Child care: implications for overweight / obesity in Canadian children?

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Abstract

Introduction: Over recent decades, two prominent trends have been observed in Canada and elsewhere: increasing prevalence of childhood overweight and obesity, and increasing participation of women (including mothers) in the paid labour force and resulting demand for child care options. While an association between child care and children's body mass index (BMI) is plausible and would have policy relevance, its existence and nature in Canada is not known.

Methods: Using data from the National Longitudinal Survey of Children and Youth, we examined exposure to three types of care at age 2/3 years (care by non-relative, care by relative, care in a daycare centre) in relation to change in BMI percentile (continuous and categorical) between age 2/3 years and age 6/7 years, adjusting for health and socio-demographic correlates.

Results: Care by a non-relative was associated with an increase in BMI percentile between age 2/3 years and age 6/7 years for boys, and for girls from households of low income adequacy.

Conclusion: Considering the potential benefits of high-quality formal child care for an array of health and social outcomes and the potentially adverse effects of certain informal care options demonstrated in this study and others, our findings support calls for ongoing research on the implications of diverse child care experiences for an array of outcomes including those related to weight.

Keywords: *body mass index, Canada, child care, obesity, overweight*

Introduction

The prevalence of childhood overweight/obesity has increased in North America, Europe and elsewhere over recent decades.[1,2] In Canada, the prevalence of obesity has more than doubled from 3% in 1978 to 8% in 2004 among children aged 2 to 17 years,[3] which has led to increasing concern about short- and long-term health implications such as hypertension, type 2 diabetes and psychosocial problems.[4]

Over a similar period, a key societal trend in North America has been the increasing proportion of women in the paid labour force.[1,5,6] For example, the participation of women in the labour force in Alberta increased steadily from 20% in 1951 to 68% in 2008[6] and in Canada from 50% in 1976 to 80% in 2001.[7] Although historical statistics on the participation of mothers in the Canadian labour force is sparse, data on women's labour force participation by age[7] and marital status[6] suggest a similar growth in proportion of working mothers of young children. In 2005, 76% of mothers with a youngest child between 3 and 5 years old worked outside the home.[5] This may have implications for overweight/obesity in children:[8] studies from the United States,[9] Canada[10,11] and the United Kingdom[12] have shown a positive association between maternal work intensity (i.e. hours of work per week) and her child's likelihood of being overweight/obese.

One way through which maternal employment may impact children's weight status is child care arrangements. The rise in maternal employment has increased the demand for both formal (e.g. regulated care settings) and informal (e.g. care by relatives) child care arrangements, particularly for preschool-age children. Availability and use of formal versus informal care varies by country. Canada, relative to other countries in the Organisation for Economic Co-operation and Development, has a fairly high proportion of mothers of young children who work outside the home, low spending on child and family programs as a proportion of gross domestic product and high costs to parents for formal child care programs.[5,13] Thus, in contrast to some other countries (e.g. Sweden) that provide high quality, publically funded care,[5,6] Canada (along with other liberal-democratic regimes* such as

* Term used in classifications of welfare state regimes to describe those characterized by active and passive encouragement of market forces.[14] These regimes have also been described as Anglo-Saxon models of capitalism.[15]

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the U.S.) relies much more on the market for this service. This results in high use of informal care,[5] which can vary considerably in quality. Regulated care opportunities in Canada, with the possible exception of Quebec, are in short supply and are inaccessible to many because of their cost or inflexibility to the labour force needs of parents.[5]

Child care arrangements—formal or informal—may have implications for childhood obesity. The care setting may promote weight gain if, for example, care providers are less likely than parents to provide adequate nutrition and/or opportunities for physical activity. A handful of studies have examined child care arrangements in relation to obesity in children. Lumeng et al.[16] examined overweight status among a nationally representative sample of 6- to 12-year-old U.S. children in relation to child care attendance from age 3 to 5 years (retrospective reporting by parents); they observed a reduced risk of overweight among children who had experienced some (i.e. less than 15 hours per week) centre-based care attendance compared with those with no attendance. Maher et al.[17] examined obesity among a nationally representative sample of U.S. children entering kindergarten in relation to various types of care prior to kindergarten (retrospective reporting by parents); they observed that children in family/friend/neighbour care (paid or unpaid, at least 10 hours per week) were more likely to be obese than children in no or limited care. Benjamin et al.[18] examined adiposity in a sample of U.S. children in relation to child care from birth to 6 months and found that care in someone else's home (such as a licensed family child care home or family's, friend's or neighbour's home) was associated with increased adiposity at 1 and 3 years of age. For both Maher et al.[17] and Benjamin et al.,[18] centre-based care was not associated with weight outcomes. Kim and Petersen[19] found that child care by a relative, but not centre-based or non-relative care, was associated with significantly more weight gain in the first 9 months of life when compared to no child care. Pearce et al.[20] examined the association between child care (formal and informal) and overweight/obesity among children in the U.K. Millennium Cohort. They found that informal child care (especially care by grandparents) between 9 months and 3 years of age was associated with increased risk of overweight/obesity at age 3 years, but only for children from more advantaged backgrounds. There was no association between overweight/obesity and formal care (nursery, child care centre, nanny, or au pair). Among a representative German sample, Rapp et al.[21] found no association between type of preschool care and body mass index (BMI) at age 4 and 6 years. Finally, Gubbels et al.[22] observed that, among a sample of Dutch offspring of women participating in a prospective cohort study, the use of formal child care outside the home at 1 and 2 years of age was positively associated with BMI at age 2 years as well as change in BMI from age 1 to 2 years.

Based on these studies, certain informal types of care may present a risk for BMI and weight gain.[17–20] Findings for formal centre-based care are less clear: one study showed a protective effect,[16] one showed a risk effect,[22] and several others showed no effect.[17–21] One limitation of the existing studies, which may complicate the overall conclusions, is that boys and girls were combined rather than examined separately. The child-caregiver interaction may differ by sex (for example, due to gender norms held by the caregiver) such that previous null and inconsistent findings may reflect non-stratified analysis.

Our objective was to examine three types of child care arrangement at age 2/3 years in relation to subsequent change in BMI between age 2/3 years and age 6/7 years in a nationally representative sample of Canadian children. We stratified the analyses by sex to investigate whether the possible effects of different care arrangements on BMI differ for boys and girls.

Data and methods

Data source

We analyzed data from the National Longitudinal Survey of Children and Youth (NLSCY), a long-term study of Canadian children that follows their development from birth to early adulthood. The inaugural cohort, which was the only subsample for whom BMI data were available from age 2/3 years to age 6/7 years, included over 22 000 children aged 0 to 11 years at the time of enrollment in 1994. Since then, there has been some sample attrition so that by cycle 5 (2002–2003) approximately 67% of the original cycle 1 cohort remained. Like other Statistics Canada surveys, the NLSCY excludes children living on First Nations reserves or on Crown Land, residents of institutions, families of full-time members of the Canadian armed forces, and residents of some remote regions and the territories. A probability sampling strategy was used (with elements of both cluster and stratified random sampling based on geographic region and urban/rural status), and sampling weights were developed to enhance the sample's representativeness of its underlying original population. Data were collected using computer-assisted interviewing, in person or via telephone, with the respondent or his/her parent/guardian.

We focused on children from the original cohort who were aged 2 or 3 years in either of the first two survey cycles (cycle 1 [1994] or cycle 2 [1996]), for whom we also had BMI data at age 6 or 7 years. We selected age 2/3 years as the exposure period because 2 is the youngest age for which BMI and BMI-for-age percentile is recommended.[23] We selected age 6/7 years as the follow-up age because it represents a significant period of time over which to examine a possible enduring effect of child care, but it is not so long that it would be impossible to account for a myriad of intervening factors.

Variables

BMI was calculated for each child at age 2/3 years and age 6/7 years using height and weight data reported by the parent/guardian. A corresponding BMI-for-age percentile was assigned to each child, using the growth charts developed by Centers for Disease Control and Prevention.[24] Several Canadian professional organizations[25] have endorsed these growth charts, which are based on a

reference population of U.S. children, to track growth of individual children.[25,26] We examined BMI percentile as an outcome variable in two ways: first, as a continuous variable, indicating the difference in percentile between age 2/3 years and age 6/7 years; and second, as a categorical variable, as in whether the child falls into the normal (BMI $< 85^{th}$ percentile) or at-risk (BMI $\geq 85^{th}$ percentile) range at age 2/3 years and age 6/7 years.

Our main predictor variable was exposure to child care (at least 10 hours per week) at age 2/3 years, as reported by the primary caregiver. We examined three types of care: care by a non-relative, care by a relative and care in a daycare centre. We also included the following covariates (from age 2/3 years), based on the literature[27,28]: income adequacy (standard Statistics Canada classification based on household income and number of persons in the household†; three categories); highest household educational attainment (high school graduation or less, some post-secondary education, post-secondary graduation or higher); number of siblings (0, 1, $\geq$ 2); number of parents in the household (1 versus 2); birth weight (normal versus low/very low [< 2500 g]); mother's age at birth (13–19 years or 35–54 years [both higher risk] versus 20–34 years [lower risk]); province of residence; urban versus rural residence; and survey cycle (i.e. whether the child was age 2/3 in cycle 1 [1994] or cycle 2 [1996]).

Analysis

We used two analytic strategies, corresponding to the two (continuous and categorical) versions of the outcome variable. First, we used ordinary least squares (OLS) regression to regress BMI percentile change (continuous) on child care (care by non-relative, care by relative, daycare centre), unadjusted and adjusted for covariates, for boys and girls separately. Also using OLS, we tested two-way (child care type * income adequacy [low versus not low]) interaction terms to explore the possibility that the impact of child care on BMI percentile differs by socioeconomic circumstances, as shown elsewhere.[20] Second, using binary logistic regression, we examined a) the odds of moving into the at-risk BMI percentile range ($\geq 85^{th}$ percentile) by age 6/7 years in children who were in the normal BMI percentile range ($< 85^{th}$ percentile) at age 2/3 years, and b) the odds of moving into the normal BMI percentile range by age 6/7 years among children who were in the at-risk percentile range at age 2/3 years, in relation to child care type, unadjusted and adjusted for covariates, for boys and girls separately. The logistic models were used to explore whether response to child care may vary by initial BMI status, thus complementing the OLS regression model that assumes uniform response regardless of BMI.

We initially ran models using five types of care (care in someone else's home by a non-relative; care in own home by a non-relative; care in someone else's home by a relative; care in own home by a relative; and care in a daycare centre). Because respondents could report more than one type of care, the five care types were represented in the models using five non-mutually exclusive variables. To query whether it was appropriate to assume no interactions amongst care types, we conducted a likelihood ratio test comparing two OLS models: the first containing the five care types, and the second containing all possible combinations of care types (n = 28, excluding combinations with zero cases). For both boys and girls, we were unable to reject the null hypothesis of no difference between models, thus supporting use of the model with five care types entered as independent variables. However, none of the five care types showed an association with BMI percentile, and thus we explored the possibility of a more parsimonious model. Specifically, we tested the interaction between caregiver (relative; non-relative) and care venue (in own home; in other's home). Finding no interaction, we collapsed these four care types into two (care by non-relative, regardless of venue; and care by relative, regardless of venue). Care in a daycare centre constituted the third care type. Because respondents could report more than one type of care, the reference category for each care type is absence of that care type, regardless of other forms of care reported.

We used Stata version 11.0 (StataCorp LP) for all analyses. All models incorporate appropriate longitudinal sampling weights to account for the complex survey design and to approximate the original population (i.e. the population at the time of original cohort sample selection), and bootstrap weights to estimate standard errors and confidence intervals.

The study received ethics approval from the Conjoint Health Research Ethics Board at the University of Calgary, Ethics ID # E-22399.

Results

Descriptive statistics for the sample are shown in Table 1. Of the 5654 children potentially available for our study (i.e. age 2/3 years in cycle 1 or cycle 2 and still in the survey at age 6/7 years), 4955 had BMI data at age 2/3 years and 3916 had BMI data at both age 2/3 years and age 6/7 years. Thus, 1738 children (30.7% of the original sample) were excluded due to missing BMI data, mostly at age 6/7 years. Compared to those with complete BMI data at age 2/3 years and age 6/7 years, those with missing BMI data at age 6/7 years were more likely to have low household income adequacy (both boys and girls); have low household education (both boys and girls); live in a single-parent household (both boys and girls); have a young (i.e. < 20 years) mother at time of birth (both boys and girls); and live in Quebec (both boys and girls) (at $p < .05$). They were less likely to have siblings (girls only); live in Prince Edward Island (boys only); live in Ontario (girls only); and live in a rural environment (boys only). For girls, there were no

† For example, the lowest income adequacy category in the 1994 cohort was assigned to households for which household income was < $10,000 and household size was 1 to 4 persons, and those for which household income was < $15,000 and household size was 5 or more persons (NLSCY Data Dictionary, Cycle 1. Available at www.statcan.gc.ca). The original variable had 5 categories, which we collapsed to 3 so that each category had adequate size.

TABLE 1
Weighted descriptive statistics for study sample, stratified by sex

Variable	Girls (n = 1760)	Boys (n = 1804)
Mean (SD) BMI percentile change, age 2/3 to 6/7 years	−.064 (.018)	−.060 (.016)
BMI status		
At risk (≥ 85th percentile) at age 2/3 years, %	45.8	47.4
At risk (≥ 85th percentile), age 6/7, %	38.3	40.1
Care by non-relative (yes), %[a]	25.5	28.8
Care by relative (yes), %[a]	13.7	13.4
Care in daycare centre (yes), %[a]	11.9	9.0
No care (other than parents), %[b]	57.0	56.0
Household income adequacy, %[c]		
Lower	13.8	14.3
Middle	30.1	31.7
Higher	56.1	54.1
Household education, %		
High school graduation or less	19.9	17.1
Some post-secondary	24.8	25.7
Post-secondary graduation plus	55.3	57.2
Number of siblings, %		
0 (only child)	26.2	27.6
1	47.0	45.4
2+	26.7	27.0
Number of parents in household, %		
1 (single parent)	9.1	12.4
2	90.9	87.6
Birth weight, %		
Low / very low [< 2500g]	7.9	5.1
Normal	92.1	94.9
Mother's age at child's birth, %		
13–19 years or 35 years+ (high risk)	10.7	12.2
20–34 years	89.3	87.8
Province of residence, %		
Newfoundland	1.6	1.9
Nova Scotia and Prince Edward Island[d]	3.1	4.0
New Brunswick	2.7	2.7
Quebec	22.9	23.2
Ontario	42.7	41.6
Manitoba	4.0	3.8
Saskatchewan	3.6	3.8
Alberta	10.0	9.7
British Columbia	9.5	9.3
Urban / rural residence, %		
Urban	83.7	82.6
Rural	16.3	17.4
Survey cycle, %[e]		
Cycle 1	55.7	57.0
Cycle 2	44.3	43.0

Table continued, see right column

differences in reported child care between those with missing and non-missing BMI data. For boys, those with missing BMI data were less likely to report care in another's home by a non-relative or care in their own home by a relative than those with complete BMI data. Of the 3916 children with complete BMI data, 3889 had complete child care data and 3745 had complete data on all covariates. Our final sample size, after purposefully excluding an additional 181 who reported less than 10 hours of child care per week, was 3564 (1760 girls and 1804 boys).

Results of OLS regression (BMI percentile change regressed on the three care types) are presented in Table 2a (for girls) and 2b (for boys). There were no associations between child care and BMI percentile change for girls (Table 2a), while for boys (Table 2b), care by a non-relative was associated with an increase in BMI percentile between age 2/3 years and 6/7 years, relative to no non-relative care.

According to results of our OLS models testing a two-way (child care type * low income adequacy) interaction (not shown), there was one significant interaction whereby care by a non-relative (relative to no care of this type) was associated with an increase in BMI percentile between age 2/3 years and age 6/7 years for girls in low-income adequacy households (coefficient for interaction term from adjusted model: 0.32; 95% confidence interval [CI] = 0.016 to 0.62, p = .039).

Results of binary logistic regression (to examine the odds of moving into or out of the at-risk BMI percentile range by age

Abbreviations: BMI, body mass index; SD, standard deviation.

[a] ≥ 10 hours/week of child care.

[b] Sum of percentages for care variables exceeds 100 because more than one type of child care could be reported.

[c] Household income adequacy is a standard Statistics Canada classification based on household income and household size.

[d] Nova Scotia and Prince Edward Island combined due to small sample size for these provinces.

[e] Survey cycle refers to when child was enrolled in the study (cycle 1, enrolled in 1994; cycle 2, enrolled in 1996). Percentages within variables may not add up to 100 due to rounding.

TABLE 2A
Results of OLS regression analysis for girls (n = 1760), with BMI percentile change (continuous variable) regressed on child care type and socio-demographic variables

Predictor variable	Unadjusted estimates[a] coefficient (95% CI)	Adjusted model[b] coefficient (95% CI)
Child care [c]		
By non-relative	−.042 (−.13 to .04)	−.040 (−.13 to .05)
By relative	−.014 (−.11 to .09)	−.006 (−.10 to .09)
Daycare centre	.060 (−.063 to .18)	.056 (−.07 to .18)
Household income adequacy (Reference: lower)		
Middle	.014 (−.09 to .12)	−.003 (−.13 to .12)
Higher	−.022 (−.12 to .08)	−.050 (−.18 to .08)
Household education (Reference: ≤ high school graduation)		
Some post-secondary	−.017 (−.12 to .08)	−.001 (−.11 to .10)
Post-secondary graduation	−.001 (−.09 to .09)	.017 (−.09 to .12)
Number of siblings (Reference: 0)		
1	−.054 (−.15 to .04)	−.052 (−.14 to .04)
≥ 2	−.065 (−.18 to .04)	−.073 (−.18 to .03)
Number of parents in household (Reference: 2)		
1	−.025 (−.14 to .09)	−.047 (−.20 to .10)
Birth weight (Reference: normal)		
Low / very low (< 2500 g)	.064 (−.08 to .21)	.050 (−.09 to .19)
Mother's age at birth, years (Reference: 20–34)		
13–19 or 35+ (combined)[d]	.061 (−.054 to .18)	.068 (−.04 to .18)
Province of residence (Reference: Ontario)		
Newfoundland	−.040 (−.16 to .08)	−.049 (−.18 to .08)
Nova Scotia & Prince Edward Island[e]	−.063 (−.15 to .03)	−.066 (−.16 to .02)
New Brunswick	.040 (−.08 to .16)	.031 (−.09 to .15)
Quebec	.050 (−.06 to .16)	.034 (−.07 to .14)
Manitoba	.009 (−.12 to .13)	.009 (−.12 to .13)
Saskatchewan	−.020 (−.13 to .09)	−.018 (−.13 to .09)
Alberta	.084 (−.03 to .20)	.078 (−.03 to .19)
British Columbia	−.055 (−.15 to .04)	−.050 (−.15 to .05)
Urban/rural residence (Reference: urban)		
Rural	.010 (−.06 to .08)	−.000035 (−.07 to .07)
Survey cycle (Reference: cycle 2)[f]		
Cycle 1	.073 (.003 to .14)**	.066 (−.003 to .14)*

Abbreviations: BMI, body mass index; CI, confidence interval; OLS, ordinary least squares.

[a] Bi-variate associations between each predictor variable and BMI percentile change, with the exception of child care and province of residence, for which all categories are entered as a block.

[b] Associations from single model containing all variables.

[c] ≥ 10 hours/week of child care.

[d] The two high-risk age groups were combined to ensure adequate cell size for vetting.

[e] Nova Scotia and Prince Edward Island combined due to small sample size for these provinces.

[f] Survey cycle refers to when child was enrolled in the study (cycle 1, enrolled in 1994; cycle 2, enrolled in 1996).

* $p < .10$

** $p < .05$

6/7 years, among those in the normal and at-risk BMI percentile range at age 2/3 years, in relation to child care type) are shown in Table 3. No associations between child care and shift in BMI percentile range were observed for girls (Table 3a) or boys (Table 3b).

We observed few associations between socio-demographic covariates and BMI percentile. In girls with normal BMI percentile at age 2/3 years, those living in middle income status households were marginally less likely to move into the at-risk BMI percentile range by age

TABLE 2B
Results of OLS regression analysis for boys (n = 1804), with BMI percentile change (continuous variable) regressed on child care type and socio-demographic variables

Predictor variable	Unadjusted estimates[a] coefficient (95% CI)	Adjusted model[b] coefficient (95% CI)
Child care[c]		
By non-relative	.061 (−.02 to .14)	.10 (.02 to .18)**
By relative	−.037 (−.14 to .06)	−.021 (−.12 to .07)
Daycare centre	.031 (−.05 to .12)	.043 (−.05 to .13)
Household income adequacy (Reference: lower)		
Middle	−.010 (−.14 to .11)	−.061 (−.19 to .07)
Higher	−.077 (−.19 to .04)	−.18 (−.31 to −.05)***
Household education (Reference: ≤ high school graduation)		
Some post-secondary	−.019 (−.13 to .10)	−.026 (−.15 to .10)
Post-secondary graduation	−.017 (−.10 to .07)	−.010 (−.11 to .09)
Number of siblings (Reference: 0)		
1	.019 (−.06 to .10)	.012 (−.07 to .09)
≥ 2	.014 (−.08 to .10)	−.020 (−.11 to .07)
Number of parents in household (Reference: 2)		
1	−.066 (−.21 to .08)	−.16 (−.33 to .002)*
Birth weight (Reference: normal)		
Low / very low (< 2500 g)	.074 (−.13 to .28)	.071 (−.12 to .27)
Mother's age at birth, years (Reference: 20–34)		
13–19 or 35+ (combined)[d]	−.051 (−.17 to .07)	−.052 (−.17 to .06)
Province of residence (Reference: Ontario)		
Newfoundland	−.074 (−.19 to .04)	−.11 (−.23 to .01)*
Nova Scotia & Prince Edward Island[e]	.037 (−.06 to .13)	−.00057 (−.10 to .10)
New Brunswick	.064 (−.08 to .21)	.027 (−.11 to .17)
Quebec	.034 (−.05 to .12)	.0038 (−.08 to .09)
Manitoba	.029 (−.09 to .15)	.011 (−.11 to .13)
Saskatchewan	.10 (−.02 to .22)	.070 (−.05 to .19)
Alberta	−.095 (−.21 to .02)*	−.11 (−.23 to −.0005)**
British Columbia	−.079 (−.21 to .05)	−.079 (−.20 to .04)
Urban/rural residence (Reference: urban)		
Rural	.034 (−.03 to .10)	.014 (−.05 to 0.08)
Survey cycle (Reference: cycle 2)[f]		
Cycle 1	.012 (−.05 to .07)	.020 (−.04 to .08)

Abbreviations: BMI, body mass index; CI, confidence interval; OLS, ordinary least squares.

[a] Bi-variate associations between each predictor variable and BMI percentile change, with the exception of child care and province of residence, for which all categories are entered as a block.

[b] Associations from single model containing all variables.

[c] ≥ 10 hours/week of child care.

[d] The two high-risk age groups were combined to ensure adequate cell size for vetting.

[e] Nova Scotia and Prince Edward Island combined due to small sample size for these provinces.

[f] Survey cycle refers to when child was enrolled in the study (cycle 1, enrolled in 1994; cycle 2, enrolled in 1996).

* $p < .10$

** $p < .05$

*** $p < .01$

6/7 years than girls in a lower household income status (Table 3a). For boys, the following attributes were associated with a decrease in BMI percentile between age 2/3 years and age 6/7 years: higher household income adequacy, single parent household, residence in Newfoundland and residence in Alberta (Table 2b). Among boys who were in the normal

TABLE 3A
Results of binary logistic regression analysis for girls (n = 1760), with BMI percentile change regressed on child care type, unadjusted and adjusted for socio-demographic variables

Predictor variable	Girls with normal BMI[a] at age 2/3 years (n = 912)		Girls with at-risk BMI[b] at age 2/3 years (n = 848)	
	OR (95% CI) for moving into the at-risk BMI range by age 6/7 years		OR (95% CI) for moving into the normal BMI range by age 6/7 years	
	Unadjusted[c]	Adjusted[d]	Unadjusted[c]	Adjusted[d]
Child care[e]				
By non-relative	0.86 (0.51 to 1.40)	0.86 (0.49 to 1.50)	1.10 (0.67 to 1.80)	0.88 (0.50 to 1.50)
By relative	1.06 (0.50 to 2.30)	0.95 (0.45 to 2.00)	0.77 (0.42 to 1.40)	0.66 (0.35 to 1.20)
Daycare centre	1.82 (0.82 to 4.00)	1.66 (0.70 to 3.90)	0.64 (0.34 to 1.20)	0.55 (0.26 to 1.20)
Household income adequacy (Reference: lower)				
Middle	0.55 (0.28 to 1.10)*	0.43 (0.18 to 1.05)*	0.59 (0.30 to 1.10)	0.60 (0.28 to 1.30)
Higher	0.62 (0.31 to 1.20)	0.48 (0.18 to 1.30)	1.17 (0.64 to 2.10)	1.30 (0.61 to 2.90)
Household education (Reference: ≤ high school graduation)				
Some post-secondary	1.12 (0.54 to 2.30)	1.21 (0.51 to 2.80)	1.40 (0.71 to 2.80)	1.27 (0.63 to 2.60)
Post-secondary graduation	0.71 (0.38 to 1.30)	0.77 (0.36 to 1.70)	1.50 (0.81 to 2.80)	1.36 (0.69 to 2.70)
Number of siblings (Reference: 0)				
1	0.72 (0.40 to 1.30)	0.73 (0.39 to 1.40)	0.67 (0.35 to 1.30)	0.60 (0.31 to 1.20)
2 or more	0.62 (0.32 to 1.20)	0.53 (0.25 to 1.20)	0.66 (0.31 to 1.40)	0.61 (0.28 to 1.30)
Number of parents in household (Reference: 2)				
1	0.96 (0.45 to 2.10)	0.55 (0.19 to 1.60)	1.08 (0.56 to 2.10)	1.12 (0.46 to 2.70)
Birth weight (Reference: normal)				
Low / very low (< 2500 g)	0.91 (0.37 to 2.20)	0.87 (0.34 to 2.30)	0.84 (0.29 to 2.40)	1.10 (0.38 to 3.20)
Mother's age at birth, years (Reference: 20–34)				
13–19 or 35+ (combined)[f]	0.71 (0.33 to 1.50)	0.75 (0.33 to 1.70)	0.82 (0.35 to 1.90)	0.71 (0.29 to 1.70)
Province of residence (Reference: Ontario)				
Newfoundland	1.76 (0.74 to 4.20)	1.41 (0.52 to 3.80)	0.72 (0.31 to 1.70)	0.69 (0.29 to 1.70)
Nova Scotia & Prince Edward Island[g]	1.01 (0.48 to 2.10)	0.96 (0.44 to 2.10)	1.27 (0.66 to 2.40)	1.41 (0.67 to 3.00)
New Brunswick	1.76 (0.76 to 4.10)	1.64 (0.67 to 4.00)	0.84 (0.43 to 1.60)	0.91 (0.44 to 1.90)
Quebec	1.48 (0.78 to 2.80)	1.41 (0.73 to 2.80)	0.60 (0.31 to 1.20)	0.65 (0.32 to 1.30)
Manitoba	1.02 (0.31 to 3.30)	0.97 (0.29 to 3.20)	0.81 (0.41 to 1.60)	0.83 (0.39 to 1.70)
Saskatchewan	1.56 (0.76 to 3.20)	1.76 (0.82 to 3.80)	1.80 (0.88 to 3.60)	1.85 (0.81 to 4.20)
Alberta	0.92 (0.40 to 2.10)	1.03 (0.44 to 2.40)	0.81 (0.38 to 1.80)	0.87 (0.38 to 2.00)
British Columbia	0.78 (0.32 to 1.90)	0.84 (0.32 to 2.20)	1.35 (0.61 to 3.00)	1.39 (0.58 to 3.30)
Urban/rural residence (Reference: urban)				
Rural	1.20 (0.77 to 1.90)	1.06 (0.62 to 1.80)	0.95 (0.63 to 1.40)	1.04 (0.64 to 1.70)
Survey cycle (Reference: cycle 2)[h]				
Cycle 1	1.06 (0.67 to 1.70)	1.01 (0.61 to 1.70)	0.94 (0.60 to 1.50)	1.05 (0.64 to 1.70)

Abbreviations: BMI, body mass index; CI, confidence interval; OR, odds ratio.

[a] BMI < 85th percentile.

[b] BMI ≥ 85th percentile.

[c] Bi-variate associations between each predictor variable and BMI percentile change, with the exception of child care and province of residence, for which all categories are entered as a block.

[d] Associations from single model containing all variables.

[e] ≥ 10 hours/week of child care.

[f] The two high-risk age groups were combined to ensure adequate cell size for vetting.

[g] Nova Scotia and Prince Edward Island combined due to small sample size for these provinces.

[h] Survey cycle refers to when child was enrolled in the study (cycle 1, enrolled in 1994; cycle 2, enrolled in 1996).

* $p < .10$

TABLE 3B
Results of binary logistic regression analysis for boys (n = 1804), with BMI percentile change regressed on child care type, unadjusted and adjusted for socio-demographic variables

Predictor variable	Boys with normal BMI[a] at age 2/3 years (n = 918)		Boys with at-risk BMI[b] at age 2/3 years (n = 886)	
	OR (95% CI) for moving into the at-risk BMI range by age 6/7 years		OR (95% CI) for moving into the normal BMI range by age 6/7 years	
	Unadjusted[c]	Adjusted[d]	Unadjusted[c]	Adjusted[d]
Child care[e]				
By non-relative	1.01 (0.60 to 1.70)	1.47 (0.87 to 2.5)	0.73 (0.45 to 1.20)	0.75 (0.45 to 1.20)
By relative	0.60 (0.33 to 1.10)	0.68 (0.35 to 1.30)	0.84 (0.42 to 1.70)	0.78 (0.38 to 1.60)
Daycare centre	1.35 (0.60 to 3.00)	1.56 (0.63 to 3.90)	1.04 (0.46 to 2.40)	0.90 (0.38 to 2.10)
Household income adequacy (Reference: lower)				
Middle	0.89 (0.40 to 2.00)	0.88 (0.35 to 2.20)	0.94 (0.49 to 1.80)	0.83 (0.38 to 1.80)
Higher	0.45 (0.22 to 0.96)**	0.51 (0.18 to 1.40)	0.87 (0.47 to 1.60)	0.73 (0.33 to 1.60)
Household education (Reference: ≤ high school graduation)				
Some post-secondary	0.75 (0.37 to 1.50)	0.84 (0.39 to 1.80)	1.96 (0.97 to 4.00)*	1.89 (0.87 to 4.10)
Post-secondary graduation	0.52 (0.28 to 0.95)**	0.64 (0.31 to 1.30)	1.34 (0.70 to 2.60)	1.33 (0.67 to 2.60)
Number of siblings (Reference: 0)				
1	1.06 (0.56 to 2.00)	1.12 (0.59 to 2.10)	0.80 (0.50 to 1.30)	0.81 (0.47 to 1.40)
≥ 2	1.67 (0.78 to 3.60)	1.60 (0.72 to 3.60)	0.71 (0.39 to 1.30)	0.67 (0.35 to 1.30)
Number of parents in household (Reference: 2)				
1	1.60 (0.58 to 4.50)	1.32 (0.29 to 6.10)	0.86 (0.41 to 1.80)	0.77 (0.32 to 1.90)
Birth weight (Reference: normal)				
Low / very low [<2500g]	0.23 (0.06 to 0.80)**	0.15 (0.03 to 0.69)**	1.51 (0.50 to 4.50)	1.18 (0.35 to 4.00)
Mother's age at birth (Reference: 20–34 yrs)				
13–19 or 35+ (combined)[f]	1.14 (0.49 to 2.60)	1.15 (0.44 to 3.00)	0.90 (0.44 to 1.80)	0.97 (0.44 to 2.20)
Province of residence (Reference: Ontario)				
Newfoundland	1.49 (0.61 to 3.70)	1.28 (0.47 to 3.50)	1.40 (0.64 to 3.10)	1.26 (0.56 to 2.80)
Nova Scotia and Prince Edward Island[g]	1.10 (0.47 to 2.60)	0.78 (0.29 to 2.10)	0.94 (0.46 to 1.90)	0.98 (0.46 to 2.10)
New Brunswick	1.83 (0.77 to 4.4)	1.80 (0.63 to 5.10)	1.15 (0.54 to 2.40)	1.11 (0.48 to 2.60)
Quebec	1.68 (0.85 to 3.30)	1.52 (0.77 to 3.00)	1.28 (0.69 to 2.40)	1.11 (0.60 to 2.10)
Manitoba	0.89 (0.37 to 2.10)	0.79 (0.30 to 2.00)	1.16 (0.50 to 2.70)	1.04 (0.41 to 2.70)
Saskatchewan	1.20 (0.60 to 2.40)	0.98 (0.46 to 2.10)	1.54 (0.75 to 3.10)	1.62 (0.73 to 3.60)
Alberta	0.92 (0.37 to 2.30)	0.87 (0.33 to 2.30)	1.61 (0.85 to 3.00)	1.48 (0.75 to 2.90)
British Columbia	1.47 (0.67 to 3.20)	1.67 (0.74 to 3.70)	1.93 (0.92 to 4.00)*	1.73 (0.78 to 3.80)
Urban/rural residence (Reference: urban)				
Rural	1.20 (0.73 to 2.00)	0.97 (0.56 to 1.70)	0.85 (0.55 to 1.30)	0.75 (0.47 to 1.20)
Survey cycle (Reference: cycle 2)				
Cycle 1	1.15 (0.73 to 1.80)	0.88 (0.55 to 1.40)	0.94 (0.61 to 1.50)	1.00 (0.65 to 1.60)

Abbreviations: BMI, body mass index; CI, confidence interval; OR, odds ratio.

[a] BMI < 85th percentile.

[b] BMI ≥ 85th percentile.

[c] Column contains bi-variate associations between each predictor variable and BMI percentile change, with the exception of child care and province of residence, for which all categories are entered as a block.

[d] Column contains associations from single model containing all variables.

[e] ≥ 10 hours/week of child care.

[f] The two high-risk age groups were combined to ensure adequate cell size for vetting.

[g] Nova Scotia and Prince Edward Island combined due to small sample size for these provinces.

[h] Survey cycle refers to when child was enrolled in the study (cycle 1, enrolled in 1994; cycle 2, enrolled in 1996).

* $p < .10$

** $p < .05$

BMI percentile range at age 2/3 years, a low/very low birth weight was associated with reduced odds of moving into the at-risk BMI percentile range by age 6/7 years, relative to a normal birth weight (Table 3b).

Discussion

We examined the association between child care (three types) at age 2/3 years and change in BMI between age 2/3 years and age 6/7 years, using both OLS models (to capture change in BMI percentile regardless of starting point) and logistic regression models (to capture change that crosses a recognized threshold, the 85th BMI percentile). Although an association between child care and later BMI is plausible and would have policy relevance, its existence and nature in Canada is not known. To examine this association, we used a data source (NLSCY) that is well-suited to our question: the NLSCY is a longitudinal, nationally representative survey that contains information on several types of child care, height and weight data from multiple time points, and sufficient sample size to stratify by sex. While other studies included sex as a covariate,[16–19,21–22] ours is unique in that we examined the child care–BMI relationship in boys and girls separately.

For boys, care by a non-relative, for example, by a nanny, a baby-sitter, an informal day-home, a friend, or a neighbour, was associated with an increase in BMI percentile between age 2/3 and age 6/7 years. Although the reason for the association is not known, the appearance of this main effect in boys but not girls brings to mind a plausible role of non-relative caregiver behaviour such as providing sugary treats as a way of placating energetic boys or distracting them with television, thereby increasing sedentary behaviour. Although a statistically significant effect of this care type was not observed in logistic regression models, we note that the direction of the effect in the logistic regression model in boys is consistent with the OLS finding (Table 3b, adjusted models, odds ratio (OR) for boys with normal BMI percentile at age 2/3 moving into the at-risk BMI percentile by age 6/7 was 1.47, whereas OR for boys with at-risk BMI percentile at age 2/3 years moving into the normal BMI percentile by age 6/7 was 0.75). For girls, no main effects of child care on BMI percentile were apparent; however, the model containing interaction terms revealed that care by a non-relative was associated with an increase in BMI percentile between age 2/3 years and age 6/7 years among girls from low-income adequacy households. One possible explanation for this finding is that families with lower income, who have a financial imperative to work outside the home, may have a limited array of child care options from which to choose, and in some cases may have to resort to care options that are sub-optimal in terms of nutrition and opportunities for physical activity / active play. It is not known why the interaction effect was not observed in boys. The child care effects observed (main effect of care by non-relative in boys, interaction between care by non-relative and low income adequacy status in girls) differed only negligibly between the adjusted and the unadjusted models, suggesting that the socio-demographic correlates included were neither confounders nor mediators.

Although existing studies on child care and BMI vary in terms of population, age group, duration, and country, we can nonetheless comment on how our findings fit with and build on the existing literature. Several studies found an association between various types of ''informal'' care and weight gain / increase in BMI.[17,18,20] : Our findings are consistent with these effects, and build on them. We identified non-relatives as a pertinent dimension of informal care with relevance to BMI in the Canadian context. The effect of informal care on increased risk of overweight observed by Pearce et al.[20] was specific to children from more advantaged backgrounds, while we observed that care by a non-relative was associated with increasing BMI percentile among girls from a lower income adequacy household. Collectively, findings from our study and others indicate that future research on the topic should take a nuanced view of informal child care – including whether the caregiver is a relative or not, the socio-economic circumstances of the child's family and the child's gender.

Our findings are consistent with those of Maher et al.,[17] Benjamin et al.[18] and Kim et al.[19] (all based on samples of U.S. children) in terms of finding no association between formal centre-based care and BMI outcomes. Although on the one hand it is good news that formal daycare does not appear to have a clear adverse effect on BMI, the absence of effect (particularly in the logistic regression models) also suggests a potentially under-exploited opportunity for health promotion. As noted, the number of young children in Canada with mothers in the paid labour force far exceeds the number of spots available in formal high-quality, affordable and accessible child care settings.[5] Many families accordingly rely on other care options, including care by a non-relative, which we observed to have an adverse effect on later BMI. Were it more widely available and accessible, it is plausible that at least some of the families currently using informal care options would opt for the formal high-quality daycare. To the extent that this care is indeed higher in quality, it could provide a more favourable environment for BMI and other outcomes. A strong case for investment in formal centre-based care requires ongoing high-quality research that examines the implications of formal centre-based care (including variants and attributes thereof) for diverse outcomes (health, social, economic) at different levels (child, family, community) over the short and particularly the longer term.[29–31]

Limitations

Our study suffers from some methodological limitations. One issue is the relatively large amount of missing data on the BMI variable. Our comparison of respondents with missing and non-missing BMI data indicated clear socio-demographic differences between the groups, though it is reassuring that the groups did not differ dramatically in terms of child care use (and not at all in the case of girls). Second, because all of our baseline data were reported at age 2/3 years, it is impossible to ascertain that BMI at age 2/3 had not already been affected by child care at age 2/3; however, we would argue that the nature of these associations is such that

immediate influence is unlikely. A third and particularly important limitation of the data is the parent-reported nature of children's heights and weights. The errors that parents commit in reporting height and weight of their children tend to result in overestimation of BMI, and these errors are larger for younger children and decline with increasing age.[32,33] One way to explore the potential implications of reporting inaccuracy for our findings is to examine correlates of reporting inaccuracy; in particular, socio-demographic attributes that are likely to be associated with child care use. Shields et al.[33] examined the association between parental education and reporting inaccuracy among children aged 6 to 11 years in the Canadian Health Measures Survey (CHMS): the CHMS is the only population-based dataset of Statistics Canada that contains both measured and parent-reported height and weight data for the same children. They found no association between parent education and reporting inaccuracy. Although the age group in the CHMS is older than our age group of interest (unfortunately, no Canadian national population-based data are available that contain both measured and parent-reported height and weight data for children of pre-school age), the findings of Shields et al.[33] support the view that parents' reports of their child's height and weight are not irredeemably biased by parents' education (one aspect of socio-economic circumstances), which heightens our confidence in our findings to some extent.

In summary, among children in the inaugural NLSCY cohort, care by a non-relative was associated with an increase in BMI over time for all boys and for girls from low-income adequacy households. Considering the high and growing demand for child care options,[6] the demonstrated benefits of high-quality formal child care for child social and health outcomes,[5,29–30] and the potentially adverse effects of certain informal forms of child care observed in this study and reported by others,[17,18] our findings contribute to a growing knowledge base with significant policy relevance, for which more research is needed.[29–31] In terms of research on child care and weight-related outcomes specifically, measured height and weight data are essential.

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