Prevention Potential of Risk Factors for Childhood Overweight

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ABSTRACT

Background: In order to better target prevention initiatives for the obesity epidemic in Canada, policy-makers, in addition to information about risk factors, require an understanding of the preventive potential which is best provided by the risk factor's population attributable risk fraction (PARF).

Objective: To estimate the PARF for childhood overweight risk factors as identified by a population-based study of elementary schoolchildren in Nova Scotia.

Methods: Population-based survey data of Grade 5 students who participated in the 2003 Children's Lifestyle and School Performance Study in Nova Scotia, Canada, were linked to a provincial perinatal registry. PARFs were calculated from a parsimonious multilevel logistic regression model.

Results: Physical activity, sedentary activity, maternal smoking during pregnancy, and maternal pre-pregnancy weight were considered potentially preventable. Sedentary activity (as estimated from time spent viewing TV, computers and video games or "screen time") and maternal pre-pregnancy weight appeared to offer the greatest potential for prevention. In total, approximately 40% of overweight in childhood could potentially be prevented.

Conclusion: Excess screen time and maternal pre-pregnancy weight offer the greatest potential for prevention of childhood overweight at 11 years of age.

Key words: Obesity; child; prevention; population attributable risk; public health; physical activity; nutrition

La traduction du résumé se trouve à la fin de l'article.

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The prevalence of childhood overweight in Canada has doubled since the early 1980s.[1,2] In Canada, 26% of children and youth are overweight and 8% are obese.[3] Poor nutrition, lack of physical activity, television watching, formula feeding, and parental overweight have been identified as risk factors for childhood overweight.[4-8] However, to better target prevention initiatives, policy-makers not only require information about risk factors but also require an understanding of their preventive potential, information that is not provided by relative risks and odds ratios. To assess the preventive potential of a risk factor, the population-attributable risk fraction (PARF) is commonly used. The PARF is the proportion of the total disease burden in a population that is due to a certain cause of that disease. The objective of the current study was to estimate the PARF for childhood overweight risk factors as identified by a population-based study of elementary schoolchildren in Nova Scotia.

METHODS

Children's Lifestyle and School Performance Study

The CLASS (Children's Lifestyle and School Performance Study) is a population-based survey of Grade 5 students and their parents in the Canadian province of Nova Scotia that took place in 2003.[5] The study consisted of a questionnaire that was completed at home by the parents; a Canadianized version of the Harvard Youth/Adolescent Food Frequency Questionnaire (YAQ)[9] administered to the students in the schools by study assistants; and a measurement of the students' height and weight. The home questionnaire collected information on socio-demographic factors, the child's place of birth and residency, as well as household income level, educational attainment, breast-feeding practices, self-rated parental physical activity and diet quality, and questions on the frequency of their child's physical activities and the number of hours of sedentary activities ("screen time": watching television, working on a computer, playing video games). The questions on physical and sedentary activity were taken from the Statistics Canada National Longitudinal Survey of Children and Youth.[10] Standing height was measured to the nearest 0.1 cm after students had removed their shoes; body weight was measured to the nearest 0.1 kg on calibrated digital scales.

In addition to the above information, participating parents were asked to provide their Nova Scotia Health Insurance number and informed consent to allow future linkage with birth and administrative health databases. Of the 291 public schools in Nova Scotia (>97% of students in Nova Scotia attend public schools) with grade 5 classes, 282 (96.9%) participated in the study. The average rate of return of questionnaire and consent form was 51.1% per school. One of the seven provincial school boards did not allow measurements of height and weight. A total of 4,298 students participated in the study and had their height and weight measured. Overweight and obesity were defined using the International Obesity

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Table 1. Prevalences, Multivariable Adjusted Population Attributable Risk Fractions (PARF) and Odds Ratios (OR) for Preventable Risk Factors of Childhood Overweight

	Prevalence	Multivariable adjusted PARF % (95% CI)	Multivariable adjusted OR (95% CI)
Physically active			
≤2x / week	22%	5.5% (2.8-8.6)	1.55 (1.25-1.91)
>2 to 4x / week	17%	2.8% (0.2-5.4)	1.35 (1.03-1.77)
>4 to 7x / week	33%	2.1% (-1.8-5.9)	1.12 (0.91-1.39)
>7x / week	25%	Reference	1.00
Television/computer/video			
≤1 h / day	10%	Reference	1.00
>1 to 3 h / day	57%	7.0% (-0.9-14.6)	1.26 (0.97-1.62)
>3 to 6 h / day	24%	6.9% (2.6-11.4)	1.66 (1.21-2.27)
>6 h / day	5%	1.6% (0.4-3.1)	1.79 (1.14-2.80)
Maternal pre-pregnancy weight			
<70 kg	66%	Reference	1.00
70 to <80 kg	13%	3.6% (1.9-5.5)	1.61 (1.30-2.00)
≥80 kg	10%	8.0% (5.7-10.8)	3.68 (2.82-4.80)
Maternal smoking at admission			
None	69%	Reference	1.00
>0 to 0.5 packs per day	16%	2.9% (1.2-5.0)	1.39 (1.14-1.70)
>0.5 packs per day	10%	1.9% (0.4-3.6)	1.41 (1.07-1.86)
Neighbourhood dwelling value			
Lowest tertile		5.7% (2.5-9.1)	1.46 (1.18-1.81)
Middle tertile		4.0% (0.4-7.7)	1.23 (1.02-1.48)
Highest tertile		Reference	1.00
Weight-for-gestational age			
AGA	77%	Reference	1.00
SGA	12%	-2.7% (-4,3;-1.0)	0.66 (0.51-0.86)
LGA	11%	1.6% (0.2-3.2)	1.29 (1.03-1.62)
Parity			
Para 1	44%	9.2% (3.9-14.6)	1.48 (1.18-1.85)
Para 2	37%	6.7% (2.2-11.4)	1.39 (1.12-1.74)
Para 3 and higher	19%	Reference	1.00

Task Force body mass index (BMI) cut-off points established for children and youth.[11] These cut-off points are based on health-related adult definitions of overweight (≥25 kg/m^2) and obesity (≥30 kg/m^2) but are adjusted to specific age and sex categories for children.

Perinatal data

The Nova Scotia Atlee Perinatal Database (NSAPD) collects demographics, procedures, interventions, maternal and newborn diagnoses, and morbidity and mortality information for all pregnancies and births occurring in hospitals in Nova Scotia since 1988. Linkage of the CLASS data with the NSAPD was carried out by the Reproductive Care Program of Nova Scotia that administers the database. A combination of deterministic and probabilistic matching was used to link the two datasets. Of the 4,298 students in the CLASS study with measured height and weight data, 3,426 (79.7%) could be linked with information in the NSAPD. The most common reason for an unsuccessful linkage was that children were born outside the province of Nova Scotia (12.4%); for the remaining children, parents had provided either an erroneous or no health insurance number. Seventy-five students (2.2%) were excluded due to missing or improbable data for birth weight and gestational age, leaving a final sample of 3,351 children (78.0%).

Data analysis

As participation rates in residential areas with lower estimates of household income were slightly lower than the average, response weights were calculated to overcome potential non-response bias. On the basis of average household incomes according to postal code data from the 2001 Census for both participants and non-participants, response rates per decile of household incomes by postal code were calculated. These response rates were converted into response weights. As all statistical analyses were weighted regarding non-response, they represent provincial population estimates for grade 5 students in Nova Scotia.

A logistic regression model for the outcome overweight was built using Hosmer and Lemeshow's purposeful selection procedure.[12] School was treated as a random factor. The parsimonious model contained the following predictors: pre-pregnancy weight; smoking status on admission to the delivery ward (as proxy for smoking during pregnancy); parity; physical activity (parent report); sedentary activity (parent report); weight for gestational age (based on birth weight data from the perinatal database – classification as small (SGA), appropriate (AGA) or large for gestational age (LGA) according to Canadian reference values for birth weight;[13] school neighbourhood dwelling value (based on postal code data from the 2001 Census). Details on the model and the CLASS/NSAPD linkage study have been published elsewhere.[14]

The PARF of an exposure is the proportional reduction in average disease risk that would be observed if the exposure in question were removed.[15] The unadjusted PARF is calculated as

PARF = 100 x (Probability (Disease) - Probability (Disease in unexposed)) / Probability (Disease)

To determine the multivariable-adjusted PARF of each risk factor, the probabilities in the above formula were predicted from the multiple regression model.[16,17] We predicted the mean adjusted probability for being overweight i) using the original data (= *Probability (Disease)*) and ii) after setting the risk factor of interest to zero (= *Probability (Disease in unexposed)*). The PARFs were then calculated using these estimates in the above equation as we and others successfully did in the past.[18,19] The 95% confidence intervals for the PARFs were calculated using 10,000 Monte Carlo replications with random coefficients based on the original parameter estimates and their standard errors. The 2.5th and 97.5th percentile were used as the upper and lower confidence limits. As the parsimonious regression model did not contain interaction terms, the PARFs cal-

culated using the above approach are additive. The PARFs for the potentially preventable risk factors (low physical activity, excess screen time, high maternal pre-pregnancy weight and maternal smoking) were added up to calculate the maximum preventive potential. Stata Version 10 (Stata Corp, College Station, TX, USA) was used to perform the statistical analysis.

This study, including data collection, parental informed consent forms, and data linkage with the NSAPD, was approved by the Health Sciences Human Research Ethics Board of Dalhousie University, the IWK Health Centre Research Ethics Board and the Joint Data Access Committee of the Reproductive Care Program of Nova Scotia.

RESULTS

Thirty-three percent of the Grade 5 students in the province of Nova Scotia were overweight. Of the risk factors included in the parsimonious model, physical activity, sedentary activity, maternal smoking during pregnancy, and, with some limitations, maternal pre-pregnancy weight can be considered preventable. There was a gradient for the association of physical activity (negative), sedentary activity and maternal pre-pregnancy weight (positive), respectively, with the risk for overweight. Sedentary activity (15.5%) and maternal pre-pregnancy weight (11.6%) appeared to offer the greatest potential for prevention. As PARFs are additive, in total (when considering maternal pre-pregnancy weight preventable) 42.1% (95% CI 31.5-48.5) of overweight in childhood could potentially be prevented. Odds ratios and PARFs from the multivariable adjusted model are presented in Table 1.

DISCUSSION

The present study is the first in Canada to investigate the preventive potential of risk factors for childhood overweight. Using population-based data, we were able to show that about 40% of childhood overweight cases could potentially be prevented through promotion of healthy eating and active living, and through cessation of maternal smoking during pregnancy. High maternal pre-pregnancy weight and excess sedentary activity in children emerged as the factors with the greatest potential for prevention.

Excess screen time contributed the largest PARF identified in our study. The observation that screen time remained a strong risk factor after considering physical activity in the analysis underlines the fact that mechanisms other than a decline in energy expenditure[20] are involved in the relationship between screen time and overweight.[21,22] One may be the influence of commercials on food choices and nutrition. The majority of foods featured in commercials targeted at children are energy-dense, high in fat and/or sugar and commonly do not meet dietary recommendations.[23] Television viewing may also provide an opportunity to consume snack foods,[24] resulting in an increased calorie intake.[25] Finally, having meals in front of the TV instead of with the family may reduce the nutritional and psychosocial benefits of family meals[26] and may be associated with higher BMI in children.[27]

In keeping with other studies from the US and Canada,[8,28,29] maternal pre-pregnancy weight was identified as a strong determinant of a child's risk for being overweight at age 11. In order to consider maternal overweight an attributable risk factor for childhood overweight, a causal link between the two needs to be established. The association between maternal weight and respective children's overweight can potentially be explained through three mechanisms: i) genetic factors,[30] ii) acquired poor health and lifestyle behaviours,[31] and iii) alterations of the intrauterine environment due to the maternal pre-diabetic state,[32] as discussed in a previous publication.[14] While it is not possible at this stage to establish a direct causal mechanism between maternal overweight and their offspring's excess body weight, these data suggest that secondary prevention of overweight in young women may reduce the risk of overweight in their children.

Only a few studies have examined the population attributable risk for childhood overweight.[19,33,34] Toschke et al., using German population-based data, reported that 42.5% of overweight cases in Germany are due to potentially preventable risk factors.[19] Parental obesity was considered a non-preventable risk factor and accounted for 15% of overweight cases. Among the preventable risk factors, TV watching >1 h per day and low meal frequency (<5 meals per day) contributed a PARF of 13.0 and 14.8%.[19] In the 1990s, a population-based study in 10 to 15 year old youth in the US reported that more than 60% of overweight was attributable to excess TV viewing time.[34] However, PARFs were calculated based on non-adjusted prevalences and perhaps confounded by socio-economic factors. A study in primary schoolchildren in Thailand found that the highest PARF was for family history of obesity (34%), followed by those for low exercise level (12%) and an obese or overweight mother (10%).[33]

The strengths of the current study are the use of two population-based data sources, the weighting for non-response, the ability to adjust for a broad range of perinatal, lifestyle and socio-economic factors, and the use of measured BMI. However, the study also has a few limitations that need to be acknowledged. Part of the data (physical activity, sedentary activity) used in the present study come from a cross-sectional survey, while calculation of PARFs requires cohort data to establish causality between the exposure and the outcome. Thus, the PARF estimates for the two activity measures must be interpreted with caution. Finally, the use of odds ratios instead of risk ratios may have resulted in an overestimation of the PARF. In the absence of an established definite causal link between maternal pre-pregnancy weight and a child's overweight, the interpretation of the PARF of maternal weight remains somewhat speculative. Further, the use of maternal body weight instead of BMI for the assessment of maternal weight status may have introduced some misclassification bias.

CONCLUSION

The present study identified excess screen time and maternal pre-pregnancy weight as potentially preventable risk factors with the greatest potential for prevention of childhood overweight at age 11 in Canada.

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RÉSUMÉ

Contexte : Pour mieux cibler les initiatives de prévention de l'épidémie d'obésité au Canada, les décideurs, en plus d'informations sur les facteurs de risque, ont besoin de connaître leur potentiel préventif, qui s'obtient idéalement par la fraction étiologique du risque (FER).

Objectifs : Estimer la FER pour les facteurs de risque de surpoids de l'enfant dans une étude représentative menée auprès d'élèves du primaire en Nouvelle-Écosse, au Canada.

Méthode : Les données d'une enquête représentative sur le mode de vie et les résultats scolaires d'élèves de 5e année ont été liées à un registre périnatal provincial. Les FER ont été calculées selon un modèle de régression logistique parcimonieuse multiniveaux.

Résultats : L'activité physique, la sédentarité, le tabagisme maternel pendant la grossesse et le poids maternel avant la grossesse ont été jugés potentiellement évitables. La sédentarité (estimée d'après le temps passé devant la télévision, l'ordinateur et les jeux vidéo, ou « temps d'écran ») et le poids maternel avant la grossesse semblaient présenter le meilleur potentiel préventif. En tout, on pourrait prévenir environ 40 % du surpoids de l'enfant.

Conclusion : L'abus d'écran et le poids maternel avant la grossesse sont les facteurs qui présentent le meilleur potentiel de prévention du surpoids à 11 ans.

Mots clés : obésité; enfant; prévention; fraction étiologique du risque; santé publique; activité physique; nutrition