identifies the need to reconceptualize the relationship between psychiatric disorder and health. Futhermore, the 2010 Canadian Index of Wellbeing report suggested that the self-reported rate of depression "has decreased and stabilized among Canadians of all ages in recent years after rates peaked in 2000/2001" at 6%.[2] Yet, in a separate 2011 Canadian Index of Wellbeing report, it was stated that the rate of depression "has increased 11.7% among Canadians of all ages from 1994 to 2008."[3]

This disparity calls for an independent approach to measurement of psychiatric illness (or well-being). Rather than self-reported symptoms, in this study the actual rates of physician-assigned psychiatric and physical (somatic/biomedical) disorders were examined between 1994 and 2009 using a representative random sample of the Alberta Health Services Calgary Zone population in Alberta, Canada. The average and median costs of biomedical and somatic disorders of patients with and without psychiatric disorders were calculated and combined in an arithmetic ratio to represent a novel health index. A population-based health index can be a useful tool to monitor the health of a community and to measure the effect of population-based promotion and prevention.

The objectives of this research were to calculate the cumulative and annual rates of mental disorder in the population-based sample and to explore whether health service utilization data are a viable and robust source of population health information. Additionally, depressive disorders are presented as an example of the population profile.

Methods

With the use of a population sampling frame, 685,684 individuals (45.8% male) were selected randomly on the basis of never having been treated in specialized, publicly funded psychiatric services (eg, no registration for treatment in regional ambulatory psychiatric clinics, nor psychiatric treatment in Emergency Departments or inpatient psychiatric units). All direct physician billings from 1994 through 2009 for treatment of any presenting concern were obtained under Calgary Research Ethics Board ID 21695. The anonymous data set included International Classification of Diseases (ICD) diagnoses, physician billing cost, visit date, age at index visit, and sex. Of 71,653,006 total unique billings, 9,918,619 (13.8%) were not included because the data were not complete (eg, diagnosis was missing). Each billing represented a visit where up to 3 diagnoses could be assigned. The 3 ICD diagnoses were used in this analysis.

The category of physical disorders (biomedical or somatic) could contain any of more than 13,000 ICD-Ninth Revision (ICD-9) diagnoses that were not psychiatric disorders. The category of psychiatric disorders was made up of 480 ICD diagnoses representing psychiatric disorders and related V codes. Within the data set, a psychiatric disorder is either present for any given visit, any given patient or it is not. Thus, the category of any psychiatric disorder was established, and there is, in fact, a clear line demarcating the difference between physical (somatic and biomedical) disorders and psychiatric disorders. The 16-year cumulative prevalence and the annual prevalence for each year were based on counts of individuals having any psychiatric disorder, divided by the total number of individuals

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visiting a physician over 16 years (cumulative prevalence) or in a given year (annual prevalence). Hence, for each year and for the 16-year cumulative rate, an individual was counted only once even if s/he had multiple ICD-9 physician-assigned psychiatric diagnoses.

The Diagnosis and Statistical Manual of Mental Disorders (Fourth Edition, Text Revision, or DSM-IV-TR) has equivalent diagnoses, and crosswalks for ICD-9 are available. Typically, ICD-9 classifications of disease are used to code psychiatric disorder for the purpose of international comparison. The ICD-9 diagnostic codes of disorders are used in Alberta to code with diagnoses associated with physician visits and billings. In general, to be paid for a particular patient visit, the physician of record must submit at least one ICD-9 code. The physician-assigned ICD-9 diagnoses considered in this study arise predominantly from primary care physician billing.

The cumulative and annual rates of ICD diagnosis were summarized for those with any psychiatric disorder and expressed as a percentage of the cumulative (16-year) or annual number of individuals receiving any diagnoses. The average and median costs and number of visits to physicians per individual for ICD physical disorders among those with and without psychiatric disorders were also summarized. The arithmetic ratio of physical disorders between these 2 patient groups provides an index that integrates estimates of population-based key health and psychiatric health parameters.

Of note is that the random sample of 685,684 individuals represents approximately two-thirds of the catchment population of the Calgary health zone. This sample was selected on the basis of never having been registered in ambulatory, inpatient, or emergency psychiatric services. Hence, there is an inherent bias in this group against having a psychiatric disorder and toward being, according to social standards and norms, most representative of the normal population.

Results

Six percent of the total number of diagnoses (n = 84,213,781) were psychiatric disorders. The cumulative proportion of individuals in the sample with any ICD psychiatric disorder from 1994 to 2009 was 53.5%. The average cost of psychiatric disorder per patient was $515 for physician visits where a psychiatric disorder was assigned (all cost values are in Canadian dollars). Over the same period, patients with psychiatric disorders had a per-patient average cost of physical (biomedical/somatic) ICD disorders of $4490 (29.3 physician visits; median cost, $3221). In comparison, patients without any psychiatric disorders had physical (biomedical/somatic) ICD disorders with a per-patient average cost of $1841 (11.6 visits; median cost, $1093). The arithmetic ratio of average biomedical/somatic costs and number of visits comparing patients with and without psychiatric disorders was 1:2.4 for costs and 1:2.5 for visits; the ratio for the median health cost index was 1:2.9. For example, over 16 years, for every billion dollars spent on the somatic/biomedical health care of those without mental disorder, $2.9 billion was spent on the somatic/biomedical healthcare of those with a mental disorder.

Table 1 shows the total number of unique patients with physician billings for ICD diagnoses and the number of unique patients with any psychiatric disorder for 3 age categories: those under 18 years of age, those between 18 and 69 years, and those 70 years and older.

Table 2 shows the proportion of individuals with physician billings having a psychiatric diagnosis by year across the 3 age categories. Notice the annual prevalence increased in each age category. Of particular note is that the rate doubled in the age group under 18 years. The percentage change in each group from 1994 to 2009 was 5.3% for those under 18 years, 4.4% for those between 18 and 69 years, and 6.2% for those 70 years or older.

Table 3 shows the rank order of different types of depression in the sample. The ICD diagnosis "Depression not elsewhere classified" had the highest cumulative 16-year rate, whereas "Other affective psychosis" was the lowest rate. Thirty-three percent of the population had a depressive disorder.

Discussion

Health care systems in the US and Canada are fundamentally different from one another. The Canadian health care system is typified at the provincial level by publicly funded health services and provincially managed physician fee-for-service billing based on a universal patient health care number. Private health care services, although available to some extent, are generally not used by the general population. The universality of the Canadian health care system permits population-based study, the results of which are perhaps most directly comparable to self-contained, all-inclusive health care systems in the US. The results of this study are of interest to any country that collects health care data.

The study follows an *a priori* hypothesis-driven study that employed the same health service utilization data, wherein the results were found to support the findings of the Adverse

Table 1. Counts of total patients and patients with psychiatric disorder in the sampled population by age group and year

| | ICD disorder by age group | | | | | |
| | < 18 years | | 18-69 years | | ≥ 70 years | |
Year	Psychiatric	All	Psychiatric	All	Psychiatric	All
1994	5345	112,609	33,191	239,912	4828	29,572
1995	7334	120,323	42,760	250,694	6423	32,194
1996	7808	117,341	45,507	252,414	7144	34,214
1997	8194	116,395	47,451	259,283	7972	36,269
1998	8513	116,521	50,078	268,800	8493	37,987
1999	8594	114,235	53,759	277,959	9204	39,636
2000	8813	110,285	56,027	281,911	9509	40,848
2001	8796	107,199	58,582	289,690	9922	42,043
2002	8344	101,409	60,230	295,885	9776	42,687
2003	7521	94,375	54,127	292,182	9085	42,738
2004	7714	91,370	58,540	322,154	9685	44,905
2005	7104	83,402	60,483	333,452	9844	45,355
2006	6693	77,233	61,585	344,583	9791	46,132
2007	6086	68,219	64,128	349,621	10,033	46,086
2008	5361	58,542	63,661	346,463	9937	45,870
2009	5033	50,271	64,187	345,689	10,326	45,990

ICD = International Classification of Diseases.

Childhood Experiences (ACE) Study, which found a preponderance of adult physical disorders to be associated with early adverse experiences.[4] The present study extends this original work, which was based on the principles of developmental psychopathology, which holds as a core assumption that early adversity is a principle risk factor for psychiatric disorder.

Psychiatric disorder was examined in a large, randomly selected sample from the Alberta Health Services Calgary Zone over 16 years for annual prevalence and cumulative average (median) of health costs (independent variable) given the presence or absence of any psychiatric disorder (dependent variable). The arithmetic ratio of health costs (minus the cost of psychiatric disorder), given the presence or absence of psychiatric disorder, is presented in this article as a novel population health index, which is justified given that 53.5% of the population

Table 2. Annual rate (percentage) of patients with any psychiatric disorder by age and year

Year	Age group		
	< 18 years	18-69 years	≥ 70 years
1994	4.7	13.8	16.3
1995	6.1	17.1	20.0
1996	6.7	18.0	20.9
1997	7.0	18.3	22.0
1998	7.3	18.6	22.4
1999	7.5	19.3	23.2
2000	8.0	19.9	23.3
2001	8.2	20.2	23.6
2002	8.2	20.4	22.9
2003	8.0	18.5	21.3
2004	8.4	18.2	21.6
2005	8.5	18.1	21.7
2006	8.7	17.9	21.2
2007	8.9	18.3	21.8
2008	9.2	18.4	21.7
2009	10.0	18.6	22.5

Table 3. Patients with specific depression-type diagnoses

Depression diagnosis type[a]	Percentage of total no. of patients with any depression diagnosis (n = 226,025)
Depressive disorder not elsewhere classified	62.1
Dysthymia	23.6
Unspecified episodic mood disorder	4.7
Depression V code	4.2
Adjustment disorder with depressed mood	2.4
Bipolar disorder	1.0
Major depression recurrent	0.6
Major depression episodic	0.7
Depressive type psychosis	0.5
Other affective psychosis	0.3

[a] From International Classification of Diseases, Ninth Revision.

had a psychiatric disorder over the 16-year period. Although the relationship between psychiatric and physical illness is well established, the fact that more than half of the population had a psychiatric disorder and almost 3 times the related health costs (in addition to the cost of psychiatric disorder) provides a basis for understanding the utility of the present novel population health index. Integration of the health costs directly related to psychiatric health into a universal population health index serves two ends. First, this index provides an empirical basis for directly measuring the effect of health and psychiatric health promotion and prevention programs. Second, the index may provide a mechanism for changing psychiatric disease-related social values within the health care system. Typically, low value is placed on the psychiatric health needs of populations. In Canada, the recent creation of yet another national mental health commission is evidence of the need to fundamentally change values related to psychiatric disorder and to reduce related stigma.

Considering psychiatric disorder as a subdomain of health may be ill advised. Although it is important to examine the impact of the burden of psychiatric disease independently,[1] it is equally important to consider the relationship of health to psychiatric health in terms of an overall health index. The 9-year cumulative rate of ICD psychiatric disorders in an independent sample from the same population base was 46%.[1] Compared with an independent population study of the 1-, 2-, and 3-year provincial rates of psychiatric disorder from physician billing data in Alberta,[5] the 16-year rate of 53.5% observed in the present study sample indicates that the rate of psychiatric disturbance in the population is logistically stable and represents an epidemic proportion. Imagine if half the population had HIV (human immunodeficiency virus) or influenza. This finding places psychiatric medicine at the center of all medical concerns.

The observed cumulative 16-year rate draws attention to and opposes the story told by politicians and policymakers in relationship to psychiatric disorder. Even though depression is anticipated to become the second-largest contributor to the global burden of disease by 2020,[6] our leaders' stories, at least in Canada, often tend to focus on the homeless and criminality once the topic of psychiatric health is raised. Our present study indicates that the populist focus does not represent the *mos maiorum*. Although it is important for the provision of treatment to focus on the psychiatric condition of marginalized groups who are homeless or who occupy our jails, focusing on these populations in telling the public story of psychiatric illness may inadvertently have the effect of further marginalizing these groups, while stigmatizing and silencing the majority with psychiatric disorder.

Why is "Silent Epidemic" the public label for depression?[2,3] Why do newsletters of the Mental Health Commission of Canada frontline homelessness while the *silent* epidemic proceeds unabated? Our study indicates that 53% of the general population experiences a psychiatric disorder over a 16-year period, with some form of depression diagnosed in 33%. The associated health costs are extraordinary. For every billion dollars spent on the health care of those without psychiatric disorder, the same health care system within the catchment spends about $2.9 billion (median) on the physical (biomedical/somatic) disorders of

those with psychiatric disorder (exclusive of associated psychiatric disorder billing costs). Institutionalizing the segregation of psychiatric services and general health services is perhaps the strongest cornerstone of system-based stigma.[7]

The present study findings stand in contrast to those of Labonte et al,[2] who indicated that depression was stable, hovering between an annual prevalence in the range of 5% to 7%, between 1994 and 2009. The present study findings are more in line with the 2011 report by the Canadian Index of Wellbeing,[3] in that the annual rate of psychiatric diagnosis doubled for children and increased in a similar linear fashion for both adult and geriatric populations. The use of population-based utilization data may in the future help to resolve and surmount issues related to survey-based data.

The reasons for the increased rates of psychiatric diagnosis are presently speculative. Further examination will be required to discern whether there are specific classes of disorder accounting for the observed increases in these age groups. Possibilities include but are not limited to the following: 1) a true increase in social psychiatric (and physical) disease related to increased social stress, 2) increased awareness of psychiatric disorder on the part of patients, 3) increased marketing of pharmaceutical products, and/or 4) improved education of physicians leading to an increase in the rate of diagnosis. However, the preponderance of the diagnosis of "Depression not elsewhere classified" argues against an improved ability to distinguish diagnostic subtypes, as least for depressive disorders. Further work will be required to unravel the influences underpinning the observed overall rate increase or rate changes within specific categories of diagnosis.

An algorithm is being designed to profile prodromal and prognostic patterns of associated disorders in time for any given index diagnosis or diagnostic cluster. Standard information from the algorithm will provide information relevant to planning health service clinical networks and pathways. In and of itself, the algorithm will serve as a window on the past from which to consider and compare future investments.

Additionally, the profiling algorithm may actually help to provide understanding about change or observed increases in specified disorders within bandwidths of the population. For example, it appears that children under the age of 6 years tend to have a higher rate of physical disorders in advance of arriving at the age when psychiatric disorders are usually assigned.[4] Identifying differences in diagnostic profiles at an early age may prove to be of substantial clinical value. To further this example, preliminary examination of the physical and psychiatric disorders associated with attention deficit hyperactivity disorder has revealed that almost half of patients also have asthma. Work in progress, presented but not yet published[8] includes profiling disorders associated with disorders such as Down syndrome, schizophrenia, conduct disorder, and eating disorders—indicates that each appears to possess a unique profile. Similarly, 81% of those with ulcerative colitis have a psychiatric disorder, which is 28% higher than the general population

The algorithm will help to establish the sequence of diagnostic events in time. Each diagnosis is worthy of unique study, as is the description of associated disorders and how these disorders emerge in time. Identifying how and when

disorders cluster within a population will be the focus of work over the coming years. At this point, the data set is being examined in broad strokes to ensure that fine-grained analysis is worthwhile.

Finally, the arithmetic ratio of 1:2.9 stands alone as a population health index and represents the median physical disease cost ratio comparing those with and without psychiatric disorders. The ratio may be calculated on the basis of any time interval, and change in this ratio is a direct indicator of population health. More robust than telephone or self-report surveys are the actual health costs, given the presence or absence of a psychiatric disorder. Importantly, these data have been available to decision makers for a long time, yet have not been specifically used for this purpose. It would be interesting to undertake population-based interventions designed to improve health, such as the ACE Study and actually be able to directly measure the effect of health promotion interventions. Similar to the substantial economic benefits of the ACE Study (Vincent J Felitti, MD, oral communication, September, 2009)[a], simply implementing an integrated population health-mental health index based on service utilization may in and of itself have an impact on the health status and health care costs, if not the stigma of mental illnesses.

Depressive disorders were used as a point of illustration, as these diagnoses have also been examined using different epidemiologic methods in the Canadian population. For example, the Canadian Index of Wellbeing survey uses several questions related to depressive symptoms to measure the population-based rate of depression. In the present study, overall psychiatric disorder and ICD-9 depression disorders were measured in two-thirds of the regional population on the basis of service utilization and physician diagnosis. This means that some degree of "casefulness" is associated with the assignment of each physician-assigned diagnostic code, whether or not the diagnosis is accurate (see limitations in the next paragraphs). Like all psychiatric disorders, depression-type disorders as a group are increasing in the population. When examined at the level of depression diagnosis types, some depression diagnosis types are increasing (eg, Depression not elsewhere classified), whereas others are decreasing or appear relatively stable in the population (eg, Other affective psychoses).

Limitations include the validity and reliability of diagnoses. Regarding the reliability and validity of the diagnosis, we have 2 studies with 2 independently selected, random samples, sampled with replacement to represent about two-thirds of the urban population in the Calgary catchment area. The first of these samples spanned 9 years,[1] and the second sample (described here) spanned 16 years. Compared with a provincial study[5] examining the 1-, 2-, and 3-year prevalence of psychiatric disorder, the 9-year prevalence and 16-year prevalence create a perfect logistic function saturating at 53% of the population. A logistic growth curve may still represent a process that is flawed. There no doubt exists some threat to the reliability and validity of every diagnosis made by every physician over the last 16 years. Misdiagnosed illnesses are

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possible with every diagnosis, and in some cases the likelihood of misdiagnosis is much greater than in others. Given that each diagnosis has the same liability to misdiagnosis within a given class of disorders, the measured variables (cost and prevalence) within the categories established given the presence or absence of any psychiatric disorder probabilistically suffer identical threats to reliability and validity. If one assumes that half or all of the psychiatric disorders are inaccurate, it stands to reason that half or all psychiatric disorders are not diagnosed. Given this assumption, how does one account for the group with any psychiatric diagnosis having a medial tripling of physical disorders (eg, heart disease, which presumably is more accurately diagnosed), if not on the variable that establishes the category that, in this case, is "any physician-assigned ICD psychiatric disorder"? In other words, if psychiatric disorder, as a diagnosis, is random (inaccurate and unreliable noise), then one would expect the same values represented within the measured independent variables (average or median costs of somatic and biomedical disorders) within each category (those with and those without psychiatric disorder).

Although there is a clear distinction between psychiatric and somatic disorders as assigned by physicians using ICD criteria, the results of this study indicate that the distinction blurs considerably when it comes to the relationship between psychiatric and somatic disorders in an individual. Within individuals, disorder appears to compound in a systematic manner. Elucidating this relationship is of first-order importance. ❖

[a] Co-principal investigator, The Adverse Childhood Experiences Study.

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

References
1. Cawthorpe D, Wilkes TC, Guyn L, Li B, Lu M. Association of mental health with health care use and cost: a population study. Can J Psychiatry 2011 Aug;56(8):490-4.
2. Labonte R, Muhajarine N, Winquist B, Quail J. Healthy populations: a report of the Canadian Index of Wellbeing (CIW) [monograph on the Internet]. Waterloo, ON: Canadian Index of Wellbeing Network; 2010 Sep [cited 2012 Jun 2]. Available from: http://ciw.ca/reports/en/Domains%20of%20Wellbeing/HealthyPopul/HealthyPopulation_DomainReport.sflb.pdf.
3. Canadian Index of Wellbeing. How are Canadians really doing? Highlights: Canadian Index of Wellbeing 1.0. [monograph on the Internet] Waterloo, ON: Canadian Index of Wellbeing Network; 2011 Oct [cited 2012 Jun 2]: p 35. Available from: http://ciw.ca/reports/en/Reports%20and%20FAQs/CIW-HowAreCanadiansReallyDoing-FINAL.pdf.
4. Wilkes TC, Guyn L, Li B, Lu M, Cawthorpe D. Association of child and adolescent psychiatric disorders with somatic or biomedical diagnoses: do population-based utilization study results support the adverse childhood experiences study? Perm J 2012 Spring;16(2):23-6. DOI: http://dx.doi.org/10.7812/TPP/11-149
5. Slomp M, Bland R, Patterson S, Whittaker S. Three-year physician treated prevalence rate of mental disorders in Alberta. Can J Psychiatry 2009 Mar;54(3):199–203.
6. World Health Organization. The world health report 2001—mental health: new understanding, new hope [monograph on the Internet]. Geneva, Switzerland: World Health Organization; 2001 [cited 2012 May 20]. Available from: www.who.int/whr/2001/en.
7. Cawthorpe D. Confronting stigma [monograph on the Internet]. Bristol, England: Research Media Ltd; Summer 2012 [cited 2012 Nov 30]. Available from: www.internationalgme.org/NewsAndEvents/p67-69.pdf.
8. Cawthorpe D. Association of child and adolescent psychiatric and somatic disorders: Evidence of stigma and implications for policy and health reform. Sixth International Conference on Child and Adolescent Psychopathology. Roehamptom University, London, England. 2012 Jul 15-18.

Within the Fairy Circle

It is … to be lamented that regular physicians have indulged in a blind routine of inefficient treatment, and have allowed themselves to be confined within the fairy circle of antiphlogisticism, and by that means to be diverted from the more important management of the mind.

— *Treatise on Insanity,* Philippe Pinel, 1745-1826, French physician