Geographic variation and sociodemographic correlates of prescription psychotropic drug use among children and youth in Ontario, Canada: a population-based study

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Abstract

Background Population-based research examining geographic variability in psychotropic medication dispensing to children and youth and the sociodemographic correlates of such variation is lacking. Variation in psychotropic use could reflect disparities in access to non-pharmacologic interventions and identify potentially concerning use patterns.

Methods We conducted a population-based study of all Ontario residents aged 0 to 24 years who were dispensed a benzodiazepine, stimulant, antipsychotic or antidepressant between January 1, 2018, and December 31, 2018. We conducted small-area variation analyses and identified determinants of dispensing using negative binomial generalized estimating equation models.

Results The age- and sex-standardized rate of psychotropic dispensing to children and youth was 76.8 (range 41.7 to 144.4) prescriptions per 1000 population, with large variation in psychotropic dispensing across Ontario's census divisions. Males had higher antipsychotic [rate ratio (RR) 1.40; 95% confidence interval (CI) 1.36 to 1.44) and stimulant (RR 1.75; 95% CI 1.70 to 1.80) dispensing rates relative to females, with less use of benzodiazepines (RR 0.85; 95% CI 0.83 to 0.88) and antidepressants (RR 0.81; 95% CI 0.80 to 0.82). Lower antipsychotic dispensing was observed in the highest income neighbourhoods (RR 0.72; 95% CI 0.70 to 0.75) relative to the lowest. Benzodiazepine (RR 1.12; 95% CI 1.01 to 1.24) and stimulant (RR 1.11; 95% CI 1.01 to 1.23) dispensing increased with the density of mental health services in census divisions, whereas antipsychotic use decreased (RR 0.82; 95% CI 0.73 to 0.91). The regional density of child and adolescent psychiatrists and developmental pediatricians (RR 1.00; 95% CI 0.99 to 1.01) was not associated with psychotropic dispensing.

Conclusion We found significant variation in psychotropic dispensing among young Ontarians. Targeted investment in regions with long wait times for publicly-funded non-pharmacological interventions and novel collaborative service models may minimize variability and promote best practices in using psychotropics among children and youth.

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Introduction

The use of psychotropic medication, such as stimulants, antipsychotics, benzodiazepines and antidepressants, has increased among Canadian children and youth, with at least 1 in 15 receiving a psychotropic drug between 2012 and 2017 [1, 2]. Similar trends have been observed in Europe and the United States [3–5]. Yet, little is known about geographic variability in the use of these drugs among children and youth and the sociodemographic correlates of such variation. While such variability may reflect regional differences in the rates of mental health conditions, geographic variation in prescription psychotropic drug use among children and youth could also reflect regional disparities in access to evidence-based non-pharmacological therapies, uneven distribution of mental health care professionals, particularly in rural and remote settings, and inappropriate overuse or underuse of these drugs in specific treatment settings [6–10]. Specifically, several studies in the United States have documented low receipt of psychosocial treatment among Medicaid-insured children and youth treated with psychotropic drugs, with 49% of individuals less than 20 years of age receiving such treatment prior to initiating antipsychotics and less than 38% of children with attention deficit/hyperactivity disorder (ADHD) receiving any psychotherapy prior to initiating treatment. In the absence of psychosocial services, medications may become the default intervention [11, 12]. Given that access to such services may be limited by geographic accessibility and cost [13], and that pharmacological therapies incur the risk of serious adverse effects, studies exploring geographic variability in psychotropic drug use among children and youth and the correlates of such use are needed to inform programming and policy for children and youth with mental health conditions.

However, available research has focused mainly on variation in stimulant treatment across the United States or among specific populations of children and youth defined by age category and child welfare system contact, with few comparisons of the different psychotropic drug classes at a population-level [14–22]. Moreover, some studies have only been able to examine psychotropic use among children and youth with specific forms of drug insurance, and therefore selectively exclude large groups of children and youth receiving treatment [17, 23–25]. Hence, inferences from these studies may not be generalizable to children and youth not represented in these databases, and thereby limit opportunities to understand local patterns and variation in psychotropic drug use in specific regions. Studies encompassing the entire population of children and youth are needed to explore variation in psychotropic drug use and identify opportunities for policy and educational intervention.

Between January 2018 and March 2019, all children and youth aged 24 and under in Ontario, Canada were eligible to receive prescription medication at no cost through a publicly-funded universal pharmacare program [26]. Prescription drug data were therefore available for the entire population of individuals aged 24 and under in Ontario during this period. This represented a unique opportunity to study variation in prescription psychotropic drug use among children and youth that was not confounded by drug insurance status. Accordingly, we studied geographic variability in prescription psychotropic drug use among the entire population of individuals aged 0 to 24 in Ontario, home to approximately 4.1 million children and youth [27]. Our objectives were to quantify the extent of geographic variability in prescription psychotropic dispensing to children and youth and identify sociodemographic correlates of use.

Methods

Setting

We conducted a population-based study of all Ontario residents between 0 and 24 years of age who were dispensed a benzodiazepine, stimulant, antipsychotic, or antidepressant drug between January 1, 2018 and December 31, 2018. These individuals had universal access to prescription drug coverage, hospital care, and physicians' services. Our study was conducted at the level of Ontario census divisions, which represent a group of neighbouring municipalities designated as counties or regional districts for the purpose of regional planning and distribution of services. There were 49 census divisions in Ontario during the study period, ranging in total population from approximately 13,000 to 2,700,000 (3500 to 738,000 individuals aged 0 to 24) in 2016 [28].

Data sources

We identified claims for psychotropics using the Ontario Drug Benefit (ODB) database, which contains comprehensive records of all publicly-funded medications dispensed to Ontario residents. To ascertain patient comorbidity and the prevalence of antipsychotic-treated children and youth with diagnoses of schizophrenia and other psychotic disorders or autism spectrum disorder,

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we used the Ontario Health Insurance Plan (OHIP) database to identify claims for physician services. We also obtained diagnostic information from inpatient hospital admissions, emergency department visits, and mental health-related hospitalizations using the Canadian Institute for Health Information's Discharge Abstract Database, National Ambulatory Care Reporting System database, and Ontario Mental Health Reporting System database, respectively.

To determine if variation in psychotropic use was associated with the regional density of medical mental health and neurodevelopmental specialists, we used the ICES Physician Database to identify all active child and adolescent psychiatrists and developmental pediatricians in Ontario. We considered both specialists in a composite of medical mental health expertise because mental health conditions such as mood and psychotic disorders are typically treated by child and adolescent psychiatrists, whereas children and youth with neurodevelopmental conditions are typically treated by developmental pediatricians. We used the Registered Persons Database, a registry for all individuals eligible for Ontario health insurance, to determine demographic characteristics. These datasets were linked using unique encoded identifiers and analyzed at ICES in Toronto, Ontario (https://www.ices.on.ca). The use of data in this project is authorized under section 45 of Ontario's Personal Health Information Protection Act, which does not require review by a Research Ethics Board.

Statistical analysis
We calculated psychotropic dispensing rates as the number of prescriptions dispensed for benzodiazepines, stimulants, antidepressants and antipsychotics per 1000 Ontarians aged 0 to 24 years in each census division. Next, we conducted several analyses to measure variation in psychotropic dispensing rates across census divisions [29]. First, we determined the extremal quotient (EQ), defined as the ratio of the highest psychotropic dispensing rate to the lowest among the census divisions. Second, we determined the coefficient of variation (CV), defined as the ratio of the standard deviation of census division dispensing rates to the mean census division dispensing rate, weighted by the population in each census division to account for their unequal population sizes. We also determined the systematic component of variation (SCV), which measures the relative systematic component of variation in rates among census divisions by subtracting the random component of variance from the total variance. The SCV is therefore an estimate of the 'true' non-random variation, with values of 3.0 to 5.4, 5.5 to 10 and greater than 10 indicating moderate, high, and very high variation, respectively [29, 30]. Finally, we

compared individual census division dispensing rates with the rate for the province as a whole using chi-square tests, adjusting for multiple comparisons using a Type 1 error threshold of 0.001 (approximately 0.05/49) to adjust for multiple comparisons.

To identify sociodemographic correlates of variation in use, we used generalized estimating equations with a log-link function and exchangeable correlation structure to account for correlation within PHUs [31]. We conducted these analyses using the entire population of children and youth between the ages of 0 and 24 who had received a psychotropic drug during the study period and a 10% random sample of the remaining population of Ontario residents aged 24 and under. We used a 10% random sample of children and youth who were not prescribed a psychotropic drug to minimize the computational burden associated with including the entire population of these children and youth. The outcome variable was the number of individuals dispensed psychotropic drugs in each census division over the study period, using the census division population size of children and youth aged 24 and under as an offset term. We defined individual-level characteristics on the first dispensing date for recipients of psychotropic drugs and a randomly assigned index date during the study period for non-recipients. Characteristics considered for inclusion in models were those that we theorized might influence psychotropic need and access based on prior research, including age, sex, rural versus urban residence, and socioeconomic status, estimated at the neighbourhood level using postal code information and Statistics Canada census data.

We ascertained individual comorbidity in the prior 2 years using the Johns Hopkins ACG® System Version 10 case-mix assignment software. We specifically used ACG® System Aggregated Diagnosis Groups (ADGs), which are clusters of diagnostic codes with similar severity and expected persistence [32]. The count of ADGs ranges from 0 to 32, with higher values reflecting more comorbidity. Although we could not derive ADGs for individuals less than 2 years of age with this approach, these children comprised only 0.01% of the cohort. We also included census division characteristics that we theorized could influence access to or need for psychotropic medication, including the number of child and adolescent psychiatrists and developmental pediatricians, the number of facilities providing mental health care to children and youth (including hospital-based inpatient and outpatient programs and community children's mental health agencies), and the regional rate of mental health-related hospitalizations and emergency department visits among children and youth. Finally, we used information from the 2016 census to derive six social and economic characteristics of census divisions, including the mean

household size and the proportions of the population with post-secondary education, identifying as a visible minority, non-Canadian citizens, employed, and those who speak neither English nor French. We expressed the impact of individual- and census division-level variables as rate ratios (RR) and their 95% confidence intervals (CIs), defined as the prescribing rate in a category (e.g., rural) relative to the rate in the referent category (e.g., urban). We stratified analyses by psychotropic drug class to explore heterogeneity in determinants of prescribing among individuals undergoing treatment with antipsychotics, stimulants, benzodiazepines, and antidepressants, using generalized estimating equations with a log-link function, independent correlation structure and robust standard errors with clustering at the census division level. All analyses were conducted using SAS Enterprise Guide version 7.1 (SAS Institute, Cary, North Carolina, USA).

Results

We identified 306,470 children and youth who received psychotropic medication between January 1, 2018 and December 31, 2018. Compared with a random 10% sample of the general population not dispensed a psychotropic during this period ($N=371,800$), psychotropic medication recipients were older (median age 18 years;

interquartile range [IQR] 14 to 21 years versus 12 years; IQR 6 to 19 years; standardized difference (SD) = 0.75) and had a greater comorbidity burden as reflected by the proportion of individuals with ten or more ADGs (15.3% vs. 4.1%; SD = 0.39) (Table 1).

When stratified by psychotropic class, the majority of benzodiazepine and antidepressant recipients were female (63.2 and 64.9%, respectively), while antipsychotic and stimulant recipients were predominantly male (53.7 and 68.8%, respectively) (Supplemental Table 1). Furthermore, a socioeconomic gradient was observed in the use of stimulants, with greater use in the highest relative to the lowest income neighbourhoods (24.4% vs. 18.9%), with the converse being true for antipsychotics (17.3% vs. 26.0%) (Supplemental Table 1). As expected, children less than 5 years of age comprised the smallest proportion of children and youth receiving psychotropic drugs. In addition, benzodiazepine and antipsychotic recipients had a greater comorbidity burden than individuals receiving other classes, with nearly 1 in 4 individuals in both groups having 10 or more aggregated diagnosis groups (Supplemental Table 1).

Regional variation

The overall crude and age- and sex-adjusted rates of psychotropic dispensing in Ontario were 74.9 (range 40.1 to

Table 1 Baseline characteristics

Variable	Psychotropic recipients ($n=306,470$)	Non-psychotropic recipients[a] ($n=371,800$)	Standardized Difference
Age (median, IQR)	18 (14–21)	12 (6–19)	0.75
0–4	1175 (0.4%)	66,067 (17.8%)	0.63
5–9	30,060 (9.8%)	76,377 (20.5%)	0.30
10–14	50,826 (16.6%)	76,773 (20.6%)	0.10
15–19	98,517 (32.1%)	72,626 (19.5%)	0.29
20–24	125,892 (41.1%)	79,957 (21.5%)	0.43
Female, No. (%)	159,740 (52.1%)	179,670 (48.3%)	0.08
Income quintile			
1 (lowest)	62,279 (20.3%)	73,710 (19.8%)	0.01
2	57,947 (18.9%)	68,804 (18.5%)	0.01
3	57,269 (18.7%)	73,995 (19.9%)	0.03
4	60,796 (19.8%)	77,411 (20.8%)	0.02
5	68,179 (22.2%)	77,880 (20.9%)	0.03
Residence			
Urban	271,467 (88.6%)	336,659 (90.5%)	0.06
Rural	35,003 (11.4%)	35,141 (9.5%)	0.06
ADG Category			
0–5	147,812 (48.2%)	272,240 (73.2%)	0.53
6–9	111,880 (36.5%)	84,390 (22.7%)	0.31
≥ 10	46,778 (15.3%)	15,170 (4.1%)	0.39

[a] 10% random sample of children and youth who were not dispensed a psychotropic medication

139.8) and 76.9 (range 41.7 to 144.4) per 1000 population, respectively (Fig. 1). Five predominantly urban census divisions representing 44.2% of the provincial population of children and youth had psychotropic dispensing rates that were significantly lower than the provincial average ($p < 0.001$), while 43 census divisions representing 55.7% of the provincial population had rates significantly higher than the provincial average ($p < 0.001$).

The age- and sex-adjusted rates for antidepressants, stimulants, antipsychotics and benzodiazepines were 47.8 per 1000, 28.4 per 1000, 13.5 per 1000 and 9.7 per 1000, respectively (Supplemental Figs. 1, 2, 3 and 4). There was a moderate correlation between psychotropic dispensing rates and the density of clinics and agencies providing mental health care for children and youth (Spearman's rho 0.52; 95% CI 0.27 to 0.71) and rates of mental health hospitalizations and emergency department visits (Spearman's rho 0.48; 95% CI 0.22 to 0.68). Conversely, there was a weak negative correlation between psychotropic dispensing rates and the density of child and adolescent psychiatrists and developmental pediatricians

(Spearman's rho -0.32; 95% CI -0.56 to -0.03). The EQ, CV, and SCV were 3.5, 33.2 and 167.5, respectively, indicating large variations in the rates of psychotropic prescribing in children and youth across Ontario's census divisions following adjustment for the age and sex composition of the population. Results were similar when stratified by psychotropic class (Supplemental Table 2).

Correlates of variation

Following multivariable adjustment, individual-level variables most strongly associated with receiving a psychotropic included age and comorbidity burden (Table 2). Specifically, compared with individuals between 5 and 9 years of age, rates of psychotropic prescribing were lower among individuals between the ages of 0 to 4 years (RR 0.05; 95% CI 0.04 to 0.06), and higher among those aged 10 to 14 years (RR 1.43; 95% CI 1.37 to 1.49), 15 to 19 years (RR 1.83; 95% CI 1.71 to 1.96) and 20 to 24 years (RR 1.88; 95% CI 1.73 to 2.03). Similar findings were observed when analyses were stratified by psychotropic class, with the exception of stimulants, where rates were
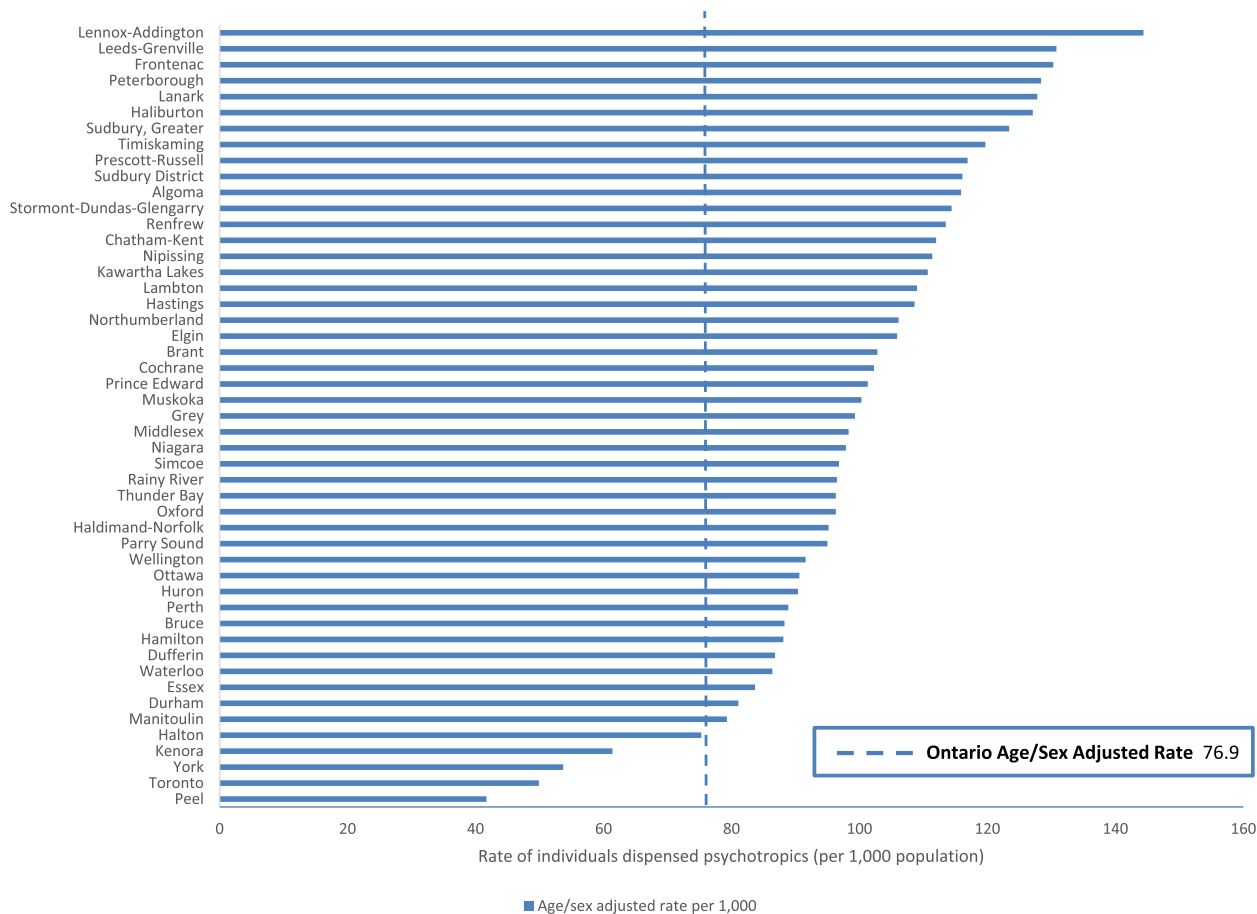

Fig. 1 Age- and sex-adjusted rates of individuals dispensed psychotropics by census division (per 1000 population)

Table 2 Individual and County Variables Associated with Psychotropic Dispensing to Children and Youth in Ontario, January 1, 2018, to December 31, 2018

Variable	All psychotropics (Adjusted rate ratio, 95% CI)	Antidepressants (Adjusted rate ratio, 95% CI)	Antipsychotics (Adjusted rate ratio, 95% CI)	Benzodiazepines (Adjusted rate ratio, 95% CI)	Stimulants (Adjusted rate ratio, 95% CI)
Individual-level variables					
Age					
0–4	0.05 (0.04 to 0.06)	0.02 (0.02 to 0.03)	0.14 (0.11 to 0.19)	0.46 (0.36 to 0,59)	0.04 (0.03 to 0.05)
5–9 (ref)	1.00	1.00	1.00	1.00	1.00
10–14	1.43 (1.37 to 1.49)	4.56 (4.09 to 5.08)	1.25 (1.18 to 1.32)	2.89 (2.55 to 3.27)	1.11 (1.08 to 1.14)
15–19	1.83 (1.71 to 1.96)	8.73 (7.60 to 10.03)	1.53 (1.38 to 1.69)	8.60 (7.39 to 10.01)	0.81 (0.77 to 0.85)
20–24	1.88 (1.73 to 2.03)	9.32 (8.05 to 10.79)	1.80 (1.58 to 2.05)	12.37 (10.50 to 14.58)	0.61 (0.55 to 0.67)
Sex					
Male	1.13 (1.11 to 1.15)	0.81 (0.80 to 0.82)	1.40 (1.36 to 1.44)	0.85 (0.83 to 0.88)	1.75 (1.70 to 1.80)
Female (ref)	1.00	1.00	1.00	1.00	1.00
Rurality					
Rural	0.93 (0.90 to 0.96)	0.95 (0.92 to 0.98)	0.90 (0.86 to 0.94)	0.94 (0.91 to 0.98)	0.91 (0.87 to 0.95)
Urban (ref)	1.00	1.00	1.00	1.00	1.00
Neighbourhood income quintile					
1 (ref)	1.00	1.00	1.00	1.00	1.00
2	0.97 (0.95 to 0.99)	1.01 (0.99 to 1.02)	0.88 (0.86 to 0.91)	1.01 (0.99 to 1.04)	0.97 (0.93 to 1.01)
3	0.93 (0.90 to 0.96)	0.98 (0.96 to 1.00)	0.81 (0.78 to 0.84)	0.98 (0.95 to 1.02)	0.95 (0.91 to 1.00)
4	0.92 (0.89 to 0.96)	0.98 (0.95 to 1.01)	0.75 (0.72 to 0.79)	1.00 (0.97 to 1.03)	0.95 (0.90 to 1.01)
5	0.92 (0.88 to 0.97)	0.97 (0.93 to 1.00)	0.72 (0.70 to 0.75)	1.01 (0.98 to 1.04)	1.00 (0.92 to 1.09)
ADG category					
0–5	1.00	1.00	1.00	1.00	1.00
6–9	1.58 (1.54 to 1.63)	1.53 (1.51 to 1.55)	1.77 (1.71 to 1.82)	1.82 (1.76 to 1.88)	1.5 (1.47 to 1.53)
≥ 10	1.88 (1.78 to 1.97)	1.73 (1.68 to 1.77)	2.33 (2.18 to 2.49)	2.61 (2.47 to 2.76)	1.71 (1.64 to 1.78)
Other psychotropic class		2.16 (2.03 to 2.3)	10.33 (9.64 to 11.07)	6.66 (6.16 to 7.2)	2.65 (2.51 to 2.79)
County-Level Variables					
Pediatric psychiatry/developmental pediatrician (count per 100,000)	1.00 (0.99 to 1.01)	1.00 (1.00 to 1.01)	1.00 (0.99 to 1.01)	1.00 (0.99 to 1.01)	1.01 (1.00 to 1.02)
Children and youth mental health agencies/services (per 1000 population)	1.07 (1.00 to 1.13)	0.98 (0.91 to 1.05)	0.82 (0.73 to 0.91)	1.12 (1.01 to 1.24)	1.11 (1.01 to 1.23)
Children and youth mental health hospital admissions/emergency department visits (per 1000 population)	1.00 (0.99 to 1.00)	1.00 (1.00 to 1.00)	1.00 (1.00 to 1.01)	0.99 (0.99 to 1.00)	0.99 (0.99 to 1.00)
% population with post-secondary education	1.01 (1.00 to 1.01)	1.00 (1.00 to 1.01)	1.00 (0.99 to 1.00)	1.00 (0.99 to 1.00)	1.01 (1.01 to 1.02)
% population that recognizes as visible minority	0.99 (0.99 to 0.99)	1.00 (0.99 to 1.00)	1.00 (0.99 to 1.00)	0.99 (0.98 to 1.00)	1.00 (0.99 to 1.00)
Mean number of persons per private household	0.90 (0.78 to 1.04)	0.83 (0.71 to 0.97)	0.88 (0.7 to 1.11)	1.34 (1.04 to 1.71)	0.74 (0.62 to 0.87)
% population that are not Canadian citizens	1.01 (0.99 to 1.02)	0.99 (0.97 to 1.01)	1.00 (0.98 to 1.02)	1.03 (1.00 to 1.07)	0.96 (0.94 to 0.97)
% population that is employed	1.00 (1.00 to 1.01)	1.00 (1.00 to 1.01)	1.00 (0.99 to 1.00)	0.99 (0.99 to 1.00)	1.00 (1.00 to 1.01)
% population that speaks neither English nor French	1.00 (0.98 to 1.01)	0.98 (0.96 to 0.99)	0.95 (0.93 to 0.97)	0.96 (0.94 to 0.99)	1.03 (1.01 to 1.04)

highest in individuals aged 10 to 14 years (RR 1.11; 95% CI 1.08 to 1.14) relative to individuals between the ages of 5 and 9. In addition, psychotropic dispensing rates were higher among individuals with high comorbidity burden. Specifically, those with 6 to 9 aggregated diagnosis groups (RR 1.58; 95% CI 1.54 to 1.63) and 10 or more (RR 1.88; 95% CI 1.78 to 1.97) aggregated diagnosis groups had higher dispensing rates relative to individuals with five or fewer aggregated diagnosis groups.

Although the use of psychotropic drugs was higher in males than females (RR 1.13; 95% CI 1.11 to 1.15), this finding was driven chiefly by higher rates of antipsychotic (RR 1.40; 95% CI 1.36 to 1.44) and stimulant (RR 1.75; 95% CI 1.70 to 1.80) use, with lower rates of benzodiazepine (RR 0.85; 95% CI 0.83 to 0.88) and antidepressant (RR 0.81; 95% CI 0.80 to 0.82) dispensing relative to females. A socioeconomic gradient was also observed, in which psychotropic dispensing rates were lower in the highest income neighbourhood (RR 0.92; 95% CI 0.88

to 0.97) relative to the lowest. This finding was driven mostly by variation in antipsychotics, the dispensing of which was 28% lower in the highest relative to the lowest income neighbourhoods (17.3% vs. 26.0%; RR 0.72, 95% 0.70 to 0.75). The proportion of antipsychotic-treated children and youth with a diagnosis of schizophrenia or other psychotic disorder in the 30- and 365-days prior to being dispensed a prescription for an antipsychotic was 16.6% ($n = 8919$) and 18,387 (34.2%), respectively, with little variation according to neighbourhood income quintile (Supplemental Table 3). Specifically, the proportions of antipsychotic-treated children and youth in the lowest and highest income neighbourhoods with a diagnosis of schizophrenia or other psychotic disorder in the 30 days prior to the antipsychotic dispensing date were 17.3% (2414/13,963) and 16.1% (1503/9329), respectively. Respective figures for a diagnosis of schizophrenia or other antipsychotic disorder within 365 days of the dispensing date were 34.5% (4851/13,963) and 33.7% (3141/9329) (Supplemental Table 3). The proportions of antipsychotic-treated children and youth with a diagnosis of autism spectrum disorder in the 30- and 365-days preceding the antipsychotic dispensing date were 3.2% ($n = 1731$) and 9.7% ($n = 5205$), respectively (Supplemental Table 3). In analyses stratified by neighbourhood income quintile, the proportions of antipsychotic-treated children and youth in the lowest and highest income neighbourhoods with a diagnosis of autism spectrum disorder in the 30 days prior to the antipsychotic dispensing date were 3.0% (421/13,963) and 3.3% (307/9329), respectively. Respective figures for a diagnosis of autism spectrum disorder within 365 days of the dispensing date were 8.9% (1241/13,963) and 10.3% (964/9329) (Supplemental Table 3).

Census division characteristics were also associated with psychotropic prescribing. Specifically, benzodiazepine (RR 1.12; 95% CI 1.01 to 1.24) and stimulant (RR 1.11; 95% CI 1.01 to 1.23) dispensing increased with the density of mental health services in census divisions, whereas antipsychotic use decreased (RR 0.82; 95% CI 0.73 to 0.91). Stimulant dispensing was also inversely associated with the mean number of individuals per household (RR 0.74; 95% CI 0.62 to 0.87) and the proportion of the census division population that are not Canadian citizens (RR 0.96; 95% CI 0.94 to 0.97). Conversely, benzodiazepine dispensing increased with household size (RR 1.34; 95% CI 1.04 to 1.71) and the proportion of the population that are not Canadian citizens (RR 1.03; 95% CI 1.00 to 1.07). Census division characteristics that were not associated with psychotropic dispensing included the regional density of child and adolescent psychiatrists and developmental pediatricians (RR 1.00; 95% CI 0.99 to

1.01) and regional rates of mental health hospital admissions and emergency department visits per 1000 children and youth (RR 1.00; 95% CI 0.99 to 1.00) (Table 2).

Discussion

In our population-based study, we found substantial variation in the magnitude and nature of psychotropic dispensing among Ontario children and youth, with demographic factors, comorbidity burden, socioeconomic status, and the availability of mental health services being important determinants of use. Although we observed a positive correlation between psychotropic dispensing and regional rates of mental health-related hospitalizations and emergency department visits, this association was not apparent following multivariable adjustment. Similarly, the regional density of child and adolescent psychiatrists and developmental pediatricians was not associated with psychotropic dispensing. Overall, our findings suggest that important disparities may exist in the use of psychotropics among children and youth despite universal access to medications and medical mental health services.

Our findings add to earlier studies exploring variation in prescription psychotropic drug use among children and youth. Although our findings associating psychotropic prescribing rates with age, male sex and comorbidity are similar to those of prior studies [33–36], we additionally quantified the extent and determinants of variation by individual drug classes, thereby allowing us to identify medication use patterns that are otherwise obscured when examining only psychotropic dispensing as a whole. Similarly, most prior studies have focused on geographic variability in stimulant use across the United States or variation in psychotropic dispensing across Canadian provinces [14–17, 37]. In contrast, we explored small-area variation in the use of four classes of psychotropic drugs in a single Canadian province. In addition, previous studies have focused on specific subpopulations of children and youth that vary according to certain characteristics, such as health insurance status and contact with the child welfare system. In contrast, we studied the entire population of children and youth treated with psychotropic drugs. Because these individuals had access to publicly financed health care, including prescription drugs, our work extends the study of geographic variability in psychotropic use among children and youth to a setting with universal health insurance. Finally, although other studies have examined population-wide psychotropic drug use in children and youth, they have generally been focused on evaluating trends over time [5, 38–40]. Conversely, we focused on geographic variation identify

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patterns of psychotropic use and its correlates in the largest population of children and youth in Canada.

Several mechanisms may explain the patterns of psychotropic dispensing observed in our study. Specifically, antipsychotic prescribing rates were inversely associated with neighbourhood income, and were highest in the lowest income neighbourhoods of Ontario. This is important, because antipsychotics are primarily used for the management of non-psychotic disorders and externalizing symptoms in children and youth [41, 42], require regular monitoring for adverse metabolic effects [43], and have been associated with an increased risk of death [44]. Our finding correlating psychotropic dispensing with mental health related hospitalizations and emergency department visits suggests that some variation in dispensing could reflect need and variation in rates of mental health conditions according to region and/or socioeconomic status. However, it does not appear that variation in need alone explains the variability in antipsychotic dispensing by socioeconomic status, as the proportion of antipsychotic-treated children and youth with a diagnosis of schizophrenia or other psychotic disorder in the 30 and 365 days preceding their prescription was similar across neighbourhood income quintile groups. In contrast, the prevalence of stimulant prescribing was greatest among children living in the highest-income neighbourhoods. This finding is consistent with past research demonstrating lower treatment rates in low-income children with attention-deficit hyperactivity disorder (ADHD) despite being as or more likely than high-income children to meet the diagnostic criteria for this condition [45]. Because all children had access to publicly funded health care and prescription drugs during our study period, it is possible that differential access to supportive specialty services contributes to the observed socioeconomic disparities in treatment. Although speculative, this assertion is supported by the lack of association between the density of publicly funded child and adolescent psychiatrists and developmental pediatricians with psychotropic dispensing rates, but higher rates of stimulant use and lower rates of antipsychotic use with an increasing density of mental health facilities providing comprehensive diagnostic assessments and access to allied health professionals and non-pharmacologic therapies that are not otherwise covered if not accessed through these organizations. Notably, treatment guidelines for most disorders in children and youth, with the exception of disorders producing psychosis, recommend starting with non-pharmacologic behavioural or psychological therapies [46–48]. However, wait times for publicly-funded child and youth mental health services in Ontario have increased considerably,

potentially delaying access to non-pharmacologic therapy and diagnostic assessment [49]. This may exacerbate income-related disparities in psychotropic medication use because higher-income families have the means to access non-pharmacologic mental health care through private funding, forcing low-income families to rely on medical settings for care in which the mainstay of treatment is medication. Prior research demonstrating that fewer than half of children and youth dispensed antipsychotics received non-pharmacological services in the preceding 90 days supports the notion of pharmacologic substitution with antipsychotics for managing non-psychotic conditions in children and youth [11].

Implicit bias on the part of healthcare professionals, educators and child-care workers, in which the behaviours of low-income children are disproportionately problematized relative to children from higher-income families, could also contribute to the greater use of antipsychotic drugs in low-income children and youth [50, 51]. This assertion is supported by U.S. research demonstrating a greater likelihood of diagnosis with conduct or oppositional defiance disorders among low-income African-American and Hispanic-American youth relative to non-Hispanic white children and youth, despite exhibiting comparable behaviours [52–56]. However, further research would be required to ascertain whether implicit bias is contributing to the patterns of psychotropic dispensing observed in our study.

Psychotropic dispensing was also influenced by household size and the proportion of the population that were non-Canadian citizens. Specifically, benzodiazepine dispensing rates were higher as the mean number of individuals per private dwelling increased, whereas the converse was true for stimulants. Existing research examining the association between family size and mental health in children and youth is limited and inconclusive, with studies demonstrating protective and deleterious effects of increased family size on the mental health of children and youth [57, 58]. In addition, past research has found a delayed diagnosis of ADHD in households with more children, potentially supporting our findings [59]. Further research examining the association between household size and mental health outcomes is needed. In addition, our finding of an inverse association between stimulant dispensing and the proportion of the population that are not Canadian citizens is similar to prior research demonstrating less use of these drugs among immigrants [60–63]. Whether this reflects less access to diagnostic testing and treatment, implicit bias on the part of health-care providers or teachers, cultural responses to health and illness or a combination of the above requires further study.

Our results have implications for practice and policy. Specifically, our findings associating the nature of psychotropic medication dispensing with the availability of services suggests that increasing access to publicly funded physician-based and non-pharmacologic services is needed to minimize wait times and antipsychotic use. However, cost, staff retention, and the size of the available clinician workforce limit the extent and pace with which system delivery enhancements can be implemented. Clinician education and training programs enabling concordance with treatment guidelines and best practices are alternative approaches for optimizing psychotropic drug use in children and youth, with several programs in the United States demonstrating improved prescribing appropriateness for stimulants and antipsychotics [64, 65]. A similar approach has been implemented in Ontario through Project Extension of Community Health Outcomes (ECHO) [66]. Project ECHO Ontario uses an innovative continuing professional education model to train health care providers throughout the province to provide specialist-level care to children and youth with mental health and neurodevelopmental conditions, with over 700 providers being trained since 2016. Evaluation of the program is ongoing.

Some limitations of our work merit emphasis. First, we did not have access to various individual-level characteristics that have been previously identified as determinants of psychotropic use, including contact with the child welfare system, race, and juvenile justice system involvement. Similarly, we lacked information regarding regional variation in illness, school-based interventions and the regional availability of community-based social workers, psychologists, and other professionals in private practice specializing in the care of children and youth with mental health and neurodevelopmental conditions. Our analyses should therefore be considered descriptive, with further research needed that considers these additional variables to better understand the observed variations. Second, we cannot ascertain whether variation in psychotropic rates represents overuse or underuse in specific populations. However, we believe that both may be occurring in the context of stimulant and antipsychotic use given the socioeconomic disparities observed, prior research, and associations with the regional density of mental health services. Finally, our study was conducted in a single Canadian province in the year universal funding of medications for all children and youth was introduced, potentially limiting the generalizability of our findings. However, our study includes all children and youth dispensed psychotropic drugs in a setting of publicly funded healthcare. Our findings of disparities that persist despite universal health care may be transferable to similar settings where prescription drugs are provided at no cost to children and youth.

Conclusions

In summary, we found considerable variation and potential disparities in psychotropic use among children and youth across Ontario. Most notably, socioeconomic gradients in antipsychotic use highlight the possibility of systemic inequity in access to non-pharmacological behavioural and psychosocial interventions despite universal pharmacare and publicly funded access to physician specialists. Targeted investment in regions with long wait times for publicly funded non-pharmacological interventions and novel service delivery models promoting clinician collaboration and education may help minimize disparities and promote best practices in psychotropic drug prescribing to children and youth.

Abbreviations

EQ	Extremal quotient
CV	Coefficient of variation
SCV	Systematic component of variation
ADGs	Aggregated diagnosis groups
RR	Rate ratio
CIs	Confidence intervals
IQR	Interquartile range
SD	Standardized difference
ADHD	Attention-deficit hyperactivity disorder
ECHO	Extension of Community Health Outcomes

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-022-14677-6.

Additional file 1: Supplemental Fig. S1. Age and sex adjusted rates of individuals dispensed antidepressants by census division (per 1000 population). **Supplemental Fig. S2.** Age and sex adjusted rates of individuals dispensed stimulants by census division (per 1000 population). **Supplemental Fig. S3.** Age and sex adjusted rates of individuals dispensed benzodiazepines by census division (per 1000 population). **Supplemental Fig. S4.** Age and sex adjusted rates of individuals dispensed antipsychotics by census division (per 1000 population).

Additional file 2: Supplemental Table 1. Baseline Variables by Drug Class. **Supplemental Table 2.** Small area variation analysis of psychotropic prescribing by drug class. **Supplemental Table 3.** Diagnosis of schizophrenia and other antipsychotic disorders or autism spectrum disorder in the 30 and 365 days preceding antipsychotic dispensing.

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Availability of data and materials
The data set from this study is not available publicly and is held securely in coded form at ICES. While data sharing agreements prohibit ICES from making the data set publicly available, access may be granted to those who meet pre-specified criteria for confidential access, available at www.ices.on.ca/DAS. The full data set creation plan and underlying analytic code are available from the authors upon request, understanding that the programs may rely upon coding templates or macros that are unique to ICES.

Declarations

Ethics approval and consent to participate
ICES is an independent, non-profit research institute whose legal status under Ontario's health information privacy law allows it to collect and analyze health care and demographic data, without consent, for health system evaluation and improvement. The use of data in this project was authorized under section 45 of Ontario's Personal Health Information Protection Act without the requirement for research ethics board approval. All methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication
Not applicable.

Competing interests
Melanie Penner has received consulting fees for unrelated work from Addis & Associates/Roche and from the Government of Nova Scotia. Mina Tadrous has received consulting fees for unrelated work from Green Shield Canada and the Canadian Agency for Drugs and Technologies in Health. Tara Gomes has received funding from the Ontario MOH for unrelated work. Tony Antoniou has no competing interests. Daniel McCormack has no competing interests. Sophie Kitchen has no competing interests. Kathleen Pajer has no competing interests. William Gardner has no competing interests. Muhammad Mamdani has no competing interests. Yona Lunsky has no competing interests. David Juurlink has no competing interests.

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References
1. Servais J, Ramage-Morin PL, Gal J, Hales CM. Prescription medication use among Canadian children and youth, 2012 to 2017. Health Rep. 2021;32:3–16.
2. Pringsheim T, Stewart DG, Chan P, Tehrani A, Patten SB. The Pharmacoepidemiology of psychotropic medication use in Canadian children from 2012 to 2016. J Child Adolesc Psychopharmacol. 2019;29:740–5.
3. Jack RH, Hollis C, Coupland C, Morriss R, Knaggs RD, Butler D, et al. Incidence and prevalence of primary care antidepressant prescribing in children and young people in England, 1998-2017: a population-based cohort study. PLoS Med. 2020;17:e1003215.
4. Gómez-Lumbreras A, Garcia Sangenis A, Prat Vallverdú O, Gatell Carbó A, Vedia Urgell C, Gisbert Gustemps L, et al. Psychotropic use in children and adolescents in Scandinavia and Catalonia: a 10-year population-based study. Psychopharmacology. 2021;238:1805–15.
5. Steinhausen HC. Recent international trends in psychotropic medication prescriptions for children and adolescents. Eur Child Adolesc Psychiatry. 2015;24:635–40.
6. Kurdyak P, Zaheer J, Cheng J, Rudoler D, Mulsant BH. Changes in characteristics and practice patterns of Ontario psychiatrists. Can J Psychiatr. 2017;62:40–7.
7. Thomas KC, Ellis AR, Konrad TR, Holzer CE, Morrissey JP. County-level estimates of mental health professional shortage in the United States. Psychiatr Serv. 2009;60:1323–8.
8. Sharma AN, Arango C, Coghill D, Gringras P, Nutt DJ, Pratt P, et al. BAP position statement: off-label prescribing of psychotropic medication to children and adolescents. J Psychopharmacol. 2016;30:416–21.
9. Leckman-Westin E, Finnerty M, Scholle SH, Pritam R, Layman D, Kealey E, et al. Differences in Medicaid antipsychotic medication measures among children with SSI, Foster Care, and income-based aid. J Manag Care Spec Pharm. 2018;24:238–46.
10. Massuti R, Moreira-Maia CR, Campani F, Sônego M, Amaro J, Akutagava-Martins GC, et al. Assessing undertreatment and overtreatment/misuse of ADHD medications in children and adolescents across continents: a systematic review and meta-analysis. Neurosci Biobehav Rev. 2021;128:64–73.
11. Finnerty M, Neese-Todd S, Pritam R, Leckman-Westin E, Bilder S, Byron SC, et al. Access to psychosocial services prior to starting antipsychotic treatment among Medicaid-insured youth. J Am Acad Child Adolesc Psychiatry. 2016;55:69–76.e3.
12. Harris E, Sorbero M, Kogan JN, Schuster J, Stein BD. Concurrent mental health therapy among Medicaid-enrolled youths starting antipsychotic medications. Psychiatr Serv. 2012;63:351–6.
13. Harati PM, Cummings JR, Serban N. Provider-level caseload of psychosocial services for Medicaid-insured children. Public Health Rep. 2020;135:599–610.
14. McDonald DC, Jalbert SK. Geographic variation and disparity in stimulant treatment of adults and children in the United States in 2008. Psychiatr Serv. 2013;64:1079–86.
15. Piper BJ, Ogden CL, Simoyan OM, Chung DY, Caggiano JF, Nichols SD, et al. Trends in use of prescription stimulants in the United States and territories, 2006 to 2016. PLoS One. 2018;13:e0206100.
16. Lin SJ, Crawford SY, Lurvey PL. Trend and area variation in amphetamine prescription usage among children and adolescents in Michigan. Soc Sci Med. 2005;60:617–26.
17. Cox ER, Motheral BR, Henderson RR, Mager D. Geographic variation in the prevalence of stimulant medication use among children 5 to 14 years old: results from a commercially insured US sample. Pediatrics. 2003;111:237–43.
18. Tseregounis IE, Stewart SL, Crawford A, Marshall BDL, Cerdá M, Shev AB, et al. Age- and sex-specific increases in stimulant prescribing rates-California, 2008-2017. J Atten Disord. 2020;24:205–14.
19. Habel LA, Schaefer CA, Levine P, Bhat AK, Elliott G. Treatment with stimulants among youths in a large California health plan. J Child Adolesc Psychopharmacol. 2005;15:62–7.

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20. Raghavan R, Lama G, Kohl P, Hamilton B. Interstate variations in psychotropic medication use among a national sample of children in the child welfare system. Child Maltreat. 2010;15:121–31.
21. Leslie LK, Raghavan R, Hurley M, Zhang J, Landsverk J, Aarons G. Investigating geographic variation in use of psychotropic medications among youth in child welfare. Child Abuse Negl. 2011;35:333–42.
22. Rubin D, Matone M, Huang YS, Feudtner C, Localio R. Interstate variation in trends of psychotropic medication use among Medicaid-enrolled children in foster care. Child Youth Serv Rev. 2012;34:1492–9.
23. Soria Saucedo R, Liu X, Hincapie-Castillo JM, Zambrano D, Bussing R, Winterstein AG. Prevalence, time trends, and utilization patterns of psychotropic Polypharmacy among pediatric Medicaid beneficiaries, 1999-2010. Psychiatr Serv. 2018;69:919–26.
24. Candon M, Shen S, Fadeyibi O, Smith JL, Rothbard A. Trends in antipsychotic prescribing for approved and unapproved indications to Medicaid-enrolled youth in Philadelphia, Pennsylvania between 2014 and 2018. BMC Psychiatry. 2021;21:524.
25. Bushnell GA, Crystal S, Olfson M. Trends in antipsychotic medication use in young privately insured children. J Am Acad Child Adolesc Psychiatry. 2021;60:877–86.
26. Ministry of Health and Long-Term Care. OHIP+: Children and Youth Pharmacare Key Facts for Prescribers. Available at: https://www.afhto.ca/wp-content/uploads/ohip_prescriber-002.pdf. Accessed 2 June 2022.
27. Statistics Canada. Focus on Geography Series, 2016 Census. Available at: https://www12.statcan.gc.ca/census-recensement/2016/as-sa/fogs-spg/Index-eng.cfm. Accessed 2 June 2022.
28. Statistics Canada. Census Profile, 2016 Census. Available at: https://www12.statcan.gc.ca/census-recensement/2016/dp-pd/prof/search-recherche/lst/results-resultats.cfm?Lang=E&TABID=1&G=1&Geo1=&Code1=&Geo2=&Code2=&GEOCODE=35&type=0. Accessed 2 June 2022.
29. Diehr P, Cain K, Connell F, Volinn E. What is too much variation? The null hypothesis in small-area analysis. Health Serv Res. 1990;24:741–71.
30. Appleby J, Raleigh V, Frosini F, Bevan G, Gao H, Lyscom T. Variations in Health Care: the Good, the Bad and the Inexplicable. Available at: http://www.kingsfund.org.uk/sites/files/kf/field/field_publication_file/Variations-in-health-care-good-bad-inexplicable-report-The-Kings-Fund-April-2011.pdf. Accessed 12 Apr 2022.
31. Liang KY, Zeger SL. Longitudinal data analysis using generalized linear models. Biometrika. 1986;73:13–22.
32. The Johns Hopkins ACG System (Johns Hopkins University, Baltimore) Available: www.hopkinsacg.org. Accessed 15 Apr 2022.
33. Sultan RS, Correll CU, Schoenbaum M, King M, Walkup JT, Olfson M. National Patterns of commonly prescribed psychotropic medications to young people. J Child Adolesc Psychopharmacol. 2018;28:158–65.
34. Olfson M, King M, Schoenbaum M. Treatment of young people with antipsychotic medications in the United States. JAMA Psychiatry. 2015;72:867–74.
35. Olfson M, King M, Schoenbaum M. Stimulant treatment of young people in the United States. J Child Adolesc Psychopharmacol. 2016;26:520–6.
36. Sidorchuk A, Isomura K, Molero Y, Hellner C, Lichtenstein P, Chang Z, et al. Benzodiazepine prescribing for children, adolescents, and young adults from 2006 through 2013: a total population register-linkage study. PLoS Med. 2018;15:e1002635.
37. Arora N, Knowles S, Gomes T, Mamdani MM, Juurlink DN, Carlisle C, et al. Interprovincial variation in antipsychotic and antidepressant prescriptions dispensed in the Canadian pediatric population. Can J Psychiatr. 2016;61:758–65.
38. Leong C, Katz LY, Bolton JM, Enns MW, Delaney J, Tan Q, et al. Psychotropic drug use in children and adolescents before and during the COVID-19 pandemic. JAMA Pediatr. 2022;176:318–20.
39. Barczyk ZA, Rucklidge JJ, Eggleston M, Mulder RT. Psychotropic medication prescription rates and trends for New Zealand children and adolescents 2008-2016. J Child Adolesc Psychopharmacol. 2020;30:87–96.
40. Hoffmann F, Glaeske G, Bachmann CJ. Trends in antidepressant prescriptions for children and adolescents in Germany from 2005 to 2012. Pharmacoepidemiol Drug Saf. 2014;23:1268–72.
41. Sohn M, Moga DC, Blumenschein K, Talbert J. National trends in off-label use of atypical antipsychotics in children and adolescents in the United States. Medicine (Baltimore). 2016;95:e3784.
42. Hoekstra PJ, Dietrich A. First do no harm: use off-label antipsychotic medication in children and adolescents with great caution. Eur Child Adolesc Psychiatry. 2022;31:1–3.
43. Pringsheim T, Panagiotopoulos C, Davidson J, Ho J. CAMESA guideline group. Evidence-based recommendations for monitoring safety of second generation antipsychotics in children and youth. J Can Acad Child Adolesc Psychiatry. 2011;20:218–33 Erratum in: J Can Acad Child Adolesc Psychiatry 2011;20:1–2.
44. Ray WA, Stein CM, Murray KT, Fuchs DC, Patrick SW, Daugherty J, et al. Association of Antipsychotic Treatment with Risk of unexpected death among children and youths. JAMA Psychiatry. 2019;76:162–71.
45. Froehlich TE, Lanphear BP, Epstein JN, Barbaresi WJ, Katusic SK, Kahn RS. Prevalence, recognition, and treatment of attention-deficit/hyperactivity disorder in a national sample of US children. Arch Pediatr Adolesc Med. 2007;161:857–64.
46. Walter HJ, Bukstein OG, Abright AR, Keable H, Ramtekkar U, Ripperger-Suhler J, et al. Clinical practice guideline for the assessment and treatment of children and adolescents with anxiety disorders. J Am Acad Child Adolesc Psychiatry. 2020;59:1107–24.
47. Barbaresi WJ, Campbell L, Diekroger EA, Froehlich TE, Liu YH, O'Malley E, et al. Society for Developmental and Behavioral Pediatrics Clinical Practice Guideline for the assessment and treatment of children and adolescents with complex attention-deficit/hyperactivity disorder. J Dev Behav Pediatr. 2020;41(Suppl 2S):S35–57.
48. Wolraich ML, Hagan JF Jr, Allan C, Chan E, Davison D, Earls M, et al. Subcommittee on children and adolescents with attention-deficit/hyperactive disorder. Clinical practice guideline for the diagnosis, evaluation, and treatment of attention-deficit/hyperactivity disorder in children and adolescents. Pediatrics. 2019;144:e20192528.
49. Children's Mental Health Ontario. Kids can't wait: 2020 report on wait lists and wait times for child and youth mental health care in Ontario. Available at: https://cmho.org/wp-content/uploads/CMHO-Report-WaitTimes-2020.pdf. Accessed 2 June 2022.
50. FitzGerald C, Hurst S. Implicit bias in healthcare professionals: a systematic review. BMC Med Ethics. 2017;18:19.
51. Fadus MC, Ginsburg KR, Sobowale K, Halliday-Boykins CA, Bryant BE, Gray KM, et al. Unconscious Bias and the diagnosis of disruptive behavior disorders and ADHD in African American and Hispanic youth. Acad Psychiatry. 2020;44:95–102.
52. Sabol TJ, Kessler CL, Rogers LO, Petitclerc A, Silver J, Briggs-Gowan M, et al. A window into racial and socioeconomic status disparities in preschool disciplinary action using developmental methodology. Ann N Y Acad Sci. 2022;1508:123–36.
53. Mason MA, Gibbs JT. Patterns of adolescent psychiatric hospitalization: implications for social policy. Am J Orthop. 1992;62:447–57.
54. Feisthamel K, Schwartz R. Differences in mental health counselors' diagnoses based on client race: an investigation of adjustment, childhood, and substance-related disorders. J Ment Health Couns. 2009;31:47–59.
55. Mandell DS, Ittenbach RF, Levy SE, Pinto-Martin JA. Disparities in diagnoses received prior to a diagnosis of autism spectrum disorder. J Autism Dev Disord. 2007;37:1795–802.
56. Mizock L, Harkins D. Diagnostic bias and conduct disorder: improving culturally sensitive diagnosis. Child Youth Serv. 2011;32:243–53.
57. Grinde B, Tambs K. Effect of household size on mental problems in children: results from the Norwegian mother and child cohort study. BMC Psychol. 2016;4:31.
58. Riordan DV, Morris C, Hattie J, Stark C. Family size and perinatal circumstances, as mental health risk factors in a Scottish birth cohort. Soc Psychiatry Psychiatr Epidemiol. 2012;47:975–83.
59. Hoang U, James AC, Liyanage H, Jones S, Joy M, Blair M, et al. Determinants of inter-practice variation in ADHD diagnosis and stimulant prescribing: cross-sectional database study of a national surveillance network. BMJ Evid Based Med. 2019;24:155–61.
60. Ghosh M, Holman CD, Preen DB. Exploring parental country of birth differences in the use of psychostimulant medications for ADHD: a whole-population linked data study. Aust N Z J Public Health. 2015;39:88–92.
61. Knopf H, Hölling H, Huss M, Schlack R. Prevalence, determinants and spectrum of attention-deficit hyperactivity disorder (ADHD) medication of children and adolescents in Germany: results of the German health interview and examination survey (KiGGS). BMJ Open. 2012;2:e000477.

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62. Wittkampf LC, Smeets HM, Knol MJ, Geerlings MI, Braam AW, De Wit NJ. Differences in psychotropic drug prescriptions among ethnic groups in the Netherlands. Soc Psychiatry Psychiatr Epidemiol. 2010;45:819–26.

63. Ghosh M, Holman CDJ, Preen DB. Identifying cross-cultural variations in psychostimulant use for attention deficit hyperactivity disorder using linked data. Child Adolesc Psychiatry Ment Health. 2017;11:16.

64. Thackeray J, Crane D, Fontanella C, Sorter M, Baum R, Applegate M. A Medicaid quality improvement collaborative on psychotropic medication prescribing for children. Psychiatr Serv. 2018;69:501–4.

65. Kelleher KJ, Rubin D, Hoagwood K. Policy and practice innovations to improve prescribing of psychoactive medications for children. Psychiatr Serv. 2020;71:706–12.

66. Furlan AD, Pajer KA, Gardner W, MacLeod B. Project ECHO: building capacity to manage complex conditions in rural, remote and underserved areas. Can J Rural Med. 2019;24:115–20.