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RESEARCH ARTICLE

Association between Weight Status and Mental Health Service Utilization in Children and Adolescents

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Abstract

Background: Previous literature reports inconsistent associations between obesity and mental health. The objective of this study was to determine the association between weight status and mental health service utilization in Ontario children and youth. **Methods**: A cross-sectional study of children 0 to 18 years, identified using primary care electronic medical records from the EMRPC database in Ontario, Canada was conducted. Height and weight data were extracted to calculate BMI and linked to administrative data on mental health related outpatient visits, emergency department visits, and hospitalizations. Multivariable logistic regression models were performed. **Results**: A total of 50,565 children were included. Overall, 2.2% were underweight, 70.4% had a normal weight, 18.3% were overweight, 6.9% had obesity and 2.2% had severe obesity. 28.2% of all children had at least one mental health visit. Multivariable analyses showed children with overweight, obesity, and severe obesity were 1.11 (95% CI 1.05-1.17), 1.18 (95% CI 1.08-1.27) and 1.39 (95% CI 1.22-1.59) times more likely to have an outpatient mental health visit compared to children with normal weight. **Conclusion**: Increased weight status was associated with mental health related outpatient visits and emergency department visits. This study may inform policy makers' planning of mental health resources for children with obesity and severe obesity.

Key Words: *body mass index, severe obesity, mental health service use, electronic medical records*

Résumé

Contexte: La littérature antérieure rapporte des associations irrégulières entre obésité et santé mentale. L'objectif de la présente étude était de déterminer l'association entre le statut pondéral et l'utilisation des services de santé mentale chez les enfants et les adolescents de l'Ontario. **Méthodes**: Une étude transversale d'enfants de 0 à 18 ans qui utilisait des dossiers médicaux électroniques des soins primaires tirés de la base de donnés EMRPC de l'Ontario, Canada a été menée. Les données sur la taille et le poids ont été extraites pour calculer l'indice de masse corporelle (IMC) et couplées aux données administratives sur la santé mentale liées aux visites de patients ambulatoires, aux visites au service d'urgence, et aux hospitalisations. Des modèles de régression logistique multivariée ont été exécutés. **Résultats**: Au total, 50 565 enfants ont été inclus. En général, 2,2 % avaient un poids insuffisant, 70,4 % avaient un poids normal, 18,3 % avaient un excès de poids, 6,9 % présentaient une obésité et 2,2 % avaient une grave obésité. Parmi tous les enfants, 28,2 % avaient au moins une visite de santé mentale. Les analyses multivariées ont indiqué que les enfants ayant un excès de poids, une obésité et une grave obésité étaient 1,11 fois (IC à 95 % 1,05 à 1,17), 1,18 fois (IC à 95 % 1,08 à

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1,27) et 1,39 fois (IC à 95 % 1,22 à 1,59) plus susceptibles d'avoir une visite ambulatoire de santé mentale comparé aux enfants de poids normal. **Conclusion**: Le statut pondéral accru était associé à des visites ambulatoires pour des raisons de santé mentale et à des visites au service d'urgence. Cette étude peut éclairer les décideurs dans leur planification des ressources de santé mentale pour les enfants souffrant d'obésité et de grave obésité.

Mots clés: *indice de masse corporelle, grave obésité, utilisation des services de santé mentale, dossiers médicaux électroniques*

Introduction

As childhood obesity remains an international focus, many countries are working to understand and accommodate the unique healthcare needs of this population. In Canada, approximately one in three children are overweight or obese (Rodd & Sharma, 2016), and thus are at an increased risk of poor cardiovascular health (Skinner, Perrin, Moss, & Skelton, 2015), asthma (Gold, Damokosh, Dockery, & Berkey, 2003), impaired glucose tolerance (Sinha et al., 2002), and poor mental health outcomes (Halfon, Larson, & Slusser, 2013; Tiffin, Arnott, Moore, & Summerbell, 2011). In particular, previous literature examining the association between weight status and mental health found that children with obesity have more internalizing (Kirk, Kuhle, Ohinmaa, Colman, & Veugelers, 2012) and externalizing behaviours (Janicke, Harman, Kelleher, & Zhang, 2008) and were three times as likely to have depressive and/or anxiety disorders (Anderson, Cohen, Naumova, Jacques, & Must, 2007) and twice as likely to have attention deficit hyperactivity disorder (Erhart et al., 2012).

There may be two potential mechanisms underlying the association between obesity and mental health outcomes. Firstly, the exposure to weight bias, stigma, and bullying, particularly for school-aged children may be associated with increased risk of poor mental health outcomes (Hebebrand & Herpertz-Dahlmann, 2009; Skinner et al., 2017). Secondly, the association may be based on dysregulated stress systems such as the hypothalamic-pituitary-adrenal (HPA) axis which is a key element in the shared biology of obesity and depression (Bornstein, Schuppenies, Wong, & Licinio, 2006). This dysregulation could be exacerbated in early childhood during the critical period of rapid brain development. Some studies have found no associations between weight status and mental health problems (Hampl, Carroll, Simon, & Sharma, 2007; Morrison, Shin, Tarnopolsky, & Taylor, 2014), and findings vary by sex, age, and mental health diagnosis (Erhart et al., 2012; Griffiths, Dezateux, & Hill, 2011; Lu et al., 2012). The majority of these studies were examining children older than 7 years, with small clinical samples of youth, or had limitations in the measurement of either weight status or mental health outcomes.

Other research has shown that children with increased weight status also have higher mental health service utilization (Hering, Pritsker, Gonchar, & Pillar, 2009). These studies, however, focused on mental health specialist visits (Estabrooks & Shetterly, 2007; Trakas, Lawrence, & Shear, 1999), which represent only 27.4% and 47.9% of child and adolescent general health care visits prompted by mental health concerns, respectively. This suggests that true levels of mental health service utilization may have been previously underestimated (Olfson, Blanco, Wang, Laje, & Correll, 2014). Furthermore, this association has not been examined in younger children or children with severe obesity, the population with possibly the greatest risk of health care use given that adults with severe obesity were almost twice as likely to visit a mental health provider compared to healthy weight peers (Espallardo et al., 2017). With 70% of mental health problems beginning in childhood (Government of Ontario, 2011), there is a possibility that findings in adults reflect mental health problems beginning earlier in life.

In recent years there has been an increase in the rates of mental health service utilization in children in the province of Ontario in Canada (Gandhi et al., 2016). Examining the association between weight status and mental health service use in children will allow practitioners, and policy makers to better anticipate and support the health care needs of children with obesity, with a goal of providing appropriate timely mental health support to prevent long-term problems throughout the lifespan. The objective of this study was to determine the association between weight status and mental health service utilization in children and adolescents 0 to 18 years of age in Ontario.

Methods

Study Design and Population

This was a cross-sectional study that included children 0 to 18 years old as of March 31, 2015, identified through the Electronic Medical Records Primary Care database (EMRPC; also known as EMRALD); held at ICES. As of 2015, EMRPC was comprised of 54,964 children registered to 339 family physicians, at 41 primary care practices across Ontario. 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. This study was approved by the Research Ethics Boards at Sunnybrook Health Sciences and the Hospital for Sick Children.

Patients were included in the study population if they met the following criteria: patients had to be less than 19 years old as of March 31, 2015, have a valid height and weight measurement to calculate body mass index z-score (zBMI), be registered to an EMRPC physician who was using the EMR for a minimum of two years, and have a valid identification number to link with the administrative databases at ICES. Children <28 days old were excluded in order to avoid capturing neonatal hospitalization codes. Missing data on covariates were less than 5% so complete case analysis was performed.

Mental Health Service Utilization

Mental health service utilization was defined as any outpatient visit to a family physician, pediatrician or psychiatrist with an Ontario Health Insurance Plan (OHIP) mental health billing code, and any emergency department (ED) visit or any hospitalization for a mental health problem, defined by International Classification of Disease 10 (ICD-10) diagnostic codes. If multiple visits were listed, the most proximal visit to the date of measured height and weight was used. All diagnostic codes used to define mental health related service use are outlined in the ICES Mental Health and Addictions Scorecard Evaluative Framework (MHASEF) (MHASEF Research Team, 2017a). This outcome should be conceptualized as health care use for mental health concerns rather than health care use for children seeking mental health services. For example, children <5 years may have behavioural problems or neurodevelopmental disorders that are associated with health care use and are captured under the umbrella term 'mental health outcomes'.

Definition of Weight Status

BMI z-scores (zBMI) were calculated by dividing weight (kg) by height squared (m^2), measured on the same date, and standardizing values by age and sex to the World Health Organization (WHO) Growth Standards and Reference (WHO, 2006). Height and weight data were cleaned using a standard set of data cleaning rules (Smith et al., 2010) and zBMI values outside -5 and +5 were excluded based on WHO recommendations for biologically implausible values (WHO, 1995). The most recent valid zBMI measurement was used and categorized by WHO definitions. For children <5 years, zBMI <-2 were categorized as underweight, zBMI≥ -2 to ≤1 as normal weight, zBMI >1 to ≤2 as 'at risk for overweight', zBMI ≥2 to <3 as overweight and zBMI >3 as obesity. For children ≥5 years, zBMI <-2 were categorized as underweight, zBMI≥ -2 to ≤1 as normal weight, zBMI>1 to ≤2 as overweight, zBMI>2 to ≤3 as obesity and zBMI>3 as severe obesity. The z-score categories for both <5 and ≥5 years old correspond approximately to the 85th, 97th and 99.9th BMI percentiles, respectively.

Covariates

Several potential confounding factors were included in the multivariate analyses between weight status and mental health service use. These were identified a priori based on the literature, and included: age, sex, rural or urban residence, and neighbourhood income quintile (Flores & Lin, 2013; Goodman, Slap, & Huang, 2003; MHASEF Research Team, 2017b). Neighbourhood income quintile was used as a proxy for socioeconomic status, and was based on the patient's postal code. The Ontario Registered Persons Database (RPDB) was used to acquire postal code which was linked to the 2006 Canadian Census data to obtain neighbourhood income quintile and rural/urban status (Glazier, Zagorski, & Rayner, 2012). These datasets were linked using unique encoded identifiers and analyzed at ICES.

Statistical Analysis

Descriptive statistics were performed for all outcome, exposure and covariate variables to determine variable distributions, frequencies and to assess normality. Descriptive characteristics were stratified by sex to determine any significant differences between the two groups using chi-square tests.

Univariate associations between weight status and lifetime mental health service use were examined for each mental health service outcome (outpatient visits, ED visits, and hospitalizations) stratified by age; children <5 and ≥5 years of age. BMI z-score was used both as a categorical variable. Multivariable logistic regression models were then examined for the relationship between zBMI and mental health related outpatient and ED visits, adjusted for age, rural or urban residence, and income quintile. To further investigate the association between zBMI and outpatient visits, models were stratified by sex and age group (<5, 5 to 9, 10 to 14 and 15+ years). When examining the age and sex stratified associations between weight status and ED visits, sample size restrictions made the models for categorical data unstable, and so stratification was only performed by sex for children ≥5 years. Very few patients had a hospitalization for mental health in this study sample therefore no further multivariable regression models were performed.

Sensitivity Analyses

In order to improve the precision of the estimated association between weight status and mental health service utilization, we narrowed the time frame a priori between exposure and outcome based on previous health services research (Gill et al., 2017; Omand et al., 2017). For patients with a mental health outpatient visit, the observation window to have a valid zBMI was limited to two years before or after the mental health outpatient visit. For patients with a mental health-related ED visit, the observation window was limited to five years because there were fewer ED visits. If multiple measurements were available, the measurement closest to the mental health visit date was selected. For the

comparison group of children without a mental health visit, the most recent visit with a valid zBMI measurement was used. Analyses were performed using SAS Enterprise version 7.1 (SAS Institute, Cary, North Carolina).

Results

Study Population

In total, 50,565 children had a valid zBMI measurement recorded in the EMRPC database. Figure 1 shows the cohort exclusions; 201 children were less than 28 days of age (0.37%), 6.5% of children had incomplete data, and 1.6% had inaccurate data. Study sample characteristics are presented in Table 1. Overall, 2.2% were underweight (zBMI<-2), 70.4% had a normal weight (-2≤ zBMI ≤1), 18.3% were at risk of overweight/overweight (1< zBMI ≤2), 6.9% had overweight status/obesity (2< zBMI ≤3), and 2.2% had obesity/severe obesity (zBMI>3). A significantly higher proportion of boys had overweight status, obesity, and severe obesity compared to girls. There were no significant differences in rural status, or income quintile. Table 2 presents the proportion of mental health outpatient visits, ED visits, and hospitalizations by age and weight status. Overall, 14,266 (28.2%) children had at least one mental health service visit.

Mental Health Outpatient Visits

Of children and adolescents 5 to 18 years, the prevalence of severe obesity was 3.0%. Fifty-one percent of those with severe obesity had a mental health related outpatient visit compared to 40% of children at a normal weight (Table 2). In adjusted logistic regression analyses, there were

Figure 1. Selection of study sample from EMRPC cohort

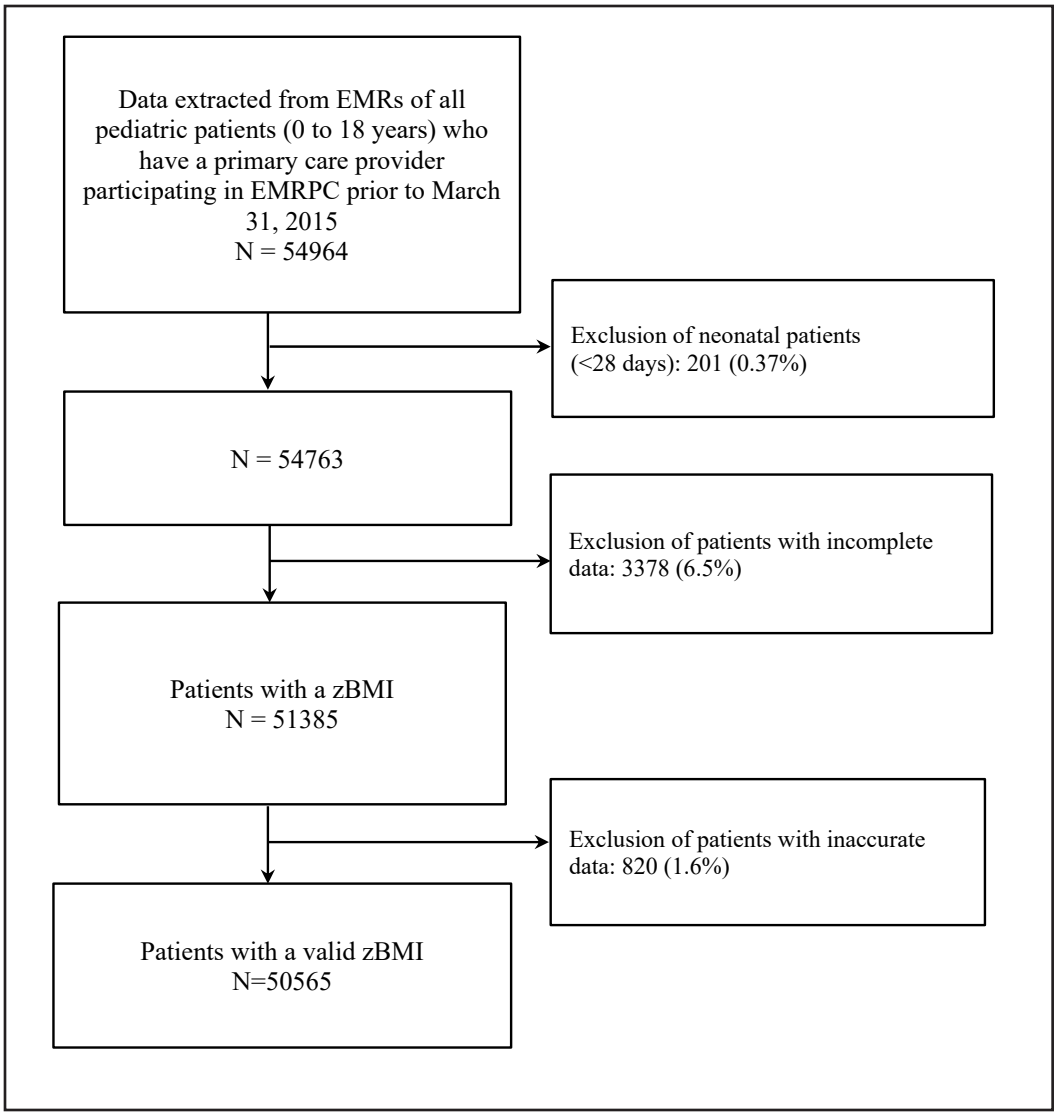

Table 1. Baseline demographics of selected EMRPC cohort (N=50565)

	Total		Females		Males	
	N	%	N	%	N	%
Age Group						
0-4	23091	45.6%	11249	45.0%	11842	46.3%
5-9	13764	27.2%	6782	27.1%	6982	27.3%
10-14	9173	18.1%	4518	18.1%	4655	18.2%
15-18	4537	9.0%	2445	9.8%	2092	8.2%
Weight Status						
Underweight (-2> zBMI)	1133	2.2%	554	2.2%	599	2.3%
Normal Weight (-2≤ zBMI ≤1)	35597	70.4%	18038	72.2%	17539	68.6%
Overweight (1< zBMI ≤2)	9247	18.3%	4417	17.7%	4830	18.3%
Obesity (2< zBMI ≤3)	3482	6.9%	1533	6.1%	1949	7.6%
Severe Obesity (zBMI > 3)	1106	2.2%	452	1.8%	654	2.2%
Sex						
Female	24994	49.43%				
Male	25571	50.57%				
Rural Status						
Rural	8840	17.7%	4394	17.8%	4446	17.6%
Urban	41221	82.3%	20600	82.2%	21125	82.4%
Income Quintile						
1- Lowest	7867	15.8%	3846	15.4%	4021	15.7%
2	8876	17.8%	4410	17.6%	4466	17.5%
3	10770	21.6%	5362	21.5%	5408	21.1%
4	11086	22.2%	5454	21.8%	5632	22.0%
5- Highest	11314	22.7%	5602	22.4%	5712	22.3%

significant associations between increased weight status and outpatient mental health visits (Table 3). Children with overweight, obesity, and severe obesity were 1.11 (95% CI 1.05-1.17), 1.18 (95% CI 1.08-1.27) and 1.39 (95% CI 1.22-1.59) times more likely to have an outpatient mental health visit compared to children with a normal weight.

Table 4 presents stratified analyses by age group and sex. There were significant associations between weight status and lifetime mental health outpatient visits for boys <5 years who had overweight and obesity, 5 to 9 years who had overweight and obesity, 10 to 14 years with severe obesity, and 15 to 19 years with obesity. In girls, there were significant associations between weight status and mental health services use at age 5 to 9 years (overweight and obesity), 10 to 14 years with underweight and obesity, and girls 15 to 19 years with severe obesity. Of those children with severe obesity and a mental health outpatient visit, the main diagnostic codes were behavioural disorders (24.8%), anxiety (24.2%), habit spasms, tics, stuttering, tension headaches, anorexia nervosa, sleep disorders, enuresis (14.6%), and educational problems (11.5%).

Mental Health Emergency Department (ED) Visits

Overall, 3.8% of children and adolescents with severe obesity had an ED visit compared to 2.5% of normal weight children. The adjusted logistic regression analysis showed children 5 to 18 with overweight status had a 1.20 (95% CI 1.00-1.44) times higher odds and with obesity had a 1.28 (95% CI 1.01-1.62) higher odds of a mental health related ED visit compared to children at normal weight. After stratifying by sex, weight status was significantly associated with outpatient visits in girls, but had no association in boys (Table 5). The main emergency department admission ICD-10 codes included anxiety disorder (unspecified) (17.7%), acute stress reaction (13.6%), and depressive episode (unspecified) (10.1%).

Table 2. Lifetime utilization of mental health-related services including outpatient visits, emergency department visits, and hospitalizations

	Total		Outpatient visits		ED visits		Hospitalizations	
Weight status	N	%	N	%	N	%	N	%
All Ages	50565		14198	28.1	825	1.6	N/A	
< 5 years	23091	45.7	2552	11.1	47	0.2	N/A	
Underweight (-2 > zBMI)	608	2.6	55	9.0	<6			
Normal Weight (-2≤ zBMI ≤1)	16787	72.7	1803	10.7	34	0.2		
Risk of Overweight (1< zBMI ≤2)	4242	18.4	507	12.0	7	0.2		
Overweight (2< zBMI ≤3)	1159	5.0	137	11.8	<6			
Obesity (zBMI > 3)	295	1.3	50	16.9	<6			
≥ 5 years	27474	54.3	11646	42.4	778	2.8	252	0.9
Underweight (-2 > zBMI)	545	2.0	244	44.8	15	2.8	10	1.8
Normal Weight (-2≤ zBMI ≤1)	18790	68.4	7583	40.4	477	2.5	159	0.8
Overweight (1< zBMI ≤2)	5005	18.2	2269	45.3	166	3.3	45	0.9
Obesity (2< zBMI ≤3)	2323	8.5	1137	48.9	89	3.8	28	1.2
Severe Obesity (zBMI > 3)	811	3.0	413	50.9	31	3.8	10	1.2

Table 3. AORs and 95% CIs for having a lifetime mental health outpatient or emergency department visit by weight status

	Outpatient visit	Emergency department visit
Variable	OR (95% CI)	OR (95% CI)
Weight status		
Underweight	1.12 (0.96-1.30)	1.15 (0.68-1.95)
Overweight	1.11 (1.05-1.17)	1.20 (1.00-1.44)
Obese	1.18 (1.08-1.27)	1.28 (1.01-1.62)
Severely obese	1.39 (1.22-1.59)	1.20 (0.82-1.77)
Sex (ref=Female)	1.40 (1.34-1.46)	0.87 (0.75-1.01)
Age (years)	1.21 (1.21-1.22)	1.28 (1.25-1.31)
Rural residence	0.87 (0.82-0.92)	1.38 (1.16-1.64)
Income quintile (ref=1, lowest)		
2	0.87 (0.81-0.94)	0.90 (0.72-1.14)
3	0.78 (0.73-0.84)	0.74 (0.59-0.93)
4	0.79 (0.73-0.84)	0.61 (0.48-0.77)
5 - highest	0.79 (0.74-0.85)	0.60 (0.47-0.76)

AOR = Adjusted Odds Ratio

Mental Health Hospitalizations

Overall, 252 children ≥5 years were hospitalized with a mental health related diagnostic code. The main ICD-10 diagnostic codes were severe depressive episode without psychotic symptoms (18.5%), adjustment disorders (11.0%), anorexia nervosa (9.1%), and unspecified depressive episode (8.7%).

Sensitivity Analyses

When we examined the relationship between BMI z-score and mental health outpatient visits using a two year window of observation rather than lifetime occurrence, we found similar results. In adjusted analyses children categorized as overweight, obese, and severely obese had a 1.27 (95% CI 1.18-1.37), 1.18 (95% CI 1.05-1.33), and 1.63 (95% CI 1.33-1.99) higher odds of having a mental health outpatient visit compared to children at normal weights (Supplemental Table 1). Analyses stratified by age and sex demonstrated similar relationships to the main results, however some associations lost significance (Supplemental Table 2).

Similarly, we examined the relationship between BMI z-score and mental health ED visits using a five-year window of observation and demonstrated similar trends to the lifetime occurrence (Supplemental Table 3). Children

Table 4. AORs (95% CI) of a lifetime outpatient mental health related visit by age group and sex (reference = normal weight)

	Female OR* (95% CI)	Male OR* (95% CI)
0 to 4 years		
Underweight	1.30 (0.87-1.93)	0.88 (0.58-1.33)
At risk of overweight	1.11 (0.94-1.32)	1.09 (0.95-1.26)
Overweight	0.82 (0.58-1.16)	1.30 (1.03-1.63)†
Obesity	1.29 (0.72-2.30)	1.53 (1.05-2.24)†
5 to 9 years		
Underweight	1.02 (0.68-1.53)	0.78 (0.54-1.11)
Overweight	1.22 (1.05-1.42)†	1.27 (1.11-1.45)†
Obesity	1.29 (1.04-1.60)†	1.24 (1.02-1.51)†
Severe obesity	1.36 (0.94-1.97)	1.06 (0.81-1.40)
10 to 14 years		
Underweight	2.17 (1.43-3.30)†	1.01 (0.66-1.55)
Overweight	1.06 (0.92-1.23)	1.06 (0.92-1.23)
Obesity	1.23 (1.00-1.51)†	0.99 (0.82-1.18)
Severe obesity	1.24 (0.85-1.80)	1.51 (1.08-2.11)†
15 to 18 years		
Underweight	1.96 (0.82-4.64)	1.70 (0.87-3.33)
Overweight	1.07 (0.86-1.33)	0.96 (0.76-1.21)
Obesity	1.18 (0.86-1.63)	1.40 (1.03-1.90)†
Severe obesity	1.74 (1.11-2.74)†	1.36 (0.81-2.28)

AOR = Adjusted Odds Ratio
*Adjusted for age, rural residence, income quintile
†Indicates significance with p-value<0.05

with overweight had 1.30 (95% CI 1.07-1.57) higher odds of having a mental health ED visit and those with obesity had a 1.32 (95% CI 1.03-1.68) times higher odds. The association was no longer significant for children who were underweight or severely obese. After stratifying analyses by sex, only girls who were overweight, obese or severely obese demonstrated an association between weight status and mental health ED visits.

Discussion

This study was a preliminary exploration of the association between weight status and mental health service utilization in children and youth in Ontario. We examined mental health service use from 0 to 18 years, across all weight status categories including severe obesity. Our findings demonstrated that increased weight status was associated with increased mental health related outpatient visits and emergency department visits. However, the strength of this association varied by age, sex, and type of service utilization.

These findings corroborate work by Estabrooks and Shetterly (2007), who found that children 3 to 17 years old with class I obesity (>95th percentile of BMI-for-age compared to the CDC 2000 growth charts) were more likely to have a specialist mental health visit within 1 and 3 years of follow up compared to those with BMI between the 85th-94th percentile (overweight). Conversely, the findings are in contrast to a study by Bianchi-Hayes (2015), which concluded that children 4 to 18 years with overweight or obesity were not more likely to have a mental health visit compared to their normal weight peers (Bianchi-Hayes et al., 2015). However, that study relied on self-reported measures of specialist mental health visits over the past year, and survey-based data have been shown to underreport levels of mental health service use when compared to administrative sources (Drapeau, Boyer, & Diallo, 2011).

The present study also noted important age and sex differences in the association between weight status and mental health service utilization. Boys <5 years with overweight and obesity were more likely to incur outpatient visits for mental health concerns. At this age, boys are more predisposed to ADHD, oppositional defiant disorder, and neurodevelopmental disorders such as autism, compared to girls, which often present in outpatient settings (Baron-Cohen et al., 2011). Autism and weight status have been linked

Table 5. AORs (95% CI) of a lifetime emergency department mental health related visit by sex

Emergency department visit lifetime	Girls OR* (95% CI)	Boys OR* (95% CI)
Underweight	0.99 (0.43-2.29)	1.27 (0.64-2.51)
Overweight	1.41 (1.10-1.80)†	0.99 (0.75-1.31)
Obesity	1.62 (1.81-2.23)†	0.99 (0.70-1.42)
Severe obesity	1.57 (0.96-2.56)	0.86 (0.46-1.59)

AOR = Adjusted Odds Ratio
*Adjusted for age, rural residence, income quintile
†Indicates significance with p-value<0.05

in previous literature, with elevated weight status in children with this condition noted as early as 2 to 5 years of age (Presmanes Hill, Zuckerman, & Fombonne, 2015). Our findings support these associations; boys <5 and 5-9 amassed the largest number of visits for behavioural disorders, educational problems, delays in development, and childhood psychoses including autism (Ozonoff, Heung, Byrd, Hansen, & Hertz-Picciotto, 2008). Diagnostic codes for anxiety were most common for girls 5-9 and 10-14 years old, as well as boys 10-14 years old.

Another notable sex difference occurred between ages 10-14 years in outpatient mental health visits; boys with severe obesity were significantly more likely to have a mental health outpatient visit. While girls were also more likely to incur a mental health outpatient visit, the relationship was only borderline significant. However, there was the emergence of a strong relationship between underweight status and outpatient mental health visits in girls, likely due to eating disorders (Kurz, van Dyck, Dremmel, Munsch, & Hilbert, 2015; Reinehr et al., 2017). Interestingly, girls with overweight and obesity were significantly more likely to incur a mental health related ED visit. There is an established link between mental health conditions such as anxiety and female sex (McLean, Asnaani, Litz, & Hofmann, 2011), which can present acutely in emergency settings. This is also supported by existing literature, which shows an association between increased BMI and increased levels of anxiety and depression in girls and women ages 9-40 years (Anderson, Cohen, Naumova, & Must, 2006).

The main strength of this study is the large sample of children with measured weight and height data and population-based administrative data on mental health care utilization. Previous studies used physician reported diagnosis of obesity as the measure of weight status, which likely underreports true prevalence (Walsh, Milliren, Feldman, & Taveras, 2013). We also demonstrated strong associations with the severe obesity weight status category in Canadian children and adolescents which has been previously unstudied. This population may require more intensive services to treat the mental health disorder and provide weight management simultaneously. Finally, the sensitivity analyses performed to narrow our window of observation strengthened the magnitude of the effect for outpatient visits, although lost significance in some stratified models, likely related to small sample size.

There are several limitations to this study. The data were cross-sectional and we categorized the outcome into a dichotomous variable, therefore these results cannot be used to infer causality nor assess a dose-response. We were not able to control for other comorbidities or medications, such as psychotropic medication use, which are known to be associated with weight changes and may have influenced weight measurements in our study (Hasnain & Vieweg, 2013). It is also important to note that we were not able to control for the onset of puberty in this age group. Puberty is associated with both changes in body weight (Jasik & Lustig, 2008) and mental health outcomes such as affective disorders (Ladouceur, 2012), and may have confounded the relationship between weight status and mental health service utilization; however, associations were found in prepubertal children as well. The inclusion of a wide age range for this association may have attenuated some effects. For example, even in the 0 to 4 age group, coding visits for mental health concerns may be different for children less than 2 years compared to preschool aged children. The outcome for this study was mental health service utilization, using a broad definition of 'mental health' that includes behavioural problems and neurodevelopmental disorders, and therefore findings cannot be used to draw conclusions regarding weight status and diagnosed mental health problems in the population. Further, data on non-physician mental health services such as visits to social work and psychologists were unavailable. Although, using administrative data, Steele et al. demonstrated the validity of using administrative mental health diagnostic codes to capture mental health service utilization in the adult primary care setting (Steele, Glazier, Lin, & Evans, 2004). Finally, all of the children included had access to a primary care physician, and the results may not be generalizable beyond this population.

Despite these limitations, this study suggests that children with obesity and severe obesity have increased mental health service utilization. Health care providers may consider screening for and addressing mental health concerns early on in children with overweight, obesity and severe obesity. Our study highlights the important role for primary care providers in early identification of both overweight and obesity status and mental health concerns (Gill et al., 2017). Children, particularly those at younger ages, visit their primary care providers often. This provides an excellent opportunity for pediatricians and family physicians to identify and refer, when appropriate, to further mental health interventions as well as behavioural weight management programs that directly address mental health. Moreover, another important implication may be providing ongoing education for primary care providers on sensitive and effective identification of mental health concerns in children with higher weight status, including reducing weight stigma, to enable healthful conversations between primary care providers, children, and families about their weight status (Provvidenza, Hartman, & McPherson, 2019). Supporting family physicians by having additional mental health services co-located at the clinic site has also been shown to improve uptake of these services (Kates et al., 2019). Future research should use longitudinal data to investigate the directionality of the relationship between weight status and mental health service utilization and assess causal pathways. Psychotropic medication use and costs could also be considered as other measures of mental health service utilization in future work. Examining the mechanisms of the relationship between weight status and specific mental health conditions will allow for a better understanding of how to provide care for children and adolescents with these prevalent health concerns.

Acknowledgements / Conflicts of Interest

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Supplemental Table 1. Sensitivity analyses for outpatient and emergency department mental health related visits within a two year window of weight status (reference = normal weight)

Variable	Outpatient Visit OR (95% CI)	Emergency department visit OR (95% CI)
Weight Status (ref=normal)		
Underweight	0.86 (0.73-1.02)	1.27 (0.73-2.20)
Overweight	1.27 (1.18-1.37)	1.30 (1.07-1.46)
Obesity	1.18 (1.05-1.33)	1.32 (1.03-1.71)
Severe obesity	1.63 (1.33-1.99)	1.28 (0.85-1.91)
Sex (ref=Female)	1.42 (1.34-1.50)	0.79 (0.67-0.92)
Age (years)	1.16 (1.15-1.16)	1.30 (1.27-1.33)
Rural residence	0.92 (0.85-1.00)	1.46 (1.21-1.75)
Income quintile (ref=1, lowest)		
2	0.89 (0.81-0.98)	0.91 (0.71-1.16)
3	0.81 (0.74-0.89)	0.76 (0.59-0.97)
4	0.79 (0.72-0.87)	0.61 (0.48-0.79)
5 - highest	0.75 (0.69-0.82)	0.62 (0.48-0.80)

Supplemental Table 2. Odds Ratios (95% CI) of an outpatient mental health related visit by age group and sex within a two year window of weight status (reference = normal weight)

Outpatient visit (2 year window)	Female OR (95% CI)	Male OR (95% CI)
0 to 4 years		
Underweight	1.30 (0.96-1.75)	0.87 (0.65-1.17)
At risk of overweight	1.11 (0.92-1.34)	1.27 (1.09-1.47)†
Overweight	1.02 (0.70-1.48)	1.19 (0.91-1.56)
Obesity	1.55 (0.87-2.76)	1.30 (0.82-2.08)
5 to 9 years		
Underweight	1.40 (0.72-2.72)	1.17 (0.73-1.89)
Overweight	1.49 (1.21-1.84)†	1.10 (0.92-1.31)
Obesity	1.24 (0.90-1.70)	1.01 (0.77-1.32)
Severe obesity	1.42 (0.82-2.47)	0.34 (0.92-1.93)
10 to 14 years		
Underweight	1.25 (0.58-2.67)	0.97 (0.48-1.95)
Overweight	1.26 (0.98-1.61)	1.12 (0.89-1.41)
Obesity	1.50 (1.07-2.10)†	1.14 (0.85-1.52)
Severe obesity	1.11 (0.58-2.15)	1.26 (0.65-2.45)
15 to 18 years		
Underweight	0.65 (0.12-3.41)	1.18 (0.37-3.82)
Overweight	1.10 (0.73-1.66)	1.06 (0.69-1.61)
Obesity	0.80 (0.43-1.49)	1.27 (0.74-2.19)
Severe obesity	1.34 (0.51-3.56)	1.98 (0.80-4.94)

*Adjusted for age, rural residence, income quintile
†Indicates significance with p-value<0.05

Supplemental Table 3. Odds Ratios (95% CI) of an emergency department mental health related visit within five years of weight status by sex, ages 5-18 years (reference = normal weight)

Emergency department visit 5 year window	Female OR (95% CI)	Male OR (95% CI)
Underweight	1.13 (0.49-2.61)	1.40 (0.68-2.89)
Overweight	1.50 (1.17-1.93)	1.09 (0.81-1.46)
Obesity	1.65 (1.18-2.30)	1.04 (0.71-1.52)
Severe obesity	1.66 (1.00-2.76)	0.87 (0.44-1.72)

*Adjusted for age, rural residence, income quintile