Title:

Multilevel exploration of the differences in the level of leisure-time physical activity among Canadian youth

The available scientific evidence supports the overall conclusion that leisure-time physical activity (LPA) provides fundamental health benefits for young people (1). The documented benefits include increased physical fitness (both cardiorespiratory fitness and muscular strength), reduced body fatness, favourable cardiovascular and metabolic disease risk profiles, enhanced bone health and reduced symptoms of depression (2-5). Among young people, the growth period is also shown as a critical time for the development of factors that have a great influence on health in adulthood, such as achieving an optimal bone wealth and a good fitness (e.g. aerobic capacity, muscular strength)(6).

Understanding what influences youth to engage in LPA contributes to evidence-based planning of public health interventions, as effective programs will target factors known to contribute to physical inactivity (7). Research into correlates or determinants of LPA has burgeoned over the past two decades, but has mostly focused on individual-level factors (8). Among them, socioeconomic status indicators such as education (9) and biological factors such as body mass index (BMI) (10) have been associated with disparities in LPA participation. While individuals

characteristics are widely studied, environmental variables are less studied, but are thought to have widespread effects (8).

A key principle is that a better understanding of all levels of influence on youth LPA can inform development of multilevel interventions which are recognized to offer the best chance for success (11). Therefore, the aim of this study was to provide a clearer picture of the differences in the practice of LPA among young Canadians influenced by contextual features of the living environment. The objectives were: (a) to describe the geographic variations of LPA among young Canadians over time and (b) to explore how contextual features explain these variations. The tested hypothesis was: *contextual features influence the level of leisure time physical activity among youth*.

Methods

Data source

The study used the Canadian Community Health Survey (CCHS) from 2003 to 2011. The CCHS is repeated biennially and contains self-reported information from a representative sample of the non-institutionalized civilian population at least 12 years old of age and living in the 10 Canadian provinces (12).

Study population and sample size

The sample included Canadians from 12 to 17 years old for whom data on racial origin, highest household education level, BMI and geographic position are available through CCHS. The following population segments were excluded for consistency with the research design: pregnant girls, persons living in the Athabasca Health Authority region (in compliance with confidentiality requirements), respondents interviewed by proxies and some observations lacking geographical concordance. Overall, this study relied on socioeconomic characteristics and LPA behaviours of 54,832 youth (Table 1).

Geographical structure

Observations were structured according to a four-level geographical hierarchy (i.e. individuals, neighbourhoods, health regions and provinces) based on Statistics Canada 2006 census units administrative structure. A neighbourhood was assigned to each individual according to their place of residence (six positions postal code). When a place of residence was located in an urban setting, i.e. included in a census metropolitan area (CMA) or a census agglomeration (CA), the "neighbourhood" corresponds to the Statistics Canada census tract (CT), otherwise it was attributed to the corresponding census subdivision (CSD) or the

municipality. The combination of CTs and CSDs enables the creation of comparable neighbourhood units that reflect the heterogeneity of the land use mix surrounding individuals' place of residence whether they are located in an urban or a rural setting. A detailed methodology of the geographical structure is presented elsewhere (13). Some Canadian health regions boundaries were modified during the study period. The geographic structure of all health regions were harmonized using the Statistics Canada digital boundary file reflecting health region limits in effect as of October 2011 (14). ArcMap (release 10.1) was used for the geospatial processing. The final data hierarchical structure comprised 26,822 girls and 28,010 boys located in 6004 neighbourhoods, within 112 health regions, and distributed through the 10 Canadian provinces.

Outcome

The dependant variable studied was a dichotomous indicator of LPA which refers to achieving (or not) the recommended daily level for physical activity performed during leisure-time. To produce health benefits, it was suggested that young people aged 12-17 years should accumulate an average of at least 60 minutes of moderate to vigorous-intensity physical activity (MVPA) daily (15, 16). Physical activity level was estimated by the average energy expenditure (Kcal

/ Kg / week) in which are considered the frequency, duration and intensity of 17 types of self-reported LPA. By definition, MVPA requires the achievement of specific and quantifiable intensity threshold which will vary depending on the activity performed. When not directly measured, intensity can be derived from a table providing values of Metabolic Equivalent of Task (METs) attributed to the various activities (17). Taking into account the theoretical works set out above and the available data, we considered that an "active" youth is one that achieves an index of energy expenditure of at least 30 Kcal / Kg / week (18) with a frequency of 5 days/week or more.

Table 1 presents summary statistics of the achievement of recommended daily level of LPA among girls and boys. In the sample studied, 36.9% of the girls achieved the standard, and 51.9% of the boys.

Table 1: Outcome and covariates distribution for girls and boys

Individual variables

To account for the consistently documented influences of various individual characteristics on LPA among youth (19-21), age, racial origin, highest education level in the

household and BMI were used as control variables. Table 1 presents the distribution of samples by all covariates and shows that a typical youth of the CCHS sample is predominantly Caucasian, living in an educated household and reporting a normal BMI.

Cycle and season

The CCHS produces a biennial microdata file combining two years of data collected from January to December. Knowing the exact date of sampling allowed us to discern differences in LPA participation depending on the season. Three seasons have been created to take into account the question asking the respondent on physical activity performed in the 3 months prior to the administration of the survey: Summer (July to October), Winter (February to March) and Transitional (November to January & April to June).

Contextual variables

Three independent area-level variables were considered. The first is the Census metropolitan influenced zone (MIZ). MIZ focuses on the municipalities that are outside of the existing census metropolitan areas (CMA) and census agglomerations (CA) and assess the degree to which all CMA/CA influence these municipalities, as measured by

commuting flows and divided in 8 zones. These zones were grouped into three influence zones to represent the continuum in the variety of living environments such as urban settings (MIZ 1-3), suburban (MIZ 4-5), and rural (MIZ 6-8). A detailed methodology of the construction of MIZ is provided by Statistics Canada (22).

The two other contextual variables were based on the factor score of two dimensions issued from a principal component analysis (PCA) and estimate the material and social deprivation of the neighbourhood units where the individual's residence is located. The social aspect was built on the proportion of individuals that are separated, divorced or widowed, the proportion of people living alone, and the proportion in single-parent families. Using the same PCA approach, the material deprivation index was built with the mean income of the neighbourhood, the proportion of people without a high school diploma, and the proportion of unemployed (23). As deprivation is seen as a relative disadvantage facing the community to which an individual belongs, the distribution of neighbourhoods' indexes was broken into quintiles within each province.

Statistical analysis

To investigate the influence of the contextual variables, a series of multilevel logistic regression analyses were conducted using the procedure of Markov chain Monte Carlo (MCMC) (24). The modelling strategy was based on four aggregate models. The first model referred to the variance component and expresses the distribution of variance between the four geographic levels described above. The second introduced control variables, cycle and season. The third introduced the MIZ. The last model introduced the neighbourhood's social and material deprivation level. The Deviance Information Criteria (DIC) was used to compare a model's goodness of fit (25). The median odds ratio (MOR) was used to translate the area level variance in the widely used odds ratio (OR) scale, which has a consistent and intuitive interpretation (26).

All analyses were stratified by sex to control for the differences in LPA between girls and boys (27). In order to be representative at population level, standardised CCHS survey design weights were used.

Province level residuals analysis

We further used the province-level residuals and associated standard error to plot and rank the odds ratio and the 95% confidence interval (CI) for each province. This procedure

allowed a visualization of provinces that are presenting a significantly different LPA level from the national mean.

Results

Girls

According to the multilevel analysis results (Table 2), the DIC showed that the introduction of Model 2 and 3 led to a better fit of the overall model (ΔDIC=-536), while Model 4 (which includes indices of material and social deprivation) showed the opposite trend. The reference category is a girl, age 12-15, Caucasian, living in a highly educated household, reporting a normal weight, surveyed during summer and living in an urban setting. The results showed lower odds of achieving LPA standards among older girls (16-17 year old), Asian ethnicity, living in a household with lower educational achievement, reporting either being under- or overweight, surveyed during winter or transitional season, and living in an urban setting. Whereas the best fitting Model 3 showed no global between-province variation, significant variations were observed between health regions (MOR=1.12) and between neighbourhoods (MOR=1.17) within the provinces. Observing that Model 4 did not fit as well, and that deprivation variables were not significant, it has not been the focus of further interpretation in this paper.

Table 2. Individual, cycle, season and contextual factors on girls' leisure-time physical activity

Boys

The results for boys (Table 3) also showed that the introduction of Model 2 and 3 led to a better fit of the overall model (ΔDIC=-643). With the exception of the sex, the reference category remained unchanged as compared to girls. The results showed lower odds of achieving LPA standards among older (16-17 years old), Asian boys, reporting being under- or overweight, and surveyed during winter or transitional seasons. Unlike girls, however, the household education level appeared to have less impact on achieving LPA standards whereas living in suburban or rural areas appeared to have no impact. Moreover, the time variable showed significant differences between each cycle of the survey (OR=0.98) suggesting a slight decrease in achieving the LPA standard for boys. As for girls, significant variations were observed in Model 3 between health regions (MOR=1.13) and between neighbourhoods (MOR=1.16) within the provinces, whereas no significant between-province variation was observed. Again, Model 4 will not be interpreted in more depth.

Table 3. Individual, cycle, season and contextual factors on boys' leisure-time physical activity

Variation between provinces

Although no significant variation was observed in the global LPA level between provinces, the analysis of the province specific residuals performed on Model 3 allowed to identify if areas presenting a LPA level significantly higher or lower than the country-wide estimates above individual and contextual characteristics. Figure 1A shows that girls living in Quebec were less likely to achieve a sufficient level of LPA compared with the national average, whereas girls living in Ontario and British-Columbia were more likely to meet the standard. Among boys (Figure 1B), only those living in Ontario were more likely to achieve the standard, whereas boys living in other provinces remained within the CI of the national average.

Figure 1. Province-level residuals of the logarithm of the odds ratio among (1A) Girls & (1B) Boys

Interpretation

This study explored differences in the practice of LPA among Canadian youth according to their life context. A four-level model was applied and adjusted for individual and contextual characteristics. After adjusting for age, racial origin, household education level and BMI, the

results showed that contextual features of the living environment were associated with the odds of an individual to accumulate an average of at least 60 minutes of moderate to vigorous-intensity LPA. Moreover, these influences were not always the same between girls and boys. To remain consistent with the study design, the influence of time, season and area-based variables will be discussed in this order.

Whereas no trend was observed among girls, a decrease of 2% in the odds of achieving physical activity guidelines by LPA between each cycle suggested a downward trend of the practice of LPA among boys since 2003. Although this trend is relatively small, it may highlight the importance to survey more closely physical activity trends among boys. No trend was detected for girls, but it was clearly observed that their LPA level remained significantly lower than boys as reported in other Canadian investigations (28, 29), reinforcing the idea to keep a closer consideration for sex specific needs when planning public health interventions. A proposed area of improvement involves strategies to ensure equitable access to resources, including availability and access to suitable physical education classes and/or

organized sports which may be subject to sex-related inequities (30, 31).

Season appeared to have a highly significant influence. Regardless of sex, winter was observed as a major barrier to performing LPA. This finding supported previous results that found an influence of seasonality on LPA among various populations, including young Canadians (32, 33). For that reason, the need to account for seasonality when developing interventions and programs targeting physical activity may be advantageous.

Suburban and rural areas were associated with higher odds to meet physical activity guidelines by LPA among girls. This result conflicts with previous findings showing the opposite pattern (34). It suggests that facilities available in urban areas might either be more suitable for boys, or that girl's inclination to engage in physical activity around the home environment makes them less sensitive to the accessibility of community facilities (35).

Observing that the introduction of area-based indices of material and social deprivation led to a poorer fit of the overall model, no conclusions could be drawn about their association with the odds of achieving the physical

activity guidelines by LPA. Yet, a recent analysis of the influence of these indices among Quebec High School students have shown that students from very privileged backgrounds on both material and social counts are proportionally more active than those from disadvantaged backgrounds (36). This finding suggests that the contextual effect of deprivation may vary importantly at the local level. Put differently, the deprivation level of a neighbourhood may influence youth LPA in some settings, while having a lesser or no impact in others. As proposed by Wilkinson and Marmot (37), the impact of deprivation on health determinants may be relative to the social context and not necessarily absolute, making it difficult to isolate the impact at the national level. More context specific investigations are required to explore the causes of these contrasting observations.

Whereas the between-province variance distribution showed no significant differences globally, residual analysis of provincial units highlighted some provinces which are different from the Canadian average. The relatively poor odds to achieve LPA standards observed among girls living in Quebec raises the question as to why Quebec girls tend to be much less active than other Canadians, and provide

rationale for further investigation on how physical activity is promoted in that province. As Ontario had better performing boys and girls than the national average, it may help to study contextual and policy differences there (in comparison to the other provinces).

Several limitations need to be kept in mind when interpreting results. Even if the sample is distributed in a nine-year period, the cross-sectional design of the data limits its ability to establish causal inferences, particularly with respect to contextual effects. Also, a self-reported data of physical activity is likely to be influenced by "social desirability" (38). Moreover, CCHS data on LPA aims to account for all activities completed over a period of three months prior to the administration of the survey. For that reason, the level of precision on duration and intensity of physical activity remains questionable as recall for non-repeating activities would likely be more difficult and there would likely be a bias to LPA where individuals are inscribed (e.g. lessons, league sports, etc.). Further, available data do not take into account physical activity performed for utilitarian purposes such as active transport which are more common in central, and often deprived, neighbourhoods (39). The

inclusion of utilitarian physical activity may enhance the effects of contextual features among youth and would carry this exploration one step further.

Notwithstanding these limitations, this exploratory analyse provides an important insight on the contextual differences of the level of LPA among Canadian youth based on a large sample, a combination of individual and contextual information and a multilevel framework which makes it possible to unveil context-specific variations (e.g. between provinces or regions). It shows differences that extend beyond individual level associations and provides new information to better understand the distribution of leisure-time physical activity of youth between Canadian regions.

REFERENCES

1. WHO. Global Recommendations on Physical Activity for Health. Geneva: 2010.
2. Janssen I. Physical activity guidelines for children and youth. Can J Public Health. 2007;98 Suppl 2:S109-21. PubMed PMID: 18213942.
3. Janssen I, Leblanc AG. Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. The international journal of behavioral nutrition and physical activity. 2010;7:40. PubMed PMID: 20459784. Pubmed Central PMCID: 2885312.
4. PAGAC. Physical Activity Guidelines Advisory Committee Report. Washington, DC: US Department of Health and Human Services, 2008.
5. Warburton DE, Nicol CW, Bredin SS. Health benefits of physical activity: the evidence. Canadian medical association journal. 2006;174(6):801-9.
6. CSKQ. L'activité physique et le poids corporel : Avis du comité. Québec: Ministère de l'Éducation, du Loisir et du Sport, 2006.
7. Sallis JFO, N.; Fotheringham, M. J. Behavioral epidemiology: a systematic framework to classify phases of research on health promotion and disease prevention. Annals of behavioral

medicine : a publication of the Society of Behavioral Medicine. 2000 Fall;22(4):294-8. PubMed PMID: 11253440.
8. Bauman AE, Reis RS, Sallis JF, Wells JC, Loos RJ, Martin BW, et al. Correlates of physical activity: why are some people physically active and others not? Lancet. 2012 Jul 21;380(9838):258-71. PubMed PMID: 22818938.
9. Van der Horst K, Paw M, Twisk JW, Van Mechelen W. A brief review on correlates of physical activity and sedentariness in youth. Medicine and science in sports and exercise. 2007;39(8):1241.
10. Patnode CD, Lytle LA, Erickson DJ, Sirard JR, Barr-Anderson D, Story M. The relative influence of demographic, individual, social, and environmental factors on physical activity among boys and girls. The international journal of behavioral nutrition and physical activity. 2010;7:79. PubMed PMID: 21047429. Pubmed Central PMCID: 2991277.
11. Sallis JF, Owen N, Fisher EB. Ecological models of health behavior. In: Glanz KR, B.K.; Viswanath, K., editor. Health Behavior and Health Education: Theory, Research, and Practice: Wiley; 2008.
12. StatCan. Canadian Community Health Survey - Annual component. 2014.
13. Lalonde BeL, A. . Indicateurs socioéconomiques pour les communautés Canadiennes, Rapport méthodologique. Plateforme d'évaluation en prévention de l'obésité, 2015.
14. StatCan. Health regions: boundaries and correspondence with census geography. 2011.
15. CSEP. Canadian Physical Activity Guidelines: Clinical Practice Guidelines Report. Ottawa: 2011.
16. Tremblay MS, Warburton DER, Janssen I, Paterson DH, Latimer AE, Rhodes RE, et al. New Canadian Physical Activity Guidelines. Applied Physiology, Nutrition, and Metabolism. 2011;36(1):36-46. PubMed PMID: 21326376.
17. Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, et al. Compendium of physical activities: an update of activity codes and MET intensities. Medicine and science in sports and exercise. 2000 Sep;32(9 Suppl):S498-504. PubMed PMID: 10993420. Epub 2000/09/19. eng.
18. Nolin B. Indice d'activité physique : codification, critères et algorithmes – Enquête québécoise sur la santé des jeunes du secondaire (EQSJS) 2010-2011. Québec: 2012.
19. Gortmaker SL, Lee R, Cradock AL, Sobol AM, Duncan DT, Wang YC. Disparities in youth physical activity in the United States: 2003-2006. Medicine and science in sports and exercise. 2012;44(5):888-93.
20. Nader PR, Bradley RH, Houts RM, McRitchie SL, O'Brien M. Moderate-to-vigorous physical activity from ages 9 to 15 years. Jama. 2008 Jul 16;300(3):295-305. PubMed PMID: 18632544.
21. Whitt-Glover MC, Taylor WC, Floyd MF, Yore MM, Yancey AK, Matthews CE. Disparities in physical activity and sedentary behaviors among US children and adolescents: prevalence, correlates, and intervention implications. Journal of public health policy. 2009;30 Suppl 1:S309-34. PubMed PMID: 19190581.
22. McNiven C, Puderer H, Janes D. Census Metropolitan Area and Census Agglomeration Influenced Zones (MIZ): A Description of the Methodology. In: Canada GDS, editor. Ottawa2000.
23. Pampalon R, Raymond G. Indice de défavorisation matérielle et sociale : son application au secteur de la santé et du bien-être. Santé, Société et Solidarité. 2003;1:191-208.
24. Browne WJ. MCMC Estimation in MLwiN, v2.26. University of Bristol2014.
25. Spiegelhalter DJ, Best NG, Carlin BP, Van Der Linde A. Bayesian measures of model complexity and fit. Journal of the Royal Statistical Society: Series B (Statistical Methodology). 2002;64(4):583-639.

26. Merlo J, Chaix B, Ohlsson H, Beckman A, Johnell K, Hjerpe P, et al. A brief conceptual tutorial of multilevel analysis in social epidemiology: using measures of clustering in multilevel logistic regression to investigate contextual phenomena. Journal of epidemiology and community health. 2006 Apr;60(4):290-7. PubMed PMID: 16537344. Pubmed Central PMCID: 2566165.
27. Duncan SC, Duncan TE, Strycker LA, Chaumeton NR. A cohort-sequential latent growth model of physical activity from ages 12 to 17 years. Annals of behavioral medicine : a publication of the Society of Behavioral Medicine. 2007 Feb;33(1):80-9. PubMed PMID: 17291173. Pubmed Central PMCID: 2729662.
28. Godin G, Anderson D, Lambert L-D, Desharnais R. Identifying factors associated with regular physical activity in leisure time among Canadian adolescents. American Journal of Health Promotion. 2005;20(1):20-7.
29. Colley RC, Garriguet D, Janssen I, Craig CL, Clarke J, Tremblay MS. Physical activity of Canadian children and youth: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. 2011.
30. Butler GP, Orpana HM, Wiens AJ. By your own two feet: factors associated with active transportation in Canada. Can J Public Health. 2007 Jul-Aug;98(4):259-64. PubMed PMID: 17896732.
31. Veugelers PJ, Fitzgerald AL. Prevalence of and risk factors for childhood overweight and obesity. Canadian Medical Association Journal. 2005 Sep;173(6):607-13. PubMed PMID: WOS:000231620100019.
32. Tucker P, Gilliland J. The effect of season and weather on physical activity: A systematic review. Public Health.121(12):909-22.
33. Bélanger M, Gray-Donald K, O'Loughlin J, Paradis G, Hanley J. Influence of Weather Conditions and Season on Physical Activity in Adolescents. Annals of Epidemiology.19(3):180-6.
34. Bruner MW, Lawson J, Pickett W, Boyce W, Janssen I. Rural Canadian adolescents are more likely to be obese compared with urban adolescents. International Journal of Pediatric Obesity. 2008;3(4):205-11.
35. Dunton GF, Jamner MS, Cooper DM. Assessing the perceived environment among minimally active adolescent girls: validity and relations to physical activity outcomes. American Journal of Health Promotion. 2003;18(1):70-3.
36. Traoré I, Nolin B, Pica LA. « Activité physique de loisirs et de transport », dans, L'Enquête québécoise sur la santé des jeunes du secondaire 2010-2011. Québec: 2012.
37. Wilkinson R, Marmot M. Social determinants of health: the solid facts. Geneva, Switzerland: World Health Organization; 2003. 2013.
38. Katzmarzyk PT, Tremblay MS. Limitations of Canada's physical activity data: implications for monitoring trends. Can J Public Health. 2007;98 Suppl 2:S185-94. PubMed PMID: 18213948.
39. Pabayo RA, Gauvin L, Barnett TA, Morency P, Nikiema B, Seguin L. Understanding the determinants of active transportation to school among children: evidence of environmental injustice from the Quebec Longitudinal Study of Child Development. Health & place. 2012 Mar;18(2):163-71. PubMed PMID: 21937255.

	Girls **n=26822**	Boys **n=28010**
Outcome: Achievement of recommended daily level for physical activity		
Active	36.9%	51.9%
Individual		
Age		
12-15	65.8%	66.1%
16-17	34.2%	34.0%
Origin		
Caucasian	74.7%	73.9%
Asian	10.4%	11.0%
Others	8.6%	8.6%
Unknown	6.4%	6.5%
Household education Level		
University	33.0%	33.2%
High School and College	49.8%	49.0%
Less then High School	3.6%	3.7%
Unknown	13.7%	14.2%
BMI		
Normal weight	68.0%	65.7%
Underweight	10.8%	5.8%
Overweight	10.7%	17.3%
Obese	2.8%	5.4%
Unknown	7.8%	5.8%
Cycle		
(1) 2003-2004	23.4%	23.7%
(2) 2005-2006	21.3%	21.0%
(3) 2007-2008	18.9%	18.6%
(4) 2009-2010	18.7%	18.8%
(5) 2011-2012	17.8%	17.9%
Season		
Summer	34.4%	34.2%
Winter	18.3%	18.4%
Transitional	47.3%	47.4%
Area-based		
MIZ		
Urban	80.6%	81.2%
Suburban	12.1%	11.8%
Rural	7.3%	7.1%
Material deprivation quintile		
Most priviledged	17.4%	16.5%
Priviledged	22.5%	23.3%
Median	28.2%	28.5%
Deprived	21.2%	21.1%
Most deprived	10.8%	10.5%
Social deprivation quintile		
Most priviledged	12.9%	12.6%
priviledged	23.6%	24.0%
Median	27.7%	27.2%
Deprived	24.8%	23.9%
Most deprived	11.1%	12.2%

	Null Model		*Model 2*		*Model 3*		*Model 4*	
	OR	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**	**OR**	**95%CI**
Individual								
Age								
12-15			**1.00**		**1.00**		**1.00**	
16-17			**0.76**	0.72-0.80*	**0.76**	0.72-0.80*	**0.76**	0.72-0.80*
Origin								
Caucasian			**1.00**		**1.00**		**1.00**	
Asian			**0.65**	0.57-0.73*	**0.66**	0.58-0.74*	**0.66**	0.59-0.75*
Others			**0.98**	0.88-1.10	**1.00**	0.89-1.11	**1.00**	0.90-1.12
Unknown			**1.07**	0.98-1.18	**1.07**	0.97-1.17	**1.07**	0.98-1.18
Household education level								
University			**1.00**		**1.00**		**1.00**	
High School and College			**0.85**	0.8-0.90*	**0.84**	0.79-0.89*	**0.84**	0.79-0.89*
Less than High School			**0.76**	0.66-0.86*	**0.74**	0.65-0.85*	**0.75**	0.66-0.86*
Unknown			**0.97**	0.89-1.06	**0.97**	0.89-1.05	**0.97**	0.89-1.05
Body Mass Index								
Normal weight			**1.00**		**1.00**		**1.00**	
Underweight			**0.88**	0.81-0.96*	**0.88**	0.81-0.96*	**0.88**	0.81-0.96*
Overweight			**0.86**	0.8-0.93*	**0.86**	0.79-0.93*	**0.86**	0.80-0.93*
Obese			**0.79**	0.69-0.92*	**0.79**	0.68-0.91*	**0.79**	0.68-0.92*
Unknown			**0.68**	0.62-0.75*	**0.68**	0.62-0.75*	**0.68**	0.62-0.75*
Cycle (2003-2012)			**1.01**	0.99-1.03	**1.01**	0.99-1.03	**1.01**	0.99-1.02
Season								
Summer			**1.00**		**1.00**		**1.00**	
Winter			**0.58**	0.54-0.62*	**0.58**	0.54-0.62*	**0.58**	0.53-0.62*
Transitional			**0.66**	0.63-0.7*	**0.66**	0.62-0.7*	**0.66**	0.62-0.70*
Area-based								
MIZ								
Urban					**1.00**			
Suburban					**1.12**	1.04-1.21*	**1.13**	1.05-1.22*
Rural					**1.13**	1.04-1.23*	**1.14**	1.05-1.24*
Social deprivation quintile								
Most priviledged							**1.00**	
Priviledged							**1.05**	0.95-1.16
Median							**0.96**	0.87-1.06
Deprived							**0.97**	0.88-1.07
Most deprived							**0.95**	0.84-1.06
Material deprivation quintile								
Most priviledged							**1.00**	
Priviledged							**1.05**	0.96-1.15
Median							**1.05**	0.96-1.14
Deprived							**1.05**	0.96-1.16
Most deprived							**0.94**	0.84-1.05
Geographical hierarchy	**Variance (S.E.)**	**MOR**	**Variance (S.E.)**	**MOR**	**Variance (S.E.)**	**MOR**	**Variance (S.E.)**	**MOR**

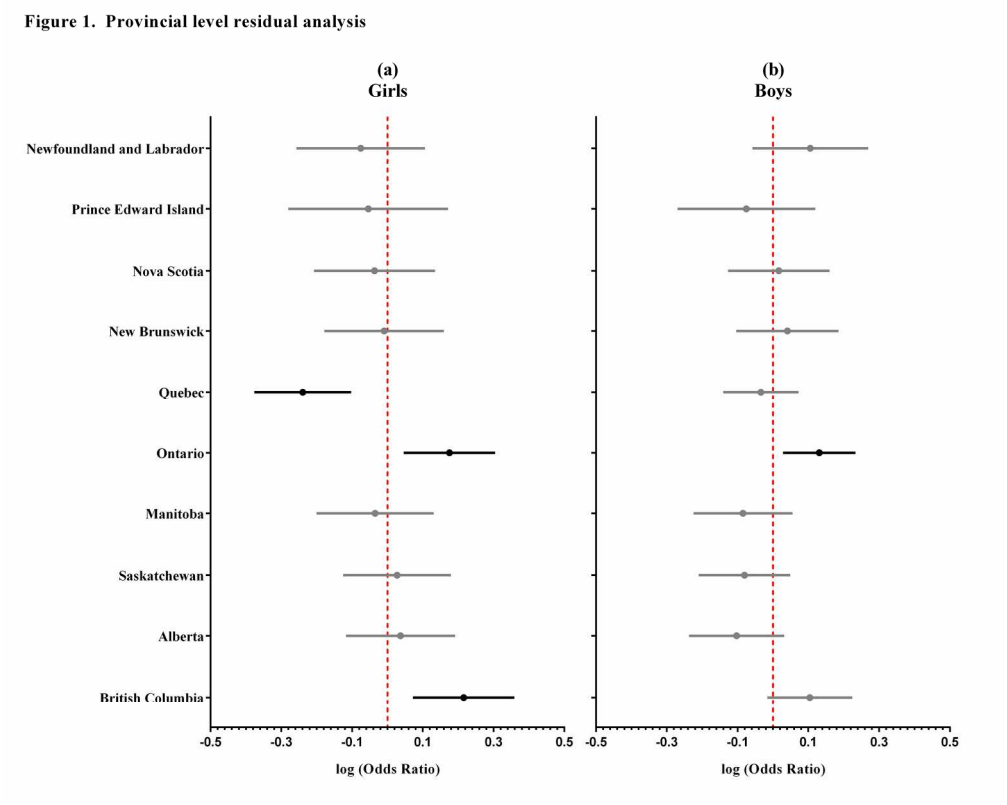
Province	0.022 (0.016)	1.15	0.025 (0.017)	1.16	0.028 (0.019)	1.17	0.027 (0.019)	1.17
Health Region	0.018 (0.005)*	1.14	0.016 (0.005)*	1.13	0.014 (0.005)*	1.12	0.014 (0.005)*	1.12
Neighbourhood	0.017 (0.007)*	1.13	0.015 (0.01)	1.12	0.026 (0.009)*	1.17	0.02 (0.011)	1.14
Deviance Information Criteria	35536.98		35007		35001		35003	
Δ DIC			-530		-6		2	

* Significant with α=0,05; Source: CCHS (2003-2012)

	Null Model		Model 2		Model 3		Model 4	
	OR	95%CI	OR	95%CI	OR	95%CI	OR	95%CI
Individual								
Age								
12-15			**1.00**		**1.00**		**1.00**	
16-17			**0.88**	0,83-0,92*	**0.88**	0,83-0,92*	**0.88**	0,83-0,92*
Origin								
Caucasian			**1.00**		**1.00**		**1.00**	
Asian			**0.86**	0,78-0,95*	**0.86**	0,77-0,95*	**0.86**	0,78-0,95*
Others			**1.35**	1,21-1,51*	**1.34**	1,20-1,50*	**1.35**	1,21-1,51*
Unknown			**1.25**	1,15-1,37*	**1.25**	1,14-1,38*	**1.26**	1,15-1,38*
Household education level								
University			**1.00**		**1.00**		**1.00**	
High School and College			**0.93**	0,82-1,06	**0.94**	0,83-1,07	**0.95**	0,84-1,08
Less then High School			**0.94**	0,89-1*	**0.94**	0,89-1*	**0.95**	0,9-1,01
Unknown			**1.01**	0,93-1,09	**1.01**	0,94-1,10	**1.02**	0,94-1,1
Body Mass Index								
Normal weight			**1.00**		**1.00**		**1.00**	
Underweight			**0.63**	0,56-0,7*	**0.63**	0,56-0,70*	**0.63**	0,56-0,7*
Overweight			**0.92**	0,86-0,98*	**0.92**	0,86-0,98*	**0.92**	0,86-0,98*
Obese			**0.59**	0,53-0,65*	**0.59**	0,53-0,65*	**0.59**	0,53-0,65*
Unknown			**0.52**	0,47-0,58*	**0.52**	0,47-0,58*	**0.52**	0,47-0,58*
Cycle and season								
Cycle (2003-2012)			**0.98**	0,96-0,99*	**0.98**	0,96-0,99*	**0.98**	0,96-0,99*
Season								
Summer			**1.00**		**1.00**		**1.00**	
Winter			**0.55**	0,51-0,59*	**0.55**	0,51-0,59*	**0.55**	0,51-0,59*
Transitional			**0.7**	0,67-0,74*	**0.7**	0,66-0,74*	**0.7**	0,66-0,74*
Area-based								
MIZ								
Urban					**1.00**			
Suburban					**0.95**	0,89-1,02	**0.96**	0,89-1,03
Rural					**0.99**	0,91-1,07	**1**	0,92-1,08
Social deprivation quintile								
Most priviledged							**1.00**	
Priviledged							**1**	0,91-1,09
Median							**0.98**	0,89-1,08
Deprived							**1**	0,91-1,09
Most deprived							**0.92**	0,83-1,03
Material deprivation quintile								
Most priviledged							**1.00**	
Priviledged							**0.96**	0,88-1,04
Median							**0.98**	0,9-1,07
Deprived							**0.95**	0,87-1,04
Most deprived							**0.95**	0,85-1,06

Geographical hierarchy	Variance (S.E.)	MOR	Variance (S.E.)	MOR	Variance (S.E.)	MOR	Variance (S.E.)	MOR
Province	0,014 (0,02)	1.12	0,016 (0,013)	1.13	0,016 (0,013)	1.13	0,016 (0,014)	1.13
Health Region	0,02 (0,006)*	1.14	0,018 (0,005)*	1.14	0,017 (0,005)*	1.13	0,018 (0,006)*	1.14
Neighbourhood	0,018 (0,01)	1.14	0,008 (0,009)	1.09	0,023 (0,009)*	1.16	0,017 (0,009)	1.13
Deviance Information Criteria (DIC)	38562		37919		37919.3		37929.01	
Δ DIC			-643		0.3		9.7	

* Significant with α=0,05; Source: CCHS (2003-2012)



Province-level residuals of the logarithm of the odds ratio among (1A) Girls & (1B) Boys
193x156mm (300 x 300 DPI)