**Brief report**

# Is there seasonality in hospitalizations for major depressive disorder in Canada?

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## Abstract

**Background:** Canada, a temperate country with four defined seasons incurs an annual productivity loss of over $30 billion on major depressive disorder (MDD); however it remains unknown whether inpatient hospitalization for MDD exhibits seasonal variations. **Objective:** Our study objective was to determine if there are seasonal variations in hospitalization rates for MDD in Canada. **Methods:** We used time series analysis to determine monthly rates of hospitalizations for MDD from 2006 – 2013, on data from population level health-administrative databases in Ontario, Canada. We also stratified analysis by gender and three age groups: 18 to 39, 40 to 65 and those over 65. We compared demographic and comorbidity profiles of patients admitted in April, August and December to elucidate if patient characteristics differed by season of admission. **Results:** We identified a total of 130,336 admissions for MDD for 95,439 unique patients. Baseline characteristics of the patients were similar across seasons. We did not detect significant seasonality of hospitalizations for MDD across any of the gender or age subgroups. **Discussion:** Our results question the popularly held belief that hospitalizations for MDD vary with seasons. These findings highlight the need for uniform hospital resource allocation for MDD throughout the year in Canada.

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**Keywords:** MDD, depression, seasonality, Canada, ICES.

## Introduction

Canada incurs an annual health care cost of $51 billion for managing 6.7 million people living with mental illnesses, and an estimated $32.3 billion productivity loss is incurred by the country annually on the most common mental illness, major depressive disorder (MDD)[1]. Depression, by its clinical nature, is prone to recur with moderate to severe major depressive episodes often needing hospitalization for treatment, stabilization and risk management[2,3]. Existing literature has shown seasonal variations in the rates of hospital admissions for MDD across the world. A Polish study found that more hospitalizations for depression occurred during spring and autumn[4]. In Norway, admission rates for depression were highest in November for women while it was highest in April for men[5]. In contrast, a recent Canadian study that used the National Population Health Survey and the Canadian Community Health Survey data showed that the highest proportion of a self-diagnosed depressive episode occurred in December, January and February and the lowest proportions occurred in June, July and August[6]. To our knowledge, no previous study has attempted to examine if there is seasonality in inpatient hospitalization rates for MDD in Canada. It is important to assess such rates for MDD, as hospitalization is a direct measure of the extent of hospital usage. Hence, we conducted a population-based study in Canada's most populous province, Ontario, to assess whether rates of hospital admissions for MDD exhibit seasonal variation.

## Methods

This study was approved by the institutional review board at Sunnybrook Health Sciences Centre, Toronto, Canada.

Using linked healthcare databases, we performed time series analyses of the rates of hospitalizations for MDD in Ontario, Canada from January 1, 2006 until December 31, 2013. We collected all hospital encounters for MDD for residents of Ontario aged 18 and older using the Ontario Mental Health Reporting System, which codes information on all patients admitted to inpatient psychiatry units across the province, and the Discharge Abstract Database (DAD), which captures data for discharges from other inpatient hospital beds. MDD was captured using International Classification of Diseases, 10th Revision codes (ICD-10) codes F32, F33, F412, F480, or the Diagnostic and Statistical Manual IV (DSM-IV) codes 29630 through 29635, 29620 through 29625 and 311. Our study time frame was divided into one month intervals. If included individuals had more than one hospitalization in a monthly interval, we counted only their first encounter during the relevant interval to ensure estimates were not driven by select individuals transferred from one institution to another. We stratified encounters for males and females in three age groups; working age adults aged 18 to 39, middle aged 40 to 65 years, and, seniors as those over 65. Rates were calculated by dividing the number of monthly encounters by the estimated population of Ontario for the appropriate year, gender and age group. Population estimates were provided by IntelliHealth Ontario[7].

Patient age and gender was obtained from the Registered Persons Database. Presence of common comorbid conditions such as dementia, alcoholism and psychosis were determined using the Discharge Abstract and National Ambulatory Care Reporting System databases. Antidepressant use among the over 65 group was determined using the Ontario Drug Benefit database. These datasets were linked using unique coded identifiers and analyzed at the Institute of Clinical Evaluative Sciences (ICES).

To compare characteristics of patients hospitalized for MDD during the four main seasons, we investigated patients admitted during April, August and December to represent the three quarters of the year from 2007-2009. Presence of comorbid conditions were identified and flagged if found within 5 years of the hospitalization. Also, antidepressant use among patients above age 65 was identified and flagged if dispensed within 120 days of the hospitalization.

To assess seasonality, we applied descriptive time-series analyses. We tested for seasonality using the Fisher's Kappa and

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Bartlett Kolmogorov Smirnov (BKS) statistics, which tests the null hypothesis that the series consists of random noise. We then used $R^2$ autoregression coefficients from a model fitted to the series to quantify the strength of seasonality. The values of 0 to < 0.4 represent non-existent to weak seasonality, 0.4 to < 0.7 represent moderate seasonality, and values higher than 0.7 represent strong seasonality[8]. All analyses were completed using SAS Enterprise Guide Version 6.1 (SAS Institute, Cary, North Carolina).

## Results

Over the 91-month study window (2006-2013), we identified 158,376 inpatient hospitalizations for MDD. We excluded 28,040 hospitalizations due to missing or invalid health card numbers, invalid age (missing or under 18), non-Ontario residency at the time of the encounter, or where a patient had another encounter during the relevant interval, creating a final cohort of 130,336 hospitalizations for 95,439 unique patients. Over the study period, the rate of monthly hospitalizations for MDD remained relatively stable and was higher in females ranging from 0.13-0.16 compared to 0.10-0.13 for males per 1000 persons. Females consistently experienced increased rates of hospitalizations compared to males across all age groups. Baseline characteristics of the patients were, for the most part, similar across seasons. Notable exceptions to this trend included males aged 18 to 39 admitted in April who were less likely to have had a prior comorbid diagnosis of psychosis, alcoholism or drug dependence compared to those admitted in August or December, and elderly males seen in August were more likely to have had a prior history of alcoholism.

We did not detect significant seasonality of hospitalizations for MDD across any of the female subgroups (Figure 1). Although males aged 18-39 showed significant values for Fisher's Kappa and BKS statistics, the $R^2$ statistic failed to provide evidence of substantive seasonal variation ($R^2$ values were 0.2 and 0.24, for males aged 18-39 and males overall, respectively).

## Discussion

Our study, which utilized a database that constituted a large, representative sample of inpatient admissions in Ontario, Canada, showed that there is no seasonal variation in hospitalizations for MDD across both the genders. Our findings contrast with seasonality observed in MDD hospitalizations in Norway and Poland[4,5]. Our results suggest that the specific demographic structure of Ontario, Canada, which includes an enriched multi-cultural society with a high proportion of an immigrant population, nullifies the theoretical effect of a geographical temperate climate causing increased risk of depression related hospitalization in the winter months. The findings of our study should help the government, policy makers and hospital managers plan appropriate resources towards adequate number of inpatient mental health beds for the management of MDD through the year.

Another recent Canadian study, however, did show higher rates of self-diagnosed depressive symptoms in the winter months[6]. In contrast to that study which used survey data, we used inpatient hospitalization data for our analysis and hence our findings are reflective of inpatient healthcare needs. This variance in findings does have important clinical implications as the combined data suggests that patients likely with underlying MDD continue to have higher rates of self-diagnosed depression in the winters in Ontario, but, they likely do not meet the severity threshold of a major depressive episode warranting an inpatient hospital admission during these months. Inpatient hospitalization remains a major determinant of severity of MDD and resource utilization[9].

Currently, there is lack of specificity in out-patient coding for MDD in Ontario, hence we restricted our study to inpatient hospitalization only. However, our study cannot rule out possible seasonal variation of presentation to other healthcare services, such as primary care services or emergency room visits. Our results point to the fact that more research is warranted on the seasonality of
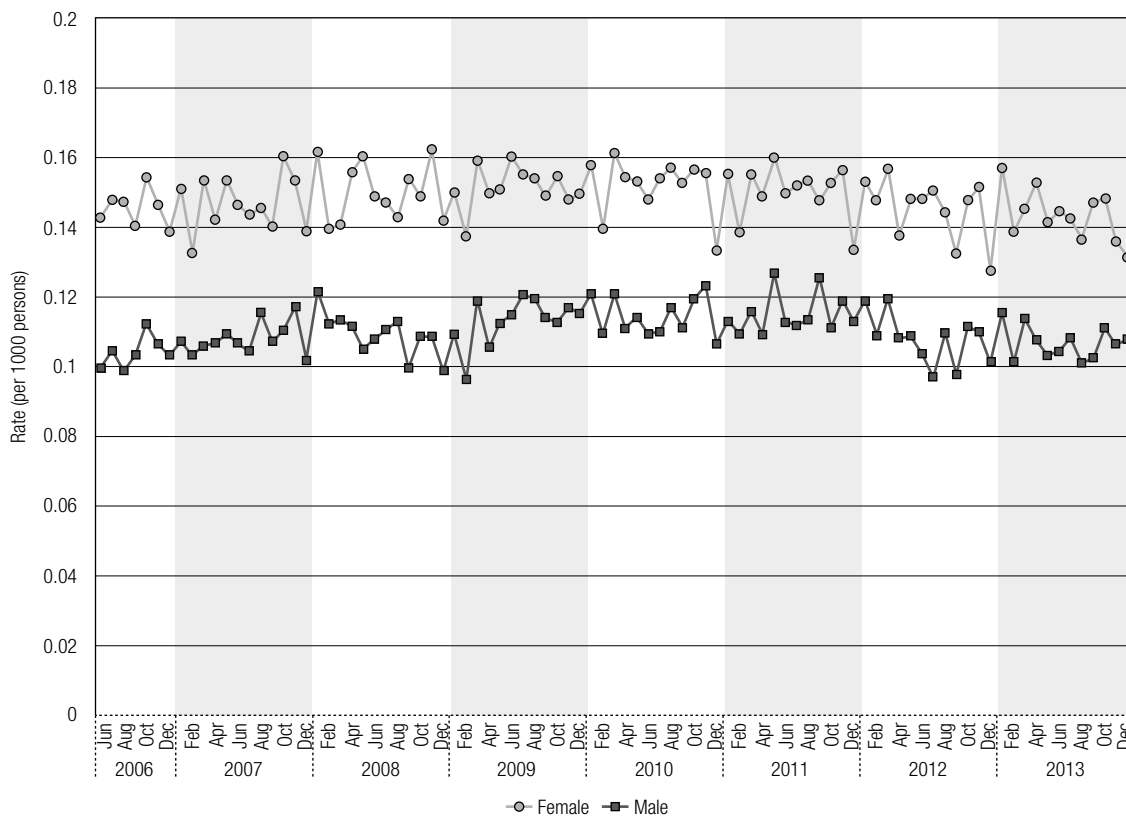


**Figure 1.** Monthly rate (per 1000 persons) of hospitalization for major depressive disorder in Ontario.

MDD, especially in Canada's other provinces and other countries where there are four well delineated seasons. To elicit a more comprehensive account of seasonal variation in the presentation of MDD, future research should consider utilizing additional data from the emergency room, primary care and outpatient mental health settings.

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## Declaration of conflicting interests

The authors declare that there is no conflict of interest.

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