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Family food insufficiency is related to overweight among preschoolers'

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Abstract

This paper studies the relationship between family food insufficiency and being overweight in a population-based cohort of preschool children ($n = 2103$) using data from the Longitudinal Study of Child Development in Québec (1998–2002) (LSCDQ). Family food insufficiency status was derived when children were 1.5 years of age (from birth to 1.5 years) and at 4.5 years of age (from 3.5 to 4.5 years). Children's height and weight were measured at home at 4.5 years. Overweight was defined according to the US CDC sex- and age-specific growth charts and Cole's criteria. Statistical analyses were done with SAS (version 8.2). In multivariate analyses, mean body mass index (BMI) was higher for children from food insufficient families compared to children from food sufficient families, even when important factors associated with BMI, such as child's birth weight, parental BMI, maternal education, and family income sufficiency were considered. We did not report any gender effects in the multivariate analyses. The presence of family food insufficiency at some point during preschool years more than tripled (OR 3.4, 95% CI 1.5–7.6) the odds for obesity using the Cole criteria, and doubled (OR 2.0, 95% CI 1.1–3.6) the odds for overweight at 4.5 years using the CDC growth curves indicator. We observed an interaction between birth weight and family food insufficiency in relation to being overweight at 4.5 years. Low-birth-weight children living in a household that experienced food insufficiency during preschool years are at higher risk of overweight at 4.5 years. Given this important finding, supportive interventions targeting low-income and food insufficient families, including pregnant women, are recommended for preventing overweight and obesity among their children.

Keywords: Overweight; Poverty; Preschoolers; Birth cohort; Food insufficiency; Canada; Obesity

Introduction

Obesity in adults, adolescents, and children has reached epidemic proportions in North America and Europe (International Obesity Task Force, 2004; Silventoinen et al., 2004; World Health Organization, 2004). It is essential to begin tracking risk factors for this condition as early as possible in life in order to prevent obesity-related health, psychological, and social problems in later ages for individuals and at the population level (Ball & McCargar, 2003; Dietz, 1998a; Reilly et al., 2003; Slyper, 2004). Moreover, obesity in childhood and adolescence may continue into adulthood and aggravate its associated health problems (Dietz, 1998b; Engeland, Bjørge, Søgaard, & Tverdal, 2003; Guo, Wu, Chumlea, & Roche, 2002; Power, Lake, & Cole, 1997). In well-developed societies, such as Canada, obesity is inversely related with different

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social position indicators. But does this relationship hold for children living in the poorest families experiencing food insufficiency?

In 2003, 36 million people, including 13 million children in the United States lived in food insecurity (Nord, Andrews, & Carlson, 2003). According to the Third National Health and Nutrition Examination Survey (NHANES III) data, 4.1% of the population lived in families that reported not getting enough food to eat and 14% were food insufficient in the low income group (Alaimo, Briefel, Frongillo, & Olson, 1998). Based on data from the Continuing Survey of Food Intakes by Individuals (CSF II), the prevalence of food insufficiency in households with children was 3.0%, while 7.5% of low-income families with children reported food insufficiency (Casey, Szeto, Lensing, Bogle, & Weber, 2001). A recent cross-sectional survey conducted at urban medical centres in five states in the United States found that 21.4% of low-income households with children (aged 36 months or less) were food insecure, while 6.8% of these households were food insecure with hunger (Cook et al., 2004).

In Canada, an increasing number of families are living in poverty, and food insufficiency is one possible outcome of material deprivation (McIntyre, Connor, & Warren, 2000; Tarasuk, 2001). In the Canadian province of Québec in 1998, where this study took place, 8.3% of families experienced food insecurity, and the proportion reached 24% in single-parent families (Dubois, Beauchesne, Girard, Bertrand, & Hamelin, 2000a, Chapter 6). Similarly, according to the results of the 2004 Canadian Community Health Survey (CCHS) approximately one-fifth of Canadian families (around 1.4 million people) lived in food insecurity (Statistics Canada, 2005a). Children were proportionally more affected than adults and boys more than girls. In 2004, 11.6% of children (19 years of age or under) experienced this situation, even though their age group represented only 25% of the total population (Statistics Canada, 2005b). The National Longitudinal Study of Children and Youth (NLSCY) of 1996 conducted in Canada reported that 1.6% of children experienced hunger, a more severe indicator of food insecurity (McIntyre, Walsh, & Connor, 2001).

Food insecurity is related to poverty, single-parenting, low levels of maternal education and maternal young age, acculturation and ethnicity, lack of work, and the area of residence (e.g., poor urban neighbourhoods) (Dubois, 2006, Chapter 6; Dubois et al., 2000a; Furness, Simon, Wold & Asarian-Anderson, 2004; Hamelin, Beaudry & Habicht, 2002; McIntyre et al., 2002). Income is the most important determinant of food security and as income decreases the odds of reporting food insecurity increases (Alaimo, 1997; Che & Chen, 2001; Hamelin, Beaudry, & Habicht, 1998; McIntyre et al., 2000; Rose, Gundersen, & Oliveira, 1998; Vozoris & Tarasuk, 2003). Although income is the most important determinant of food security, there is no linear relationship with income and food security (Power, 2005).

Food insecurity is a broad conceptual model comprised of three concepts: food uncertainty, food insufficiency and hunger (National Research Council, 2005). Although these concepts are different and separate, they are related. It is thought that food insufficiency is more severe than the concept of food security, although not as severe as hunger and closer to the phenomenon of hunger than food security (Alaimo, 1997; Alaimo et al., 1998; Briefel & Woteki, 1992; Carlson et al., 1998). The food security continuum includes households that are food secure, and those that are food insecure without hunger, with moderate hunger and with severe hunger (Keenan, Olson, Hersey, & Parmer, 2003; Nord et al., 2000). Within this scale is a measure of food insufficiency which is defined as an inadequacy in the amount of food intake because of money or resources to access enough food (Briefel, 1992). Moreover, it is a dynamic, complex and temporal process whereby different persons in the family may experience food insufficiency at different times (Briefel & Woteki, 1992; Tarasuk, 2001).

Alaimo, Olson, and Frongillo (2001) were among the first to raise awareness of a potentially paradoxical situation in which food insecurity and obesity could exist concurrently in well-developed countries. In adults, food insecurity has been associated with overweight in certain populations of women, and with obesity in the U.S. (Adams, Grummer-Strawn, & Chavez, 2003; Basiotis & Lino, 2003; Olson, 1999; Townsend, Peerson, Love, Achterberg, & Murphy, 2001). Alternatively, men who lived in food insecure households were less likely to be overweight than men living in food-secure households (Vozoris & Tarasuk, 2003). There are few studies that link food insecurity and overweight in children, and these studies show inconsistent results. The NHANES III data indicates a relationship between food insecurity and

overweight only in white girls aged 8–16 years (Alaimo et al., 2001). A study done in Korea with 370 children aged 4 to 12 years living in urban areas found a positive relationship between food insecurity and overweight (Oh & Hong, 2003). The NLSCY is another important study that showed early gender effects of hunger related to overweight in girls and underweight in boys (McIntyre et al., 2001). However, the CSF II data failed to indicate a relationship between food insecurity and overweight (Casey et al., 2001) in children, even though differences were observed between income levels. On the other hand, another study on children reported that food-insecure children were leaner than non-insecure children (Jimenez-Cruz, Bacardi-Gascon, & Spindler, 2003). Despite moderate evidence supporting the association of food insufficiency and overweight among some groups, the causal pathway between food insufficiency and bodyweight in early childhood is poorly understood.

Given that few studies have examined the relationship of food insufficiency and bodyweight among preschool children, this study will make a contribution to the understanding of the impact of food insufficiency and early childhood providing a basis for the development of future interventions to prevent overweight and obesity in children. The aim of this paper is to study the relationship between family food insufficiency and overweight in a population-based cohort of preschool children born in 1998 in the Province of Québec, Canada.

Methods

The analyses were performed using data from the Longitudinal Study of Child Development in Québec (1998–2002) (LSCDQ), conducted by Santé Québec, a division of the Institut de la Statistique du Québec (ISQ) and funded by the Ministry of Health and Social Services of Québec (Dubois, Bédard, Girard, & Beauchesne, 2000b; Dubois & Girard, 2002). The main objective of the study is to analyze the role of familial and social factors on children's health and on their cognitive and behavioural development. The study follows a representative sample ($n = 2103$) of children born in 1998 in the Canadian province of Québec (total population over 7 million, with approximately 70,000 newborns per year). The representative sample was chosen by a random selection of children born in each public health geographic area of the province of Québec over the year such that the seasonality effect was minimized. Birth weight and gestational age were collected from the birth medical record. The children were first seen at 5 months (gestational age adjusted for pre-term birth) and then once a year thereafter. The study is based on face-to-face structured interviews and questionnaires were administered to the person most knowledgeable (PMK) about the child, which is generally the mother. Of the 2103 children at the first data collection, 1944 remained in 2002 at age 4–5 years (the ages of the children varying from 44 to 56 months). Of this group, 1549 volunteered to take part in the nutrition study. Children in this sample deemed as a representative sample of the same-age children in the province of Québec by ISQ. The "Self-Administered Questionnaire for Mothers" included a nutrition component comprised of questions relating to children's eating behaviours and food insufficiency. Also, children's height and weight were measured.

Prior to conducting the analysis, data were weighted by a factor based on the inverse of the selection probability, the probability of non-response, the post-stratification rate, and the attrition rate, to ensure that data were longitudinally representative of the same-age children in the population (Cox & Cohen, 1985). Statistical analyses were based on individuals with no missing values for any of the studied variables. Among the 1549 children, 1514 (98% of the sub-sample) were part of the analyses. The impact of missing data was evaluated by conducting with-and-without analyses. Missing data were excluded from the analyses since they had no impact on the results.

The family food insufficiency questions for assessing the prevalence of family food insufficiency were originally developed for the Radimer/Cornell questionnaire validated in the United States (Kendall, Olson, & Frongillo, 1995; Radimer, Olson, & Campbell, 1990; Radimer, Olson, Greene, Campbell, & Habicht, 1992). It is worthwhile noting that many of the food security studies cited above were based on the United States Household Food Security Scale, a comprehensive 18-item scale that measures the level of food security and hunger experienced in the household (Hamilton et al., 1997). While, the food insufficiency indicator used in this study was comprised of one question derived from the NLSCY survey which has been using the same question since 1994 (McIntyre et al., 2001). Food insufficiency is typically measured by a single survey question about the quantity and quality of

food eaten in the household and is seen as a measure of fairly severe food insecurity (Alaimo et al., 1998; Rose & Oliveira, 1997). The validity of estimating the prevalence of food insufficiency in Québec was evaluated in an exploratory study using a non-random sample (Hamelin, 1999).

Data on food insufficiency were collected via self-administered maternal questionnaires at two different times. The first questionnaire was administered when the child was 1.5 years of age and the second at 4.5 years of age. Specifically, at 1.5 years, the mothers were asked: (1) "*Since the birth of your child, have you or a member of your family not eaten adequately because the family had run out of food or money to buy food?*" At 4.5 years, the mothers were asked: (1) "*In the past* 12 *months, have you or a member of your family not eaten adequately because the family had run out of food or money to buy food ?*" The mothers were asked to provide one answer to food insufficiency question: "regularly or every month", "more than once a month", "only during certain months", "occasionally but not regularly" and "no".). The frequency of food insufficiency following positive responses to the hunger experience was tabulated.

For the analysis, children were classified as *living in families with food insufficiency* if the mother answered yes to: "regularly or every month" or "more than once a month", or "only during certain months" or "occasionally but not regularly"; and as *not living in families with food insufficiency* if the mother answered "no". Methods of combining responses in this manner was employed in other food insufficient studies (Alaimo et al., 1998; Basiotis, 1992; Cristofar & Basiotis, 1992; Rose et al., 1998). The food insufficiency question relates to the household level which has been demonstrated to have both external validity (Basiotis, 1992; Cristofar & Basiotis, 1992) and face validity (Briefel & Woteki, 1992; Carlson & Briefel, 1995). For the analysis, we regrouped children living in households reporting this situation at the 1.5 years and/or at the 4.5 years data collection (6.3% of the children).

Children's height and weight were measured at home by a trained nutritionist following a standardized protocol and were analyzed using BMI (weight (kg)/height $(m)^2$) when the children were 4.5 years. Overweight is defined as having a BMI at or above the 95th percentile on the US CDC sex- and age-specific growth charts (National Center for Health Statistics and the National Center for Chronic Disease Prevention and Health Promotion, 2000). Overweight/obesity was also defined according to Cole's criteria that provides age and sex specific cut-off points from 2 to 18 years for overweight and obesity (Cole, Bellisi, Flegal, & Dietz, 2000).

The factors related to family food insufficiency and children's overweight selected for analysis were based on a literature review. The proportions for our population of preschoolers are presented in Table 1. Children's sex and birth weight (less than 2500 g, 2500–4000 g, 4000 g or more) were part of the analyses. Also included in the analyses were mothers' characteristics (collected when the children were 4.5 years) such as age group (under 25 y, 25–29 y, 30–34 y, 35 years and above); immigrant status (immigrant or not); education (no high school diploma, high school diploma, college diploma or university diploma); psychological distress based on an abridged version of the Depression scale CES-D (in distress (90th percentile or above) or not in distress); self-perceived health (excellent/very good, or good/average/bad). Other factors (also collected when the children were 4.5 years) analyzed included family type (single-parent family or not); household gross annual income ($<$\$20,000, \$20,000–39,999, \$40,000–59,999, $>=$\$60,000). Income sufficiency level (sufficient or insufficient[1]) is an index based on: the household size, household income, and the size of the residential area.[2] Socioeconomic status[3] is based on parents' education, household income,

[1]Statistics Canada's low-income cut-offs (LICOs) are income thresholds at which a family would typically spend 20% more of its income than the average family on the necessities of food, shelter and clothing (Statistics Canada, 2005a). Although LICOs are widely used they do not measure poverty. Unlike the US, Canada does not have a measure of poverty. For example, low-income thresholds range from \$20,047 for a family of four living in a rural area to \$30,576 for similar families living in large cities (Statistics Canada, 2005b). Sufficiency of income is determined by LICOs set by Statistics Canada for the reference year 1997 (1992 Baseline). It accounts for the size of the household and the size of the residence area. Families are classified as having 'sufficient income' when the household income is above the low-income threshold determined by Statistics Canada. When income is between 60% and 90% of the low-income threshold, households are classified as having 'insufficient income'; income levels below 60% of the low-income threshold are considered as 'very insufficient' (Statistics Canada, 2005a).

[2]Size of the residential area is the size of the population in a geographic area (e.g., the number of persons per square kilometer) (Statistics Canada, 2005b).

[3]Socioeconomic status is a composite of income, level of education, and occupational prestige for both parents. The SES index was calculated by the Institut de la statistique de Québec (Jetté & Des Groseilliers, 2000) based on methods by Willms and Shields (1996).

Table 1
Proportion of 4.5-year-old children living in a family with food insufficiency or food sufficiency, by selected characteristics[a]

Characteristic	Category	Proportion (%) of the children in the population	Proportion (%) of children living in a family with food sufficiency	Proportion (%) of children living in a family with food insufficiency
Total			93.7	6.3
Child's sex	Girl	49.0	49.7	39.2
	Boy	51.0	50.3	60.8
Child's birth weight	Less then 2500 g	4.4	4.2*	7.8*
	2500–4000 g	84.8	85.0	81.3
	More than 4000 g	10.8	10.8	11.0
Mother's age group	Under 25 y	6.8	6.5	11.4
	25–29 y	23.1	22.7	28.2
	30–34 y	32.1	32.1	32.5
	35 y or over	38.0	38.7	27.9
Mother's immigrant status	Not immigrant	86.4	86.8	80.3
	Immigrant	13.6	13.2	19.7
Mother's education	No high school diploma	15.7	14.6*	31.3*
	High school diploma	22.0	21.4	30.6
	College diploma	35.1	35.8	25.7
	University diploma	27.2	28.2	12.4
Mother's BMI	Less than 25 (normal weight)	71.8	72.4*	62.9*
	25 or more (overweight or obese)	28.2	27.6	37.1
Mother's psychological distress	No	87.7	88.3*	75.6*
	Yes	12.3	11.7	24.4
Maternal smoking during pregnancy	Non-smoking	75.1	75.7	66.6
	Smoking	24.9	24.3	33.4
Mother's self-perceived health status	Excellent/Very good	71.2	71.9*	60.4*
	Good/average/bad	28.8	28.1	39.6
Number of overweight/obese parents (BMI 25 or over)	0 parent	37.6	36.6	51.0*
	1 parent	47.0	48.1	30.0
	2 parents	15.4	15.2	19.0
Family type	Single-parent family	14.3	13.4*	28.0*
	Two-parent family	85.7	86.6	72.0
Family annual gross income	Less than $20,000	10.1	8.5*	34.6*
	$20,000–39,999	20.7	20.1	29.7
	$40,000–59,999	26.4	26.2	29.8
	$60,000 or more	42.8	45.3	5.9
Family income sufficiency level	Very insufficient	6.9	5.4*	29.8*
	Insufficient	12.7	11.8	25.6
	Sufficient	80.4	82.8	44.5
Family socioeconomic status	Quintile 1 (low) and Quintile 2	39.3	37.4*	67.7*
	Quintile 3	20.4	20.2	24.1
	Quintile 4 and Quintile 5 (high)	40.3	42.4	8.2
Number of working parents	0 parent	6.4	5.7*	16.0*
	At least 1 parent	93.6	94.3	84.0
Breastfeeding	Not breastfed	25.6	24.3	37.8

Table 1 (*continued*)

Characteristic	Category	Proportion (%) of the children in the population	Proportion (%) of children living in a family with food sufficiency	Proportion (%) of children living in a family with food insufficiency
Total			93.7	6.3
	Breastfed less than 4 months	31.5	31.6	32.8
	Breastfed for at least 4 months	42.9	44.1	29.5
Family food insufficiency	No	93.7	–	–
	Yes	6.3	–	–

*Statistically significant association between the characteristic and the dependant variable (p-value (chi-square)$\leqslant 0.05$).
[a]Analysis done with weighted data to ensure that they are representative of the targeted population.

and parents' working prestige (in quintiles); and number of working parents (0 parent, at least 1 parent). The number of overweight/obese parents (based on BMI of mothers and fathers calculated from reported height and weight when the children were 1.5 years old) was also included in the analyses.

Statistical analyses were done with SAS (version 8.2). All variables were treated as categorical variables except for BMI, which was analyzed as both a continuous and a categorical variable. Univariate associations were verified through a chi-square test on contingency tables. Significant independent variables were included in multivariate analyses. Odds ratios (OR) estimates, as well as their confidence intervals, adjusted for identified significant variables from univariate analyses, were calculated by logistic regressions. Adjusted means were calculated by one-way analysis-of-variances (ANOVA), and Tukey's adjusted post-hoc tests were performed only when the overall F-test was significant. Weighted data were used in the analysis, and the significance level was set at 5%.

Results

Table 1 presents the relationship between various child and family characteristics and food insufficiency. Approximately 6.3% of the 4.5-year-old children had experienced a situation of household food insufficiency, either in their first 18 months of life and/or between 3.5 and 4.5 years. Only 1.4% of mothers reported food insufficiency at both periods. The proportion of children (7.8%) living a family with food insufficiency who were low-birth weight (less than 2500 g) was nearly double compared to children (4.4%) from food sufficient families. A greater proportion of children living in a family with food insufficiency had mothers who were overweight or obese (BMI 25 or over) compared to children living in families that were food sufficient. A significantly greater proportion of children living with food insufficiency were from families that were income insufficient or very insufficient and had lower socioeconomic status compared to children from food sufficient families. A smaller proportion of children living in food sufficient families had mothers with less than a high school diploma, were single-parents, had self-reported psychological distress, and had poor perceptions of their health compared to mothers from food insufficient families. Also, breastfeeding was not associated with children from either food insufficient or food sufficient families.

We performed multivariate analysis to study the relationship between family food insufficiency and children's BMI at 4.5 years (Fig. 1). Family food insufficiency was positively related to mean BMI at 4.5 years. Mean BMI was higher for children living in food insufficient families compared to children from food sufficient families, even when important variables associated with BMI, such as child's birth weight, parental BMI, maternal education, and family income sufficiency, were taken simultaneously into consideration in the analysis.

Table 2 presents crude and adjusted OR for obesity as measured by the Cole criteria, and for overweight as measured by being at or above the 95th percentile of the US CDC growth curves, for

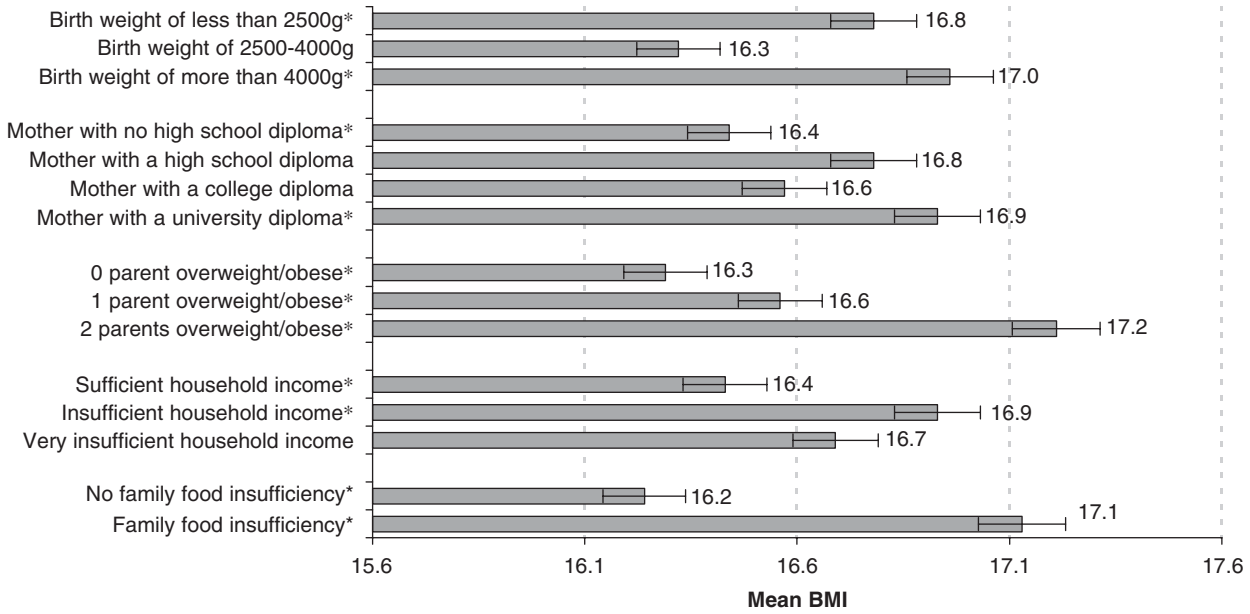

Fig. 1. Adjusted means (adjusted for sex and for all of the other variables listed in the figure) (with confidence intervals) of children's BMI, by selected characteristics (analysis done with weighted data to ensure that they are representative of the targeted population). *For each variable, means from categories shown with an "*" are statistically different ($p \leqslant 0.05$).

4.5-year-old children. The analysis indicates that using the Cole criteria, the odds for obesity more than tripled (OR 3.4, 95% CI 1.5–7.6) for children from food insufficient families in preschool years, even when other important factors were taken into consideration in multivariate analyses. Being born with a low-birth-weight (OR 3.1, 95% CI 1.2–8.5), to mothers who smoked during pregnancy (OR 2.3, 95% CI 1.3–4.1), or to overweight/obese parents (OR 2.5, 95% CI 1.2–5.4 for one overweight/obese parent; OR 5.2, 95% CI 2.3–11.9 for two overweight/obese parents) also increased the odds for obesity, when data were adjusted for child's sex and family income sufficiency. For food insufficiency, crude and adjusted OR were similar, indicating that the other variables did not substantially modify the relationship between family food insufficiency, and children's obesity. For other variables, the odds were even stronger when all variables were taken into account simultaneously, in comparison to crude OR, indicating a stronger effect for these variables in combination than for variables taken separately.

Using the CDC growth curves indicator for overweight, similar results may be observed. Family food insufficiency doubled the odds (OR 2.0, 95% CI 1.1–3.6) of childhood overweight at 4.5 years, even when birth weight, maternal smoking during pregnancy, and parental overweight or obesity were also taken into account (adjusted for child's sex and family income sufficiency) in the analysis. Even with a slight decrease between the crude and adjusted odd ratios, these results indicate that an independent effect is still present for family food insufficiency in the development of overweight in preschool years. With this indicator, a higher birth weight (4000 g or more) is related to overweight at 4.5 years.

In our statistical analysis from Table 2, we observed an interaction between birth weight and family food insufficiency in relation to overweight at 4.5 years. As illustrated in Fig. 2, which presents adjusted OR, low-birth-weight children who lived in a food insufficient household in their preschool years (from birth to 1.5 years and/or from 3.5 to 4.5 years) had higher odds (OR 28–95% CI 6.2–125.3) of being overweight at 4.5 years, compared to normal-birth-weight children who had not lived in a food insufficient household. For high-birth-weight children, the odds is 2.3 times higher (95% CI—1.4–3.8) for the ones living in food sufficient families, and 5.7 times higher (95% CI—1.3–25.0) for the ones living in food insufficient families. The odds for normal-birth-weight children is increased by almost 2 (1.8, 95% CI—0.9–3.6) for children living in food insufficient families. Similar results

Table 2
Crude and adjusted[a] odds ratios for overweight/obese children, by selected characteristics[b]

Characteristic	Category	Obese under Cole criteria		Overweight BMI ⩾95th percentile on USDA Growth curves	
		Crude OR (95% CI)	Adjusted OR (95% CI)	Crude OR (95% CI)	Adjusted OR (95% CI)
Child's birth weight	Less then 2500 g	2.643 (1.012–6.903)*	3.144 (1.160–8.525)*	0.956 (0.378–2.418)	1.088 (0.419–2.825)
	2500–4000 g[c]	1	1	1	1
	More than 4000 g	1.796 (0.870–3.708)	2.008 (0.942–4.282)	2.227 (1.399–3.544)*	2.295 (1.407–3.744)*
Maternal smoking during pregnancy	Non-smoking[c]	1	1	1	1
	Smoking	2.074 (1.197–3.594)*	2.315 (1.298–4.131)*	1.512 (1.030–2.218)*	1.521 (1.007–2.298)*
Number of overweight/obese parents	0 parent[c]	1	1	1	1
	1 parent	1.881 (0.928–3.813)	2.532 (1.180–5.431)*	1.965 (1.247–3.095)*	2.065 (1.278–3.335)*
	2 parents	4.001 (1.864–8.586)*	5.233 (2.292–11.943)*	3.707 (2.219–6.193)*	3.837 (2.238–6.579)*
Family food insufficiency	No[c]	1	1	1	1
	Yes	3.480 (1.708–7.091)*	3.430 (1.543–7.621)*	2.346 (1.342–4.100)*	1.958 (1.052–3.644)*

*Statistically significant (p-value $\leqslant 0.05$).
[a]Adjusted for sex and income level, and for all the listed variables in the table.
[b]Analysis done with weighted data to ensure that they are representative of the targeted population.
[c]Reference category.

were found with Cole criteria for overweight. Also, when other factors such as sex, income level, maternal smoking during pregnancy and number of overweight/obese parents, family food insufficiency remains associated.

Discussion

Our study indicates that 6.3% of all children and 29.8% of children from very insufficient income families lived in a family with food insufficiency between birth and 18 months, and/or between 3.5 and 4.5 years. Results from NHANES III found that 6.8% of families with children under 5 years reported sometimes or often not getting enough food to eat (Alaimo et al., 1998). The prevalence of children living in families with food insufficiency among our cohort is similar to other studies (Alaimo, 1997; Casey et al., 2001). As expected, there is a higher prevalence of food insufficiency among low-income families which is consistent with other studies (Alaimo, 1997; Che & Chen, 2001; Hamelin et al., 1998; McIntyre et al., 2000; Rose et al., 1999; Vozoris & Tarasuk, 2003).

Our study indicates there may be a link between preschool children living in a household that has experienced food insufficiency and the prevalence of overweight or obesity. We were able to show this relationship over and above the effects of living in insufficient-income families. This relationship persists even when other important confounding factors related to childhood overweight/obesity are considered in the analysis. This finding is a potentially important one because it indicates there is an element related to household food insufficiency that may have a role over and above income insufficiency in overweight/obesity among preschool children. Studies examining the relationship of food insufficiency and overweight/obesity among children have shown inconsistent results. Over a decade ago, Dietz's (1995) found that hunger and food insecurity may be related to obesity. Conversely, Casey et al. (2001) failed to find a relationship between children living in food insufficient families and overweight. Unlike other studies, we did not observe any sex differences in the relationship between food insufficiency and overweight (Alaimo et al., 2001; McIntyre et al., 2001; Vozoris & Tarasuk, 2003). For example, the NLSCY showed early gender effects of hunger related to overweight in girls and underweight in boys (McIntyre et al., 2001). Although differences in findings may be

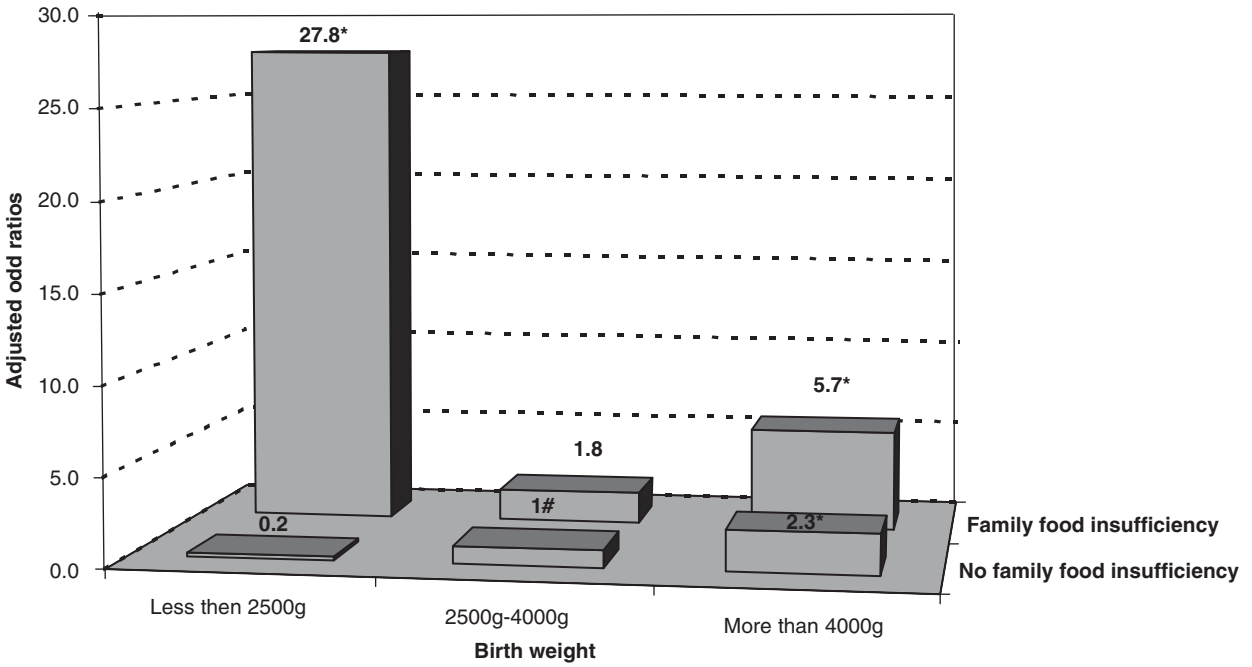

Fig. 2. Adjusted odds ratios (adjusted for sex, income level, maternal smoking status during pregnancy and number of overweight/obese parents) of overweight status in children (overweight is defined as having a BMI $\geqslant$95th percentile on the age-sex-specific US CDC growth curves) by birth weight and family food insufficiency (analysis done with weighted data to ensure that they are representative of the targeted population). *Statistically significant (p-value $\leqslant 0.05$). # = Reference category.

attributable to having younger children in this study compared to other studies.

Food assistance programs have the potential to modify the effects of food insecurity on a child's weight and health status. In contrast to our findings, one study showed that BMI of children from the poorest families who did not participate in a school lunch program were below the average, whereas the BMI levels were about average compared to those who participated (Hofferth & Curtin, 2005). Another study reported a lower risk of overweight for food insecure school-aged girls who participated in a food assistance program (Jones, Jahns, Laraia, & Haughton, 2003). Yet long-term reliance on food assistance programs is shown to be a risk factor for overweight in girls aged 5–11 years, but is shown to be a protective factor for same-age boys (Gibson, 2004). Another study found that families receiving Food Stamps was associated with fewer health problems among young low-income children (Cook et al., 2004). Given that food insufficiency can affect a child's health and well-being, supportive interventions during early childhood are warranted for preventing obesity in children.

Our study indicates that children from income insufficient families were more likely to be obese than children from income sufficient families. In fact, a larger proportion of children living in food insufficient households in our study were from families that had very insufficient income and low socioeconomic status. While there is good evidence to support that lower income adults have a higher incidence of obesity than higher income adults, the same may not be true for low-income children. Some studies report that obesity occurs more frequently among children from low socioeconomic status (Danielzik, Czerwinski-Mast, Langnäse, Dilba, & Müller, 2004; Johnson-Down, O'Loughlin, Koski, & Gray-Donald, 1997), while another study suggests there are no differences (Booth, Macaskill, & Baur, 1999). In contrast to our findings, Hofferth and Curtin (2005) found that children in the lowest income groups are less likely to be overweight and have lower BMI's. Hence, the mediating relationship between a child's socioeconomic status and development of overweight or obesity remains poorly described (Power et al., 2005; Reilly et al., 2003).

Although there may be a link between poverty and obesity, we were able to show an association between food insufficiency at the family level and increased likelihood of overweight and obesity among preschool children. Indeed, we were able to show this relationship exists over and above the effects of living in income insufficient families. However, it may be difficult to separate specific effects of food insufficiency given that food hardship frequently occurs in a context of poverty which has adverse independent effects on health (Tarasuk, 2001). Because there are challenges in disentangling poverty effects from food insufficiency, Vozoris and Tarasuk (2003) suggest that food insufficiency represents only one dimension of many vulnerabilities that are inherent to families experiencing economic constraints. For example, one study suggests that weight gain may be attributed in part to stress associated with the food insecurity situation (Laitinen, Ek, & Sovio, 2002). Similarly, in our study, a greater proportion of mothers living in food insufficiency self-reported poorer perceptions of their health and psychological distress compared to mothers living in food sufficiency. These findings concur with another study reporting that mothers who were food insecure had lower perceptions of their health status compared to mothers who were food secure (Cook et al., 2004). Ensuring that families have adequate resources for meeting their families' needs has the potential to reduce health problems during early childhood years and at later ages.

Although evidence linking food inadequacy and overweight among children is limited. Various explanations related to food adequacy and diet quality can be formulated for the observed relationship between children living in food insufficient households and overweight. The first explanation posits that parents experiencing privation are overprotecting their young children by giving them more than they need (McIntyre et al., 2003). Second, children living in this situation may be eating at 'friends or neighbours' homes to compensate for food shortages (Bhattacharya, Currie, & Haider, 2004). Third, when resources are limited, a common coping strategy is to consume less expensive foods to maintain energy intakes at a lower cost (Drewnowski & Specter, 2004). In this situation, families may have enough to eat, but they may not be eating a variety of foods they want to eat (Basiotis, 1992). However, as income disparities increase, the quality of the diet is reduced, whilst the consumption of energy dense foods increases (Drewnowski & Specter, 2004; Lino, Basiotis, Gerrior, & Carlson, 2002). For example, two Canadian studies reported that low-income families tend to consume fewer fruit and vegetables, meat and dairy products and more foods that are energy-dense foods that are high in refined grains, added fats and sugars (Dubois & Girard, 2001; Kirkpatrick & Tarasuk, 2003). Thus, consumption of energy dense foods may exceed energy requirements leading to overweight (Dietz, 1995; Drewnowski & Specter, 2004; Olson, 1999). Finally, following a period of food restriction individuals may have overeating or binge eating behaviours when food is available (Polivy, 1996), as is often the case in food-insecurity situations (Alaimo et al., 2001; Sarlio-Lähteenkorva & Lahelma, 2001; Townsend et al., 2001). Further research on the effect of diet quality among young children is warranted.

An alternative explanation may be related to the Barker Hypothesis (Barker, 1993) in which the relationship between low-birth-weight and chronic diseases later in life (e.g., cardiovascular diseases, diabetes) may be related to fetal malnutrition. We observed an interaction between birth weight and family food insufficiency in relation to overweight at 4.5 years. Our study indicates that children born with low-birth-weights who live in a household that experienced food insufficiency are at higher risk of overweight at 4.5 years. These results are compelling because these children lived in families that experienced food insufficiency in their preschool years, and for some, during the first 18 months of their life. Given there is a consistent trend of reporting food insufficiency among households during preschool years, it is possible that mothers also experienced food insufficiency in pregnancy which subsequently contributed to low-birth-weight. Also, another explanation is owing to food restriction during pregnancy, particularly in cases where genetic predisposition to obesity is high (as observed in the relationship between parental overweight/obesity and children's obesity in our study) creating conditions favourable to the development of later childhood overweight and obesity.

There was no significant difference in the prevalence of families who reported being in a food insufficiency situation at both 1.5 and 4.5 years. Our analyses were limited by the small proportion of food insufficient families in this population. Reporting a low prevalence of food insufficiency in a general population survey is typical and limited our

ability to observe any statistically significant effects of various aspects of food insufficiency over time. Given that food insufficiency is associated with income constraints, this problem may be resolved in future studies by over sampling very low-income households (Tarasuk, 2001).

Although only 6.3% of families experienced food insufficiency at one and/or other data collection periods, it is likely that a higher prevalence of food insufficiency would have been found given a less specific food insecurity question. There are some limitations to using only a few questions to capture food insufficiency in a population survey. Although some of the strength may be lost in reducing the concept of food insufficiency to one question, answering positively to this question raises the "red flag" that there is some indication of vulnerability in the sample (Tarasuk, 2001). Despite this limitation, surveys using minimal questions related to food insufficiency have been shown to have good specificity (e.g., correctly classifying truly food secure), and poor sensitivity (e.g., correctly classifying those who are truly food insecure) (Frongillo, Rauschenbach, Olson, Kendall, & Colmenares, 1997; Keenan et al., 2003; National Research Council, 2005). While an instrument that more fully captures the multidimensional aspects of food security would gain content validity, it might not improve the estimation of prevalence of food security (Tarasuk, 2001).

Possible limitations of the study include self-reported data of maternal perceptions of food insufficiency and their food situation. Asking questions about food insufficiency is highly sensitive and some respondents may be too embarrassed to admit they sometimes or often do not get enough to eat, leading to under-reporting of food insufficiency (Briefel & Woteki, 1992). Members of the same household may report different impressions about food situations in their household. In one study, assessment of child hunger derived from parents' responses was compared to their school-aged children and agreement appeared good but inferences in this study are limited because a small proportion of households were identified as hungry (Murphy et al., 1998).

Conclusion

Our results suggest that children living in households experiencing food insufficiency were more likely at some time to be overweight compared to children from food sufficient families. Although, there is a link between income insufficiency and obesity, we were able to show an association between food insufficiency at the family level and increased likelihood of overweight/obesity among preschool children. We were able to show this relationship over and above the effects of living in insufficient-income families. Food insufficiency experienced in early childhood is related to overweight at 4.5 years. Moreover, the highest risk for overweight at 4.5 years is among low-birth-weight children who experience food insufficiency in their preschool years. Given this important finding, supportive interventions targeting low-income and food insufficient families, including pregnant women, are recommended for preventing overweight and obesity among their children.

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