

Changes in the prevalence of overweight, obesity, and severe obesity between 2010 and 2017 in preschoolers: A population-based study

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Summary

We evaluated changes in overweight, obesity, and severe obesity in a population of 4- to 6-year-olds from 2010 to 2017. Anthropometric data were collected during children's preschool immunization visits in Edmonton and Calgary, Alberta, Canada. Body mass index (BMI), BMI z scores, and weight status categories were based on the World Health Organization criteria. Across 8 years, we examined population-level data from 161 114 children in which the prevalence of overweight (17.8%-15.7%; $P < .001$) and obesity (4.7%-4.2%; .004) decreased, while severe obesity (2.4%-2.2%; .3) remained unchanged. Overweight decreased in both boys (19.2%-16.8%; $P < .0001$) and girls (16.4%-14.6%; .003); obesity decreased in boys (5.3%-4.4%; .005), but not girls (4.1%-3.9%; .2). Severe obesity was stable in both sexes. Annual household income and breast feeding had positive, but variable moderating effects on overweight and obesity exclusively. Overall, reductions in overweight and obesity were positive findings, but targeted strategies are needed to reduce severe obesity in preschoolers.

KEYWORDS

Canada, obesity, preschoolers, prevalence

1 | INTRODUCTION

The prevalence of overweight and obesity in children remains high,¹⁻³ but recent reports suggest that excess weight has either plateaued or decreased in recent years.^{4,5} Most pediatric studies have focused on the prevalence of overweight and obesity exclusively, yet health risks often increase with increasing levels of body fatness, leading to growing interest in studying severe obesity in children.^{6,7} Indeed, there are clinically important differences in cardiometabolic risk factors between children with overweight or obesity versus severe obesity,^{8,9} whereby insulin resistance, blood pressure, and triglycerides tend to worsen across increasing categories of excess weight. These findings are relevant for population-level, obesity prevention initiatives (eg, policies to promote healthy nutrition in schools) since they may have variable impacts across different weight categories. Also, there is value in examining trends in excess weight among preschool-aged children since

maternal and family-level factors can have proximal and protective effects on children's weight and health early in life.¹⁰ The preschool years represent a critical period of development within which to promote optimal growth and development, especially in light of longitudinal data showing more than 80% of 4-year-olds with obesity grow to have overweight or obesity in adolescence.¹¹ With these issues in mind, our purpose was to examine changes in the prevalence of overweight, obesity, and severe obesity from 2010 to 2017 in a population of preschoolers (4- to 6-year-olds) from Alberta, Canada and determine the influence of maternal and family-level factors on excess weight.

2 | METHODS

This population-based study included children born between January 1, 2005 and August 31, 2013 with anthropometric measurements

collected between January 1, 2010 and August 31, 2017. Anthropometric data were retrieved from the Alberta Health Services (AHS) Public Health Database, which included age at time of assessment, date of birth, sex, measured height (to the nearest 0.1 cm), and measured weight (to the nearest 0.1 kg). Using standardized equipment and measurement protocols, public health nurses collected data from children and their parents who attended public health clinics in Edmonton and Calgary, the two major urban municipalities in the province of Alberta, Canada, which collectively represent approximately two thirds of the 4.3 million residents in the province. The AHS Public Health Database captures information on the source of children's nutrition and breast feeding data at all visits that occur prior to 24 months of age. For Calgary, the Public Health Database was available only at those visits for immunization purposes, namely, the 2-, 4-, 6-, 12-, and 18-month visits; for Edmonton, data were available at visits for immunization and well-child check-ups. The database was also linked to the Alberta Population Registry, which contains information on year of birth, sex, and postal code for all Alberta residents registered for provincial health insurance. Algorithms from the University of Calgary Ethnicity Program and the Institute for Clinical Evaluative Studies (ICES) Ethnicity Program were applied on the earliest mother surname available in the Alberta Population Registry, which allowed us to categorize children's ethnicity as either *Chinese*, *South Asian*, or *General Population*.¹²⁻¹⁴ Census data (2011) from Statistics Canada were linked at the Forward Sortation Area level, which were based on the first three digits of the postal code. Annual household income at the neighborhood level in 2010 was used as a measure of families' socioeconomic status.

We defined children's weight status based on BMI (kg/m^2) and the World Health Organization criteria^{15,16} using the last available BMI measurement at children's preschool age (4 y or older and younger than 7 y of age). The WHO applies different terms for categories of excess weight for younger (younger than 5 y old) versus older (5 y or older) children, so for simplicity and to remain consistent with previous reports,^{17,18} we refer to these different increasing weight categories as *not overweight* (BMI z score less than or equal to 1), *overweight* (BMI z score greater than 1, but less than or equal to 2), *obesity* (BMI z score greater than 2, but less than or equal to 3), and *severe obesity* (BMI z score greater than 3).

We defined breast feeding in the first 6 months of life if an infant was reported as being breast fed at any visit selected from (a) the 2- or 4-month immunization visit (for Calgary) and (b) any visit that occurred between 7 and 180 days after birth (for Edmonton).

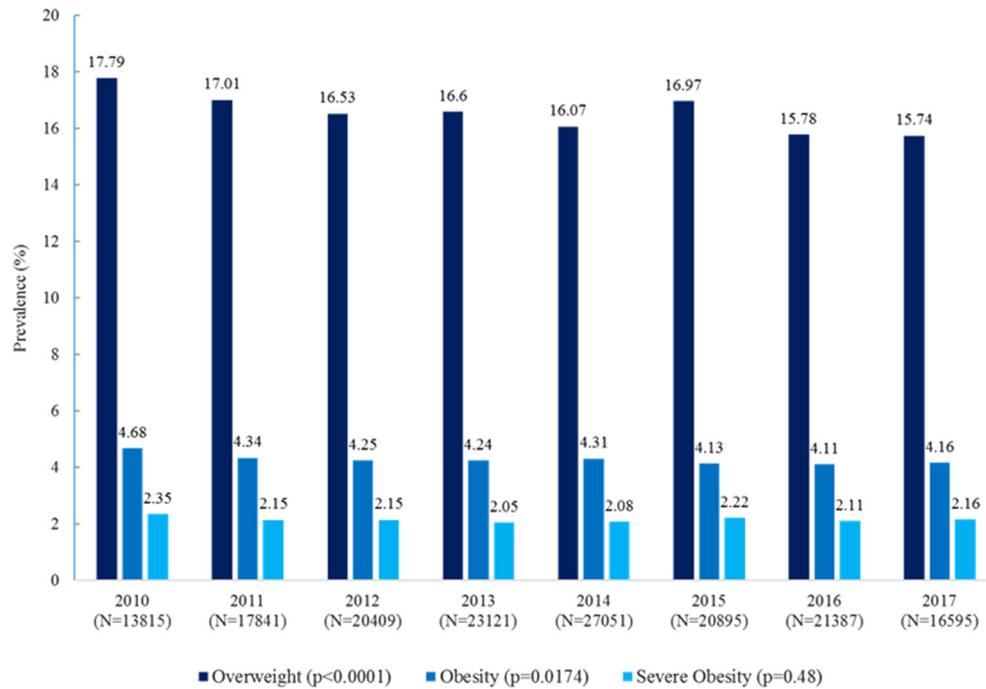
We compared child sex, anthropometry, annual household income, ethnicity, and breast feeding practices in preschoolers across the four weight categories. Categorical variables were presented using counts and percentages, with comparisons using the χ^2 test. Continuous variables were presented using means and standard deviations, with comparisons using one-way analysis of variance. Trends from 2010 to 2017 across the four weight categories were assessed in the overall group by sex, by quartiles of annual household income, and by breast feeding practices using multinomial regression with weight category as a nominal outcome and year as the only predictor. All statistical

analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC, USA) and P values $< .05$ were considered statistically significant. The University of Alberta Human Research Ethics Board approved this study.

3 | RESULTS

Across an 8-year period, we examined population-level data from 161 114 children (2010: $n = 13\ 815$; 2011: $n = 17\ 841$; 2012: $n = 20\ 409$; 2013: $n = 23\ 121$; 2014: $n = 27\ 051$; 2015: $n = 20\ 895$; 2016: $n = 21\ 387$; and 2017: $n = 16\ 595$). The ratio of girls-to-boys did not differ by year (girls: 48.5%-49.4%; boys: 50.6%-51.5%; P for trend = .4). On the basis of the number of total babies born 4 to 6 years prior to data collection, we accessed and analyzed anthropometric data on 66.3% of all preschoolers living in Edmonton and Calgary, a proportion that was similar across years (low: 62.3%; high: 69.7%). The prevalence of overweight (17.8%-15.7%; $P < .001$) and obesity (4.7%-4.2%; .004) decreased, while severe obesity (2.4%-2.2%; .3) remained unchanged (Figure 1). The prevalence of excess weight (overweight, obesity, and severe obesity combined) decreased over time from 24.9% to 22.1% ($P < .0001$). In relative terms, overall excess weight decreased by 11.2%, overweight decreased by 11.5%, obesity decreased by 11.1%, and severe obesity decreased by 8.3%, although the latter was not statistically significant. Overweight decreased in both boys (19.2%-16.8%; $P < .0001$) and girls (16.4%-14.6%; .003), whereas obesity decreased in boys only (boys: 5.3%-4.4%; .005 versus girls: 4.1%-3.9%; .2). Severe obesity remained stable in both boys and girls. Children in the obesity and severe obesity categories were older at the time their anthropometric data were collected ($P < .0001$). Across all categories of excess weight, a greater proportion of boys versus girls were classified as having either overweight, obesity, or severe obesity (Table 1). Although our name-based algorithms had limited specificity to identify ethnicity, we determined that approximately 90% of children were from the General Population (the majority of which was Caucasian) and approximately 10% were from either a South Asian or Chinese background.

Annual household income decreased in a stepwise manner across increasing categories of weight status ($P < .0001$). When examined in the context of annual household income, only those children from families with annual household incomes above the median (top two quartiles) experienced reductions in overweight over time. Further, in both boys (.04) and girls (.01) born in neighborhoods with annual household incomes above the median, we observed a downward trend in obesity over time. The proportions of children that were breast fed within the first 6 months decreased across increasing weight categories (Table 1). Breast feeding data were available for 131 860 (81.8%) infants, of which 78.4% were breastfed within the first 6 months. Boys who were breast fed within the first 6 months were more likely to have a decrease in overweight ($P < .0001$) or obesity (.04) over the study period, but this association was not observed in girls. Neither household income nor breast feeding practices were associated with severe obesity in boys or girls. Finally,



Colour online, B&W in print

FIGURE 1 Changes (unadjusted) in the prevalence of overweight, obesity, and severe obesity in preschoolers from 2010-2017 (*P* values for trend).

TABLE 1 Child- and family-related characteristics across all years (2010-2017)

	Not Overweight	Overweight	Obesity	Severe Obesity	<i>P</i> value
Total, n	124 210	26 581	6865	3458	
Sex					<.0001
Female; n (%)	62 814 (50.6)	11 762 (44.2)	2967 (43.2)	1237 (35.8)	
Male; n (%)	61 396 (49.4)	14 819 (55.8)	3898 (56.8)	2221 (64.2)	
Age at measurement					<.0001
4y; n, %	74 935 (60.3)	16 744 (63.0)	3992 (58.2)	1954 (56.5)	
5y; n, %	43 715 (35.2)	8782 (33.0)	2503 (36.5)	1304 (37.7)	
6y; n, %	5560 (4.5)	1055 (4.0)	370 (5.4)	200 (5.8)	
Height, cm; mean, SD	108.6 (5.8)	109.7 (6.0)	111.8 (6.3)	113.6 (6.9)	<.0001
Weight, kg; mean, SD	18.0 (2.3)	21.0 (2.5)	24.3 (3.1)	30.5 (6.4)	<.0001
BMI, kg/m ² ; mean, SD	15.2 (0.9)	17.4 (0.5)	19.3 (0.7)	23.5 (4.2)	<.0001
BMI, z score; mean, SD	-0.0 (0.6)	1.5 (0.3)	2.7 (0.4)	5.6 (2.8)	<.0001
Annual Household Income, \$CDN; mean, SD	86 312 (20 899)	84 364 (21 063)	81 746 (20 348)	80 455 (20 655)	<.0001
Breast fed within the first 6 mo ^a ; n/N, %	80 998/101 641 (79.7)	16 454/21 736 (75.7)	3981/5608 (71.0)	1886/2875 (65.6)	<.0001

Abbreviations: BMI, body mass index; SD, standard deviation. Some columns may not sum to 100% due to decimal rounding.

^aIf the infant was reported as being breast fed at any visit based on: (1) the 2- or 4-month immunization visit for infants living in Calgary and (2) any visit that occurred between 7 and 180 days after birth for infants living in Edmonton.

our nominal regression analyses (Table 2) showed that changes in excess weight over time remained significant after age, sex, ethnicity, and annual household income were included in the model as covariates.

4 | DISCUSSION

In this population of preschoolers from Alberta, Canada, we documented reductions in overweight and obesity from 2010 to 2017.

TABLE 2 Nominal regression of changes in excess weight over time adjusting for age, sex, ethnicity, and annual household income as covariates

	Overweight vs Normal Weight OR (95% CI)	Obesity vs Normal Weight OR (95% CI)	Severe Obesity vs Normal Weight OR (95% CI)
Sex (boy vs girl)	1.29 (1.26-1.33)	1.34 (1.28-1.41)	1.84 (1.71-1.97)
Age at BMI measurement (per 1 mo)	0.99 (0.99-0.99)	1.01 (1.00-1.01)	1.01 (1.01-1.02)
Ethnicity			
Chinese vs General Population	0.66 (0.62-0.71)	0.54 (0.47-0.62)	0.53 (0.44-0.65)
South Asian vs General Population	0.71 (0.66-0.76)	1.22 (1.1-1.36)	1.54 (1.35-1.76)
Household income at neighborhood level in 2010 (per 10,000 \$CDN)	0.96 (0.95-0.96)	0.9 (0.89-0.91)	0.87 (0.85-0.88)

Abbreviations: BMI, body mass index; CI, confidence interval; OR, odds ratio. All results were statistically significant at $<.001$.

Decreases in overweight and obesity were moderated by socio-economic status; children living in homes with annual household incomes in the top two quartiles were most likely to experience reductions in excess weight. Breast feeding decreased across increasing categories of excess weight and moderated reductions in overweight and obesity (for boys only). Severe obesity remained stable and was not associated with annual household income or breast feeding practices, suggesting factors that led to reductions in overweight and obesity did not exert the same degree of influence in children with severe obesity.

Previous studies have also reported reductions in overweight and obesity. In the United States, Ogden and colleagues¹⁹ reported a decrease in obesity in 2- to 5-year-olds ($n =$ approximately 900) from 13.9% in 2003 to 2004 to 8.4% in 2011 to 2012 (relative reduction: 39.7%). With Canadian data from approximately 14 000 3- to 19-year-olds from two nationally-representative cross-sectional studies, Rodd and Sharma⁵ showed decreased overweight (from 30.7% to 27.0%; relative reduction: 12.1%) and stabilized obesity (approximately 13%) between 2004 to 2005 and 2009 to 2013, although few children ($n =$ approximately 1600) in these analyses were preschool-aged. On the basis of a representative sample of grade 5 children in Alberta, the prevalence of overweight decreased slightly (37.9% to 36.0%) while obesity remained relatively stable (14.2%-14.6%) across a series of four cross-sectional surveys from 2008 to 2014.²⁰ Other recent studies^{21,22} from high-income countries have also described decreased or stabilized overweight and obesity in children, suggesting a plateau or reduction in excess weight among sub-sets of children. Our finding that overweight (in boys and girls) and obesity (in boys only) decreased over time among those children from homes with higher annual incomes highlighted that socio-economic inequalities moderate excess weight gain early in childhood,²³ even in Alberta, a province that has higher household incomes than other Canadian provinces.²⁴ They also highlight the need for multi-level, multi-sectoral initiatives that can have a positive influence on children's weight and growth since different, complementary, and dynamic strategies will be needed to prevent excess weight in children.

The stability of severe obesity over time could be interpreted as a disappointing finding, especially considering the reductions we documented in overweight and obesity; however, it is worth noting that the non-significant changes in severe obesity occurred in the same direction as the overweight and obesity categories. Further, these changes contrast with other studies that reported an increase in

severe obesity in children, including preschoolers.²⁵ The fact that we and others (eg, Shackleton et al²¹) found that severe obesity did not increase over our 8-year study period can be viewed positively. There is a strong imperative to reduce the impact of severe obesity early in life since the longer obesity persists through childhood, the greater the likelihood it remains entrenched over time.¹¹ The importance of such efforts cannot be overstated considering modest treatment outcomes²⁶ and substantial resources (eg, financial and time) invested by families and clinicians in managing obesity in children.

Access to population-level data, including both child and maternal/family variables, and long-term data collection are strengths of our study; however, we acknowledge our limitations. We captured data from the majority of children residing in Edmonton and Calgary, the two major urban centers in Alberta, but did not have access to data from smaller communities, so we do not know whether our results represent similar trends in other parts of the province. Further, the absence of other maternal variables (eg, BMI) limited our ability to examine whether temporal changes in maternal weight status occurred concurrently. Finally, our data regarding children's ethnicity were limited and lacked specificity, so these findings should be considered preliminary.

In summary, our analyses revealed reductions in overweight and obesity as well as stabilization of severe obesity in a population of Canadian preschoolers. The moderating effects of household income and breast feeding practices on some, but not all, categories of excess weight underscore the importance of continued monitoring of young children's growth and development over time, especially those with severe obesity. Our findings also highlight the imperative to develop, implement, and evaluate population-level initiatives designed to support the health and well-being of all young children and their families, especially those with lower household incomes.

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CONFLICTS OF INTEREST

No conflict of interest was declared.

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