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Prevalence and determinants of overweight and obesity among preschool-aged children from migrant and socioeconomically disadvantaged contexts in Montreal, Canada

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ABSTRACT

Among migrant and socioeconomically disadvantaged preschool-aged children followed in social perinatal primary care services in Montreal, Canada, we estimated the prevalence of overweight/obesity and identified determinants of body mass index z-score (zBMI) at 4–5 years old. We conducted a retrospective cohort study using electronic medical records of 275 child-mother dyads followed from birth to 4–5 years. Anthropometric measures and established maternal, perinatal and child risk factors for childhood obesity were examined. Age- and sex-specific zBMI at 4–5-years were computed and categorized according to WHO standards. Linear regression with model averaging was used to identify early life factors associated with zBMI. At 4–5 years, children's weight status was classified as underweight (1.5%), normal weight (69.7%), at-risk-of-overweight (19.2%), overweight (6.9%), and obesity (2.7%). Primiparity (0.51, 95% CI 0.24; 0.78), higher birthweight (1.04, 95% CI 0.70; 1.37), accelerated weight gain in the first year of life (0.21, 95% CI 0.13; 0.31), and introduction to solid foods before 6 months (0.89, 95% CI 0.42; 1.36) were associated with a higher zBMI, while less than high school education (-0.50, 95% CI −0.95; −0.05) and higher gestational age (-0.14, 95% CI −0.21; −0.05) were associated with lower zBMI at 4–5 years. Overweight/obesity is prevalent among preschool-aged children from migrant and socioeconomically disadvantaged contexts and is associated with known risk factors. Future research is needed to better understand the role of social perinatal primary care services in promoting optimal weight gain among children living in contexts of vulnerability.

1. Introduction

Overweight and obesity are prevalent worldwide in children of all age groups. (The Global Burden Disease, 2015) In Canada, the estimated prevalence of overweight and obesity in children ages 5–11 years is 27.1% based on World Health Organisation (WHO) definitions. (Statistics Canada, 2018) Among children ages 3–5 years in 2012–2015 in Quebec, Canada, it is estimated that 34.2% had a body mass index (BMI) classified as at-risk-of-overweight, overweight or obesity. (CHMS, 2012).

Early childhood is a critical period for the prevention of obesity, (Woo Baidal et al., 2016) particularly among children from vulnerable contexts (e.g., poverty, racially/ethnically marginalised, precarious migration status) who are at increased risk for overweight/obesity. (Lane et al., 2018; Rodd and Sharma, 2017) Obesity tracks from early childhood into adolescence and adulthood, (Simmonds et al., 2016) it is associated with multiple comorbidities, and many of its risk factors are social determinants of health already present early in life. (Hampl et al., 2023) To inform policy and intervention efforts, Woo Baidel et al. synthesised the evidence on modifiable risk factors for childhood obesity in

Abbreviations: zBMI, Body Mass Index z-score; BMI, Body Mass Index; WHO, World Health Organisation; AIC, Akaike Information Criterion; SD, standard deviation.

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the period from conception to 2 years. (Woo Baidal et al., 2016) Maternal and perinatal risk factors include high pre-pregnancy maternal BMI, high weight gain during pregnancy, gestational diabetes, pre-eclampsia/hypertension and prenatal tobacco exposure. (Riedel et al., 2014; Ouyang et al., 2016; Patro Golab et al., 2018) Infant risk factors comprise both high birthweight and low birthweight followed with rapid weight gain in infancy. (Yu et al., 2011; Zheng et al., 2018) Infant feeding practices, namely non-exclusive breastmilk feeding in the first 6 months of life, early introduction of solid foods and consumption of sweet beverages, (Ortega-García et al., 2018; Sonneville et al., 2015) and infant and child movement behaviours (physical inactivity, sedentary behaviour, poor sleep habits) have been linked with childhood obesity. (Tremblay et al., 2012).

Less research has focused specifically on risk factors for obesity among young children living in migrant and socioeconomically disadvantaged contexts. (Lane et al., 2018) La Maison Bleue offers social perinatal care services at 4 clinical sites in Montreal (Quebec, Canada) to families living in a context of vulnerability (e.g., poverty, precarious immigration status, social isolation, maternal mental health problems, teen/unintended pregnancies, and situations of abuse, violence, neglect or addiction) from pregnancy until children reach 5 years of age. (La Maison Bleue, 2021) At the time of pregnancy, women must present at least one vulnerability factor in order to be eligible for care and services. La Maison Bleue's mission is to reduce social inequalities and promote the optimal development, health and well-being of the child and family. One of their priorities is to regularly evaluate services and identify areas that may require improvements. To this end, we partnered with La Maison Bleue to estimate the prevalence of overweight and obesity among preschool-aged children followed at their centre and to identify maternal, perinatal and child-related determinants of BMI z-scores (zBMI) in this population.

2. Materials and methods

2.1. Study design and population

We conducted a retrospective cohort study of medical records among 275 children followed at two La Maison Bleue sites from birth until 4–5 years. Children born between January 1st 2012 and December 31st 2017 and who had a 4–5-year well-child visit between January 1st 2016 and December 31st 2021 were included. For families with more than one child who met these inclusion criteria, only the first-born child was included. We excluded children with missing anthropometric measures at 4–5 years as well as children who had a medical diagnosis of severe mental or physical disabilities that could affect development or growth (Fig. 1). The Research Ethics Board of Centre intégré universitaire de santé et de services sociaux Centre-Ouest de Montréal (CIUSSS-CODIM) provided approval for this study (#2022–2835).

2.2. Data collection and measures

Data from 3 sources were used: 1) La Maison Bleue's database which integrates the mother's admission intake form (sociodemographics) and some pregnancy and birth data, 2) the mother's digitised obstetrical health record; and 3) the child's medical record which includes age-specific standardised forms completed during routine well-child visits with medical, family and social context information, as well as anthropometric, early nutrition and lifestyle data. (Le CHU Sainte-Justine,

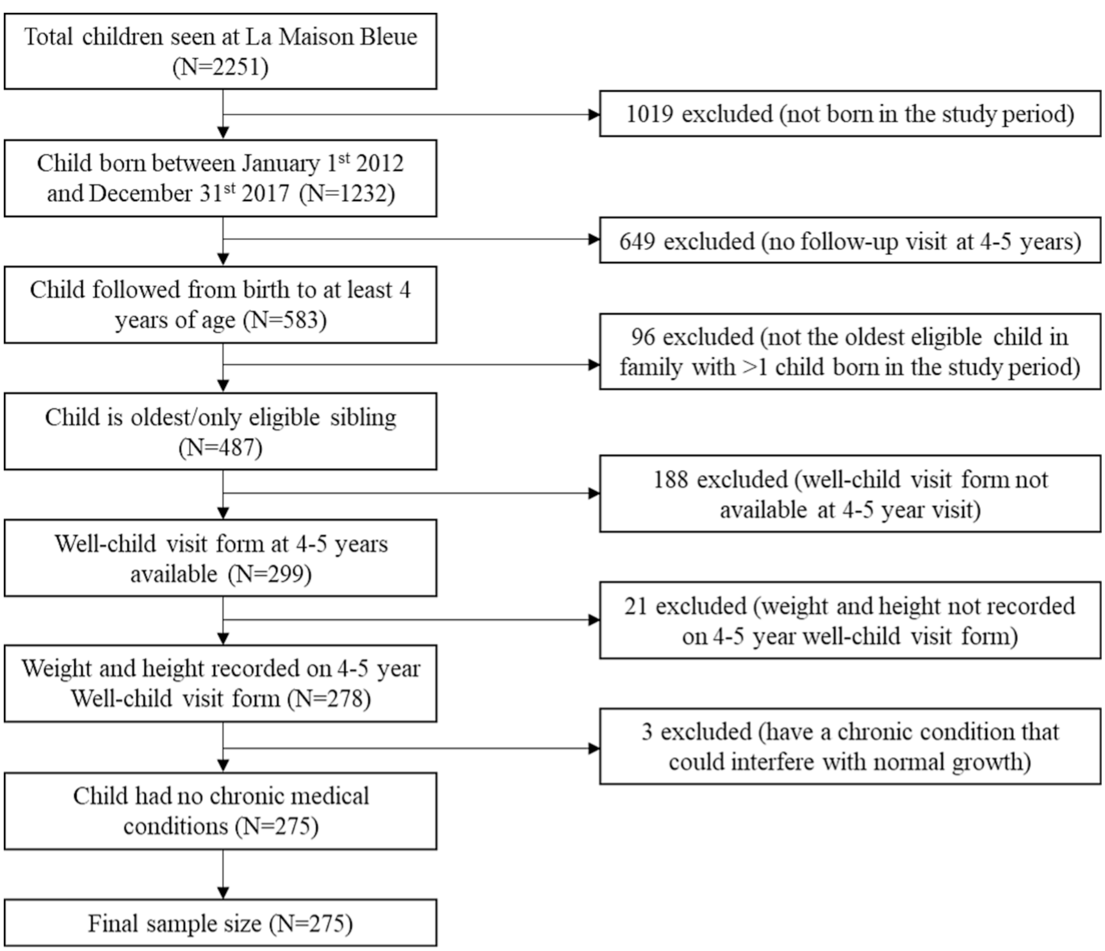

Fig. 1. Participant flow chart. Children 4–5 years old followed at La Maison Bleue, Montreal, 2012–2021.

2020) Prior to 2016, child medical records were available through digitised health records and thereafter through an electronic medical record platform. Data were extracted between September and December 2021, preceded by a pilot test of the data extraction tool in August 2021. A detailed description of the study variables, data source and operationalisation is provided in Supplemental Table 1 and a graphical representation of data collection time points is provided in Supplemental Fig. 1.

2.2.1. Outcome measurement

For this study's outcome, we used weight and height obtained from the 4- or 5-year well-child visit forms. These were measured at the La Maison Bleue clinics by nurses or family doctors using calibrated Elivate Detecto Clinical Scale with integrated stadiometer. Routine growth monitoring data collected in primary health care settings are generally considered to be valid and reliable for research, including for the purpose of tracking obesity prevalence. (Carsley et al., 2019) BMI was calculated and transformed to WHO age- and sex-specific zBMI and used as the outcome variable. We also classified participant's weight status using WHO zBMI cut-points for children aged < 5 years, namely underweight (<-2 SD), healthy weight (-2 to 1 SD), at-risk-of-overweight (>1 to 2 SD), overweight (>2 to 3 SD) or obesity (>3 SD). (Canadian Paediatric Society, 2010; World Health Organization, 2008) These cut-points are more conservative compared to those used for children ≥ 5 years, and compared to the Centers for Disease Control and Prevention growth charts (Grummer-Strawn et al., 2010).

2.2.2. Predictor variable measurement

The predictors considered in this study were informed by a systematic review on modifiable obesity risk factors from conception through age 2 years by Woo Baidal et al.; (Woo Baidal et al., 2016) these included maternal, perinatal, and child factors. Data on maternal factors were obtained from the intake form completed by a social worker upon initiation of care at La Maison Bleue. Maternal age was calculated using the mother and child's date of birth, and categorized as < 20, 20–34 and ≥ 35 years. At intake, La Maison Bleue assesses the presence/absence of several vulnerability factors (e.g., difficult financial situation, social isolation, maternal mental health concerns, teen/unintended pregnancies, and situations of abuse, past violence, neglect or addiction). Most mothers cumulated multiple La Maison Bleue vulnerability factors, thus these were summed and categorised as ≤ 2 vs 3 vs ≥ 4 vulnerability factors. Information on maternal immigration status at intake was obtained based on free text from the intake form and recoded as precarious migration status (i.e., non-status, asylum seeker, refugee) vs not. Length of time in Canada was also obtained as free text based on immigration year and categorized as < 2 vs 2–5 vs > 5 years or Canadian-born. Maternal country of origin was recorded and then categorized based on the country's income level using the World Bank Atlas (low income vs lower-middle income vs upper-middle or high income). (The World Bank. GNI per capita. The World Bank Development Indicators, 2023) Lastly, information on the highest level of maternal education attained (less than high-school diploma vs high-school diploma obtained vs any college/university education) as well as information on the family structure (single vs two-parent family) were extracted.

Perinatal factors were extracted from the mothers' intake forms and the mothers' obstetrical records for the index child. These included parity (primiparous vs multiparous), gestational diabetes (y/n), prenatal tobacco exposure (mother herself or someone living with her is a smoker, y/n), delivery method (vaginal vs cesarian), gestational age in weeks which was recoded as term (≥37 weeks) vs preterm (<37 weeks), and infant's birth weight in kilograms which was recoded as low birth weight (<2.5 kg) vs not. Size at birth for gestational age was computed as well using population-based Canadian references and categorized as small (<10th percentile), appropriate (10th to 90th percentile), and large (>90th percentile) for gestational age. (Kramer et al., 2001).

Child factors were taken from well-child visit forms, including the child's biological sex (male/female). In addition to weight and height from the 4- to 5-year visit, we also extracted data for weight and length at birth (medical record) and at the 1-year La Maison Bleue visit which were transformed into WHO zBMIs. Accelerated weight gain during infancy was calculated by subtracting the child's zBMI at birth from the zBMI at 1 year and classifying positive changes of > 1 SD in zBMI as accelerated weight gain in infancy. (Jones-Smith et al., 2007) Exclusive breastfeeding was recorded at the 4-month visit (y/n), as well as any breastfeeding at 18 months (y/n). Information on age at introduction of solid foods was extracted from the 4, 6 and 9-month well-child visit forms. Children were categorised based on whether they had initiated complementary feeding before the age of 6 months or later. Other data extracted from the 4–5 year well-child visit included intake of juice or sweetened beverages (any vs none), evidence of adequate sleep duration defined as usually cumulating at least 10 to 13 h of sleep in a 24-hour period (y/n) (Paruthi et al., 2016), and use of child daycare (y/n).

2.3. Data analysis

The distribution of variables was examined using descriptive statistics. Proportions, means, and standard deviations were examined, as well as the distribution of all categorical risk factor variables according to zBMI and weight status categories. Preliminary associations for each risk factor and zBMI at 4–5 years were examined using 2-sided independent Student t-tests for dichotomous risk factors and one-way ANOVAs for categorical risk factors. Statistical significance was set at $p < 0.05$. To identify the subset of factors with the strongest impact on zBMI at 4–5 years, we then used linear regression with model averaging based on the Akaike Information Criterion (AIC). Model averaging is a model selection method that decreases uncertainties related to model selection by reducing misspecification and estimation errors. (Hansen, 2007) Models with each possible combination of variables are evaluated using the AIC and are assigned weights (i.e., models with a higher AIC are assigned a higher weight). Model averaging then pools the estimates from each model using weighted averages resulting in more robust estimates. Missing data were addressed using multiple imputation by chained equations (MICE). (Raghunathan et al., 2001; van Buuren, 2007) Variables used to inform the imputation process are listed in Supplemental Table 2. Predictive mean matching, logistic regression and polytomous logistic regression were used to impute continuous, dichotomous and categorical variables, respectively. Analyses were conducted using SPSS Version 28 (IBM Corp. Armonk, NY) and R 4.1.12 (R Core Team, Vienna, Austria) Statistical packages "anthro" (Schumacher, 2023) and "anthroplus" (Schumacher, 2007) were used for BMI

Table 1
Prevalence of overweight and obesity in children 4–5 years old (n = 275) followed at La Maison Bleue, Montreal, 2012–2021.

Weight Status Categories (zBMI cut points)	Total	Girls[a]	Boys[a]
	% (n)		
Underweight (<-2)	1.5 (4)	1.4 (2)	1.5 (2)
Normal weight (>-2 to 1)	69.1 (190)	69.0 (100)	69.2 (90)
At-risk-of-overweight (>1 to < 2)	19.6 (54)	19.3 (28)	20.0 (26)
Overweight (>2 to < 3)	6.9 (19)	8.3 (12)	5.4 (7)
Obesity (>3)	2.9 (8)	2.0 (3)	3.8 (5)

[a] Chi-squared test comparing proportions between girls and boys p-value = 0.949.

Table 2
Mothers' characteristics in the total sample and by child weight status categories among children 4–5 years old followed at La Maison Bleue, Montreal, 2012–2021 (n = 275).

	Total Sample (n = 275)		p-value[a]	Normal Weight[b] (n = 194)	At risk of Overweight (n = 54)	Overweight/Obesity (n = 27)
	% (n)	Mean zBMI at 4–5 yrs (SD)		% (n)	% (n)	% (n)
Mother's age at childbirth			0.656			
< 20 years	3.3 (9)	0.79 (1.33)		3.1 (6)	3.7 (2)	3.7 (1)
20–34 years	76.0 (209)	0.39 (1.26)		77.8 (151)	70.4 (38)	74.1 (20)
≥ 35 years	20.7 (57)	0.40 (1.27)		19.1 (37)	25.9 (14)	22.2 (6)
Number of La Maison Bleue vulnerability factors			0.829			
1 or 2	24.3 (67)	0.43 (1.32)		23.2 (45)	27.8 (15)	25.9 (7)
3	43.6 (120)	0.45 (1.24)		43.3 (84)	46.3 (25)	40.7 (11)
4 or more	32.1 (88)	0.34 (1.25)		33.5 (65)	25.9 (14)	33.3 (9)
Immigration status at intake			0.290			
Precarious Migration Status	21.8 (60)	0.56 (1.12)		20.6 (40)	25.9 (14)	22.2 (6)
Non-precarious immigrants or Canadian Citizens	75.3 (207)	0.36 (1.30)		76.8 (149)	70.4 (38)	74.1 (20)
Missing	2.9 (8)			2.6 (5)	3.7 (2)	3.7 (1)
Length of time in Canada			0.580			
<2 years	48.4 (133)	0.49 (1.17)		45.9 (89)	51.9 (28)	59.3 (16)
2–5 years	24.0 (66)	0.32 (1.19)		25.3 (49)	24.1 (13)	14.8 (4)
>5 years	22.2 (61)	0.34 (1.25)		22.7 (44)	18.5 (10)	25.9 (7)
Canadian-born	2.2 (6)	0.37 (0.45)		3.1 (6)	0	0
Missing	3.3 (9)			3.1 (6)	5.6 (3)	0
Country of origin income level[c]			0.140			
Low-income country	9.1 (25)	0.05 (1.11)		9.8 (19)	9.3 (5)	3.7 (1)
Low-middle income country	76.4 (210)	0.40 (1.33)		75.3 (146)	77.8 (42)	77.8 (22)
Upper-middle/high income country	14.5 (40)	0.68 (0.89)		14.9 (29)	13.0 (7)	14.8 (4)
Level of education			0.211			
Less than High School	9.8 (27)	−0.03 (1.09)		10.8 (21)	11.1 (6)	0
High School completed	43.3 (119)	0.53 (1.44)		43.3 (84)	33.3 (18)	63.0 (17)
Any College/University	36.4 (100)	0.43 (1.30)		34.5 (67)	44.4 (24)	33.3 (9)
Missing	10.5 (29)			11.3 (22)	11.1 (6)	3.7 (1)
Single parent household			0.500			
Yes	26.2 (72)	0.49 (1.11)		24.7 (48)	33.3 (18)	22.2 (6)
No	73.8 (203)	0.38 (1.31)		75.3 (146)	66.7 (36)	77.8 (21)
Parity			0.015			
Primiparous	41.8 (115)	0.62 (1.26)		38.7 (75)	46.3 (25)	55.6 (15)
Multiparous	57.1 (157)	0.24 (1.25)		60.8 (118)	50.0 (27)	44.4 (12)
Missing	1.1 (3)			0.5 (1)	3.7 (2)	0
History of gestational diabetes			0.282			
Yes	7.6 (21)	0.12 (1.43)		8.2 (16)	5.6 (3)	7.4 (2)
No	87.3 (240)	0.43 (1.27)		86.6 (168)	87.0 (47)	92.6 (25)
Missing	5.1 (14)			5.2 (10)	7.4 (4)	0
Maternal exposure to tobacco during pregnancy						
Yes	8.4 (23)	−0.05 (1.27)	0.069	10.3 (20)	3.7 (2)	3.7 (1)
No	61.4 (169)	0.470 (1.27)		60.8 (118)	57.4 (31)	74.1 (20)
Missing	30.2 (83)			28.9 (56)	38.9 (21)	22.2 (6)
Delivery method of index child			0.839			
Vaginal	69.8 (192)	0.43 (1.26)		68.0 (132)	72.2 (39)	77.8 (21)
Caesarean	25.1 (69)	0.41 (1.19)		25.7 (50)	25.9 (14)	18.5 (5)
Missing	5.1 (14)			6.2 (12)	1.9 (1)	3.7 (1)

Note: % (n) missing data are presented only for variables where data are missing.
[a] p-values are for 2-sided independent Student t-tests for dichotomous risk factors and one-way ANOVAs for categorical risk factors comparing mean zBMI by maternal characteristics.
[b] Underweight (zBMI < -2) children at the 4–5-yr visit were included in the normal weight category due to their low number (n = 4).
[c] Calculated using the World Bank Atlas method (The World Bank. GNI per capita. The World Back Development Indicators, 2023).

Table 3
Child characteristics in the total sample and by weight status categories among children 4–5 years old followed at La Maison Bleue, Montreal, 2012–2021 (n = 275).

	Total Sample (n = 275)			Normal Weight[c] (n = 194)	At risk of Overweight (n = 54)	Overweight/Obesity (n = 27)
	% (n)	Mean zBMI at 4–5 yrs	p-value[b]	% (n)	% (n)	% (n)
Biological sex			0.756			
Male	47.2 (130)	0.43 (1.32)		47.4 (92)	48.1 (26)	44.4 (12)
Female	52.8 (145)	0.38 (1.22)		52.6 (102)	51.9 (28)	55.6 (15)
Child's age (mean years, sd)	4.1 (0.2)[a]			4.1 (0.2)[a]	4.1 (0.3)[a]	4.1 (0.2)[a]
Gestational age			0.447			
Preterm (<37 weeks)	4.0 (11)	0.34 (1.27)		3.6 (7)	7.4 (4)	0
Term (≥37 weeks)	93.5 (257)	0.41 (1.28)		93.3 (181)	90.7 (49)	100.0 (27)
Missing	2.5 (7)			3.1 (6)	1.9 (1)	0
Birthweight (mean kg, sd)	3.33 (0.60)[a]			3.28 (0.60)[a]	3.47 (0.78)[a]	3.434 (0.39)[a]
Low birthweight (<2.5 kg)	4.7 (13)	−0.33 (1.56)	< 0.001	4.1 (8)	9.3 (5)	0
Normal birthweight (≥2.5 kg)	93.5 (257)	0.43 (1.26)		93.3 (181)	90.7 (49)	100.0 (27)
Missing	1.8 (5)			2.6 (5)	0	0
Birth size			0.050			
Small for gestational age (<10th percentile)	8.0 (22)	−0.41 (1.08)		9.3 (18)	3.7 (2)	7.4 (2)
Appropriate for gestational age	81.5 (224)	0.40 (1.27)		80.9 (157)	81.5 (44)	85.2 (23)
Large for gestational age (>90th percentile)	7.6 (21)	0.91 (1.41)		6.2 (12)	13.0 (7)	7.4 (2)
Missing	2.9 (8)			3.6 (7)	1.9 (1)	0
Accelerated weight gain during infancy			0.002			
Yes	29.5 (81)	0.78 (1.37)		25.8 (50)	25.9 (14)	51.9 (17)
No	34.2 (94)	0.18 (1.15)		38.1 (74)	29.6 (16)	25.9 (4)
Missing	36.4 (100)			36.1 (70)	44.4 (24)	22.2 (6)
Exclusive breastfeeding at 4-month visit			0.243			
Yes	46.9 (129)	0.29 (1.16)		47.9 (93)	51.9 (28)	29.6 (8)
No	35.3 (97)	0.49 (1.39)		34.5 (67)	29.6 (16)	51.9 (14)
Missing	17.8 (49)			17.5 (34)	18.5 (10)	18.5 (5)
Any breastfeeding at 18-month visit			0.181			
Yes	28.7 (79)	0.24 (1.02)		29.4 (57)	37.0 (20)	7.4 (2)
No	53.1 (146)	0.46 (1.40)		52.1 (101)	46.3 (25)	74.1 (20)
Missing	18.2 (50)			18.6 (36)	16.7 (9)	18.5 (5)
Age at introduction of solid foods			< 0.001			
< 6 months	6.5 (18)	1.34 (1.38)		4.1 (8)	7.4 (4)	22.2 (6)
≥ 6 months	70.9 (195)	0.27 (1.20)		73.2 (142)	72.2 (39)	51.9 (14)
Missing	22.5 (62)			22.7 (44)	20.4 (11)	25.9 (7)
Regular intake of juice or sugary drinks at 4–5-yr visit			0.595			
Yes	25.8 (71)	0.52 (1.33)		25.8 (50)	22.2 (12)	33.3 (9)
No	49.8 (137)	0.42 (1.28)		50.5 (98)	48.1 (26)	48.1 (13)
Missing	24.4 (67)			23.7 (46)	29.6 (16)	18.5 (5)
Adequate sleep duration at 4–5-yr visit			0.054			
Yes	63.6 (175)	0.44 (1.22)		62.4 (121)	68.5 (37)	63.0 (17)
No	10.9 (30)	−0.04 (1.54)		13.4 (26)	1.9 (1)	11.1 (3)
Missing	25.5 (70)			24.2 (47)	29.6 (16)	25.9 (7)
Type of childcare at 4–5-yr visit			0.480			
Daycare	65.8 (181)	0.42 (1.28)		63.9 (124)	66.7 (36)	77.8 (21)
Home	11.6 (32)	0.40 (1.07)		12.4 (24)	13.0 (7)	3.7 (1)
Missing	22.5 (62)			23.7 (46)	20.3 (11)	18.5 (5)

Note: % (n) missing data are presented only for variables where data are missing.
[a] Numbers indicated are means (SD).
[b] p-values are for 2-sided independent Student t-tests for dichotomous risk factors and one-way ANOVAs for categorical risk factors comparing mean zBMI by child characteristics.
[c] Underweight (zBMI < -2) children at the 4–5-yr visit were included in the normal weight category due to their low number (n = 4).

calculations. The "MAMI" package (Friedman et al., 2010) was used for model averaging methods, and the "MICE" package was used to impute missing data. (van Buuren and Groothuis-Oudshoorn, 2011).

3. Results

Among the 275 children included in our sample, 52.8% were girls and the mean age at the last La Maison Bleue well-child visit was 4.1 years (SD 0.2). Weight status at this visit were as follows: underweight (1.5%), normal weight (69.1%), at-risk-of-overweight (19.6%), overweight (6.9%), and obesity (2.9%) (Table 1). The prevalence of overweight/obesity combined was similar between girls and boys.

Characteristics of mothers (Table 2) and those of children (Table 3) are shown for the entire sample and by weight status categories. Overall, mothers were disadvantaged on several fronts, with 32.1% cumulating 4 or more La Maison Bleue vulnerability factors. A precarious migration status was common (21.8%), 48.4% of mothers had immigrated<2 years prior to intake at La Maison Bleue, and 85.5% originated from a low or low-middle-income country. Close to 10% had less than a high school education, and 26.2% were heading a single-parent household.

In univariate analyses, children born to primiparous mothers had higher zBMI scores (mean 0.62, SD 1.26) compared to children born to multiparous women (mean 0.24, SD 1.24). Children who were large-for-gestational-age had a higher zBMI (mean 0.91, SD 1.41) than those who were appropriate- or small-for-gestational-age. Similarly, children with accelerated weight gain during infancy had higher zBMI scores (mean 0.78, SD 1.37) compared to children without accelerated weight gain (mean 0.18, SD 1.15). Children who were introduced to solid foods before 6 months had a higher zBMI (mean 1.34, SD 1.38) compared to children introduced to solid foods at ≥ 6 months of age (mean 0.25, SD 1.18). In addition to cumulative La Maison Bleue vulnerability factors, we examined distinct vulnerability factors by child zBMI and found no differences in zBMI based on the presence/absence of each distinct factor (Supplemental Table 3).

Linear regression with model averaging allowed us to identify the following independent risk factors associated with higher zBMI at 4–5 years (Table 4): primiparity (β = 0.51, 95% CI: 0.24; 0.78), birthweight (β = 1.04, 95% CI: 0.70; 1.37; per 1 kg increase in birthweight), accelerated weight gain during infancy (β = 0.21, 95% CI: 0.13; 0.31), and early introduction of solid foods (β = 0.89, 95% CI: 0.42; 1.36). Non-exclusive breastfeeding at 4 months was associated with a higher zBMI, albeit without reaching statistical significance (β = 0.24, 95% CI: −0.04; 0.52). Lastly, 2 factors were associated with a lower zBMI, namely having a mother who completed less than high school education (vs college or university education) (β = -0.50, 95% CI: −0.95; −0.05) and higher gestational age (β = -0.14, 95% CI: −0.21; −0.05; per 1-week increase in gestational age).

Table 4
Associations between maternal, perinatal and child factors and child body mass index z-score among children 4–5 years old followed at La Maison Bleue, Montreal, 2012–2021 (n = 275).

	Beta Coefficients[a]	95% CI
Maternal level of education		
Less than High School	−0.50	(-0.95; −0.05)
Some or High School Diploma	−0.007	(-0.29; 0.28)
College/University	Reference	
Parity		
Primiparous	0.51	(0.24; 0.78)
Multiparous	Reference	
Gestational age (weeks)	−0.14	(-0.21; −0.05)
Birthweight (kg)	1.04	(0.70; 1.37)
Accelerated weight gain during infancy		
Yes	0.21	(0.13; 0.31)
No	Reference	
Exclusive breastfeeding at 4-month visit		
No	0.24	(-0.04; 0.52)
Yes	Reference	
Age at introduction of solid foods		
< 6 months	0.89	(0.42; 1.36)
≥ 6 months	Reference	

[a] Variable selection was done using model averaging. Variables with associated beta coefficient and 95% confidence intervals shown in Table 4 are those that were selected for inclusion based on Akaike Information Criterion (AIC) values. Variables that were submitted but not included are mother's age, number of La Maison Bleue vulnerability factors, maternal immigration status at intake, country of origin income level, single parent households, history of gestational diabetes with index child, maternal exposure to tobacco during pregnancy, delivery mode, birth size, child's biological sex, and any breastfeeding at 18 months.

4. Discussion

Among migrant and socioeconomically disadvantaged preschool-aged children followed at La Maison Bleue, 9.8% had overweight or obesity when using conservative WHO BMI cut-points (zBMI > 2 SD), and 29.4% had at-risk-of-overweight, overweight or obesity based on standard cut-points (zBMI > 1 SD). Primiparity, higher birthweight, accelerated weight gain in infancy, and introduction of solid foods before 6 months were associated with a higher zBMI at 4–5 years, while lower maternal education and higher gestational age were associated with a lower zBMI.

In 2012–2015, the prevalence of at-risk-of-overweight, overweight and obesity among children ages 3–5 years in Quebec, Canada, was 34.2% (CHMS, 2012). Although the overall prevalence of childhood overweight and obesity has gradually decreased over the past decade in Canada, (Statistics Canada, 2017) prevalence increased among children from low-income households. (Rodd and Sharma, 2017) Despite important socioeconomic vulnerabilities of children followed at La Maison Bleue, prevalence of at-risk-of-overweight, overweight and obesity may be lower in our sample (29%) by comparison to provincial estimates for children of similar ages. One explanation for a possible lower prevalence of overweight/obesity among children followed at La Maison Bleue may be that prenatal and early childhood integrated primary health care and social services intervention models can result in more optimal early growth and weight gain. In addition to routine medical, developmental and social assessments and follow ups, La Maison Bleue offers culturally sensitive prenatal and postnatal parenting groups that are adapted to the diverse cultures and circumstances of its clientele and aim to empower families, foster resiliency, break isolation and develop parenting skills. (Aubé et al., 2019) Growing evidence supports the effectiveness of parenting support programs to promote the adoption of healthier behaviors and prevent obesity, (Kader et al., 2015) particularly among families from disadvantaged socioeconomic backgrounds. (Denney-Wilson et al., 2014) It may also be that the possible lower prevalence of at-risk-of-overweight, overweight and obesity in our sample of children born largely to recent immigrant mothers from low-to-middle income countries is a reflection of the higher prevalence of underweight and undernutrition in these countries.

Among established risk factors for early childhood obesity examined in the current study, only a limited number were associated with child zBMI. Our findings on parity and accelerated weight gain are consistent with those of others. Infants of multiparous mothers have been found to have a lower BMI and percentage body fat mass compared to infants from primiparous mothers. (Gaillard et al., 2014) This association may be mediated by lower accelerated growth in children born to multiparous compared to primiparous mothers. (Gaillard et al., 2014) Rapid weight gain during infancy itself was associated with increased zBMI scores at 4–5 years in the current study and in others. (Zheng et al., 2018) Additionally, parity may be linked to obesity through greater sibling interactions in large families and opportunities for physical activity. (Kracht and Sisson, 2018) Several studies have documented the benefits of early obesity prevention interventions among first time-mothers, (Redsell et al., 2016) for example, using a responsive parenting intervention with an education component on infant feeding, sleep hygiene, interactive play and emotional regulation. (Savage et al., 2016).

Other perinatal risk factors, such as gestational diabetes or exposure to tobacco during pregnancy, were not associated with child zBMI in our data. We did not have reliable information on maternal pre-pregnancy BMI or on weight gain during pregnancy from medical records preventing us from examining these known risk factors of childhood obesity. (Ouyang et al., 2016) However, birth weight, which is linked with gestational diabetes, maternal obesity and weight gain during pregnancy, (Black et al., 2013; Santangeli et al., 2015) was associated with a higher zBMI by 4–5 years, a finding consistent with those of a systematic review on birth weight and subsequent obesity. (Yu et al., 2011).

Low maternal education, a measure of socioeconomic status, has been linked to childhood obesity. (Dixon et al., 2012; Pillas et al., 2014) However, in the present study, children of mothers with less than a high-school education had a 0.5 SD lower zBMI compared to children of mothers with college or university education. This finding may be specific to our study population as mothers who completed less than a high school diploma were more likely to have recently immigrated from low or low-middle-income countries where underweight and undernutrition are prevalent. (The World Bank, 2016).

Our findings are consistent with those of other studies documenting the role of infant feeding practices on obesity. (Ortega-García et al., 2018; Taveras et al., 2013; Rito et al., 2019) Introduction to solid foods before 6 months was found in 7% of participants and was associated with a 0.9 SD higher zBMI at 4–5 years. Cultural differences in feeding practices may impact the timing of solid food introduction. For example, the early introduction of complementary foods is a common practice in Latin America, the Caribbean, East Asia and the Pacific, where nearly half of infants are introduced to complementary feeding by 4–5 months of age. (White et al., 2017) There is a need to better understand parents' decisions and practices regarding the introduction of complementary feeding, particularly among recent immigrants and low-income families. Similarly, non-exclusive breastmilk feeding at 4 months was associated with a higher zBMI, although statistical significance was not reached. A recent WHO study including data from 16 European countries documented the beneficial effect of exclusive breastfeeding against childhood obesity at ages 6–9 years.(Rito et al., 2019).

This study has limitations. In addition to the relatively small sample size, the study relied on data from medical records collected for clinical and not research purposes. Incomplete and missing data were common, particularly for data obtained from the well-child visit forms. This was in part due to changes made to the forms over time with new items added and changes in how certain items were assessed. In multivariable analyses, we accounted for missing data using multiple imputation and excluded variables with>25% missing data (e.g., intake of juice and sweet drinks, sleep duration). Additionally, data on some known risk factors for childhood obesity were not systematically available in medical records and thus could not be examined in this study (e.g., maternal BMI, gestational weight gain, maternal/family lifestyle behaviours). Selection bias is possible due to selective retention of children and families with more complex medical or social conditions, which may also be linked to obesity risk. However, characteristics of study participants (e.g., mother's age, level of education, parity, immigration status) are similar to those of the overall La Maison Bleue clientele (Dubois et al., 2015), suggesting that our sample is likely representative of the target population. A key strength of this study is the unique sample with long term follow-up of children from marginalised families due to social, economic and migration-related circumstances and who are often underrepresented in obesity research.

5. Conclusion

We identified a high prevalence of at-risk-of-overweight, overweight and obesity in preschool-aged children from vulnerable migratory, social and economic contexts living in Montreal, Canada, and followed since birth in a community-based primary care centre. This study further points to specific maternal, perinatal and childhood factors, such as primiparity, high birth weight, accelerated weight gain during infancy and early introduction of solid foods, that are associated with higher zBMI in this population. Some risk factors, such early introduction of solid foods and accelerated weight gain in infancy, are modifiable and can be targeted for interventions in primary care settings. Although parity is a non-modifiable factor, findings suggest first-time mothers may benefit from tailored, culturally sensitive and contextually adapted early interventions. Future research is needed to better understand the role and underlying mechanisms through which social perinatal primary care services can promote optimal weight gain among children living in contexts of vulnerability.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2023.102397.

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