Effects of Generation of Immigration on Overweight in Canadian Youth

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ABSTRACT

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Research has shown that the prevalence of overweight in recent immigrants increases with time spent in North America; however, there is a lack of research on overweight in Canadian immigrant youth. The purpose of the current study was to assess the relationship between generation of immigration and overweight in Canadian youth, and to examine the influence of various risk factors (acculturation, ethnicity, socioeconomic status) on this relationship. Longitudinal data from Cycles 1 to 7 of the National Longitudinal Survey of Children and Youth were used. Children aged 6-11 years ($N = 13,657$) and adolescents aged 12-17 years ($N = 10,467$) were included. Generation of immigration was classified based on youth and parents' countries of birth. Overweight was assessed using age- and sex-specific percentiles, based on parent- and self-reported body mass index. Multilevel modeling was used to test hypotheses. Results showed that generation of immigration predicted overweight in both children and adolescents, after controlling for gender, age, socioeconomic status, and ethnicity. First-generation immigrants showed relative weight gain between childhood and adolescence. The effects of acculturation on overweight depended on generation of immigration. This research suggests that consideration of generation of immigration and the acculturation process are important for obesity prevention strategies in Canadian youth.

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Canadian youth are becoming progressively more overweight and obese (Tremblay & Willms, 2000). Recent representative national surveys show the prevalence of overweight to be 18% and the prevalence of obesity to be 8% among children and adolescents aged 2 to 17 (Shields, 2006). Prevalence rates for immigrant youth are not available; however, these youth may be at risk for weight gain. Adult immigrants tend to have a lower prevalence of obesity when they first arrive in Canada, but their rates increase with time spent in Canada. In the United States, first-generation immigrant youth have a lower prevalence of overweight than second-generation immigrants. A similar relationship may exist in Canada, but to date, no research exists to establish whether generation of immigration is related to overweight and obesity in Canadian children and adolescents. In addition, risk factors that may influence this relationship, including acculturation, ethnicity, and socioeconomic status have not yet been examined.

In the following sections, an overview of the literature demonstrating that more recent immigrants have lower levels of overweight and obesity than long-term immigrants will first be presented. Second, research on several risk factors for overweight and obesity across youth from different generations of immigration will be described. Finally, the aims of the present study, which addresses some of the gaps in current knowledge, will be explained.

Obesity in Immigrants and Non-immigrants

The "healthy immigrant effect" refers to the observation that the health of immigrants at the time of immigration is superior to the health of the native-born population. It is thought to result from two processes: healthier people self-select into the immigration process and immigration criteria select immigrants on the basis of education, language ability, and job skills (which often co-exist with healthful lifestyles) and stipulate that certain health status criteria are met (Hyman, 2001). The healthy immigrant effect also refers to the observation that immigrants lose their health advantage with time.

These effects appear to hold true in Canada; adult immigrants are healthier than native-born Canadians when they first arrive, but their health seems to deteriorate with time in Canada, and eventually converges to Canadian-born levels. Using the 2000/01 Canadian Community Health Survey, Perez (2002) showed that immigrants had a lower prevalence of chronic health conditions than non-immigrants. Immigrants were also grouped according to length of residence in Canada (0-4 years, 5-9 years, 10-14 years, 15-19 years, 20-29 years, 30 or more years). The odds-ratios for reporting a chronic condition, relative to non-immigrants, increased steadily across groups, and those immigrants who had resided in Canada for more than 30 years were indistinguishable from their Canadian-born counterparts. The healthy immigrant effect has also been documented in the United States (Singh & Siahpush, 2002), the United Kingdom (Kennedy, Mcdonald, & Biddle, 2006), and Australia (Biddle, Kennedy, & McDonald, 2006).

The underlying reasons driving this decline in immigrant health are unclear thus far. One possibility is that the differences result from a cohort effect. In other words, immigrants who arrived more recently in Canada may have had a better health profile when they entered the country than did immigrants who arrived earlier. This could be the result of evolving immigration criteria and increasing competition to immigrate to Canada. Alternatively, the health status of immigrants may actually deteriorate with time in Canada. This deterioration in health may be due to acculturation, or culture change from being in contact with Canadian culture. During the process of acculturation, immigrants may adopt Canadian health-related behaviours, which make them more similar to native-born Canadians and they lose their health advantage. The results from Perez (2002) indicated that while immigrants' patterns of health-related lifestyle behaviours (smoking, alcohol drinking, physical inactivity, fruit and vegetable consumption) varied with time in Canada, the results did not show a clear convergence to Canadian-born levels. In addition, after controlling for socio-demographic variables, health behaviours did not explain health differences between immigrants and non-immigrants.

McDonald and Kennedy (2005) argued that if lifestyle changes contribute to the deterioration of immigrant health, then changes in excess weight should be observed over time. Excess weight may also partially mediate the relationship between lifestyle change and the decline in health. Therefore, are levels of overweight and obesity lower for immigrants upon arrival in Canada compared to native-born Canadians? And do these rates increase with time spent in Canada? Cairney and Ostbye (1998) used the 1994 National Population Health Survey to calculate body mass index (BMI) on the basis of self-report height and weight and to determine the length of time since immigration (0-4 years, 5-9 years, 10 or more years, born in Canada). Rates of overweight (BMI above 25kg/m^2) were lower for immigrants who had arrived within four years (34% for men, 17% for women) compared to immigrants who had lived in Canada for 10 or more years (53% for men, 42% for women). Moreover, this effect was not due to other demographic, lifestyle and health factors that are also related to BMI. By pooling the results from the

1996 National Population Health Survey and the 2000/01 Canadian Community Health Survey, McDonald and Kennedy (2005) found that foreign-born men and women had lower prevalence of overweight (61% and 45%, respectively) than native-born men and women (74% and 53%, respectively). However, the probability of being overweight or obese increased gradually with additional years in Canada, reaching native-born levels after 20 to 30 years. Finally, Tremblay, Perez, Ardem, Bryan, and Katzmarzyk (2005) pooled results from the 2000/01 and 2003 Canadian Community Health Survey and showed that recent immigrants (10 years or less in Canada) had significantly lower prevalence of overweight (BMI between 25 and 30kg/m^2) and obesity (BMI above 30kg/m^2) than long-term immigrants (11 or more years in Canada) or non-immigrants (born in Canada).

Similar results have been observed in the United States. Using the 2000 National Health Interview Survey, which measured self-reported height and weight to establish BMI, Goel, McCarthy, Philips, and Wee (2004) found that 16% of foreign-born adults were obese compared to 22% of US-born adults. In addition, the proportion of foreign-born immigrants who were obese increased from 8% for those who had lived in the US less than one year to 19% for those who had lived in the US for 15 years.

Therefore, it appears that excess weight follows a similar trajectory to that of general physical health. In other words, the healthy immigrant effect is also present in weight status. This suggests that the healthy immigrant effect may be driven by lifestyle factors, such as diet and physical activity, which also affect overweight and obesity. However, due to the cross-sectional nature of the research to date, these inferences are not conclusive. Analysis of longitudinal data is required to support the idea that immigrant weight gain is a result of additional time spent in Canada, rather than due to cohort effects. In addition, it remains to be seen whether excess weight mediates the relationship between time since immigration and deterioration of immigrant health.

Being an immigrant may also be a risk factor for obesity in children and adolescents, but the evidence is mixed and this has not been examined in Canada. Because of the limited length of time since immigration, most studies compare first- to second-generation immigrant children (i.e., foreign-born to native-born children). The prevalence of overweight or obese was significantly higher in children of first- or second-generation immigrants aged 6, 10, and 15 years in Austria, compared to third-generation or higher Austrian children at the same ages (Kirchengast & Schober, 2006). Overweight was defined as above the 90th percentile and obesity was defined as above the 97th percentile according to BMI percentiles for Central Europe (Kromeyer-Hausschild et al., 2001). However, this sample was much different than immigrants to Canada in that all the immigrants were from Turkey or the former Yugoslavia. For instance, overweight in Turkey is traditionally positively interpreted as a sign of middle- to high-income social classes.

Popkin and Udry (1998) used the United States National Longitudinal Study of Adolescent Health Wave II, which sampled Anglo-, African-, Hispanic-, and Asian-American adolescents and measured height and weight. They defined overweight as above the 85th percentile of age- and sex-specific standards according to National Health and Nutrition Examination Survey I data and compared the prevalence of overweight in first-, second-, and third-generation immigrants. They found that for both the Hispanic and Asian groups, first-generation immigrants (not born in the US) had a lower prevalence of overweight than second-generation immigrants (born in the US, with at least one foreign-born parent). There was no difference between second- and third-generation immigrants (born in the US to US-born parents).

Similarly, Gordon-Larsen, Harris, Ward, and Popkin (2003) studied Hispanic adolescent immigrants to the United States using Wave I and II of the National Longitudinal Study of Adolescent Health. They defined overweight as above the 85th percentile of age and sex-specific cut-off points from the 2000 Centers for Disease Control and Prevention/National Center for Health Statistics growth charts. They found that overweight prevalence was lower among foreign-born Puerto Rican (16.8%) and Cuban (29.9%) adolescents compared to their US-born counterparts (31.0% and 35.5%, respectively). However, there was no difference across generation of immigration for Mexican adolescents. Finally, Haas, Lee, Kaplan, Sonneborn, Phillips, and Liang (2003) examined country of birth (US-born vs. foreign-born) as a risk factor for obesity (BMI above the 95th percentile for age and sex according to Centers for Disease Control and Prevention charts) among children (aged 6-11 years) and adolescents (aged 12-17 years). In children, obesity rates were lower in foreign-born (20%) compared to US-born children (27%), although this difference was not statistically significant. In adolescents, no differences were observed between rates of obesity for foreign-born (12%) and US-born (11%). These findings suggest that the prevalence of overweight is lower in first-generation than in second-generation or higher immigrant youth in the United States.

Despite these findings in other countries, little or no research has been undertaken to understand how obesity develops in immigrant children and adolescents in Canada.

Relatedly, a review of obesity prevention and intervention programs in Canada found that there are no such programs targeted at immigrant youth in Canada (Flynn et al., 2004).

While most Canadians can trace their ancestry to immigrants, Aboriginal Canadians are those peoples whose ancestors were native to Canada (i.e., Aboriginal Canadians are non-immigrants). Similar to immigrants, Aboriginal Canadians have experienced acculturation, although the nature of culture change is quite different. To date, no research has compared overweight status in Aboriginal youth to other generations of immigrants in Canada.

Results from the 2000/01 and 2003 Canadian Community Health Survey showed that adult Aboriginal Canadians (living off the reserve) had the highest self-reported prevalence of overweight (35%) and obesity (28%) of all ethnic groups (Tremblay et al., 2005). In addition, using the 2004 Canadian Community Health Survey, which measured height and weight to more accurately derive BMI and over-sampled Aboriginal Canadians to obtain nationally representative data in this group, Katzmarzyk (2008) found that off-reserve Aboriginal adults (38%) had a much higher prevalence of obesity than the rest of the population (23%). Importantly, the prevalence of obesity (according to international age- and sex-specific cut-offs) in Aboriginal youth aged 2-17 years (16%) was almost twice that of non-Aboriginal youth in the same age group (8%; Katzmarzyk, 2008).

Since the Canadian Community Health Survey did not measure Aboriginals living on reserves, these surveys preclude an accurate representation of all Aboriginal people living in Canada. The First Nations Centre (2005) surveyed children and adults living in 238 First Nations communities across Canada using the 2002/03 First Nations Regional

Longitudinal Health Survey. Using self-reported height and weight to calculate BMI and classifying children and adolescents as obese according to international age- and sex-specific cut-offs, results of this survey showed extremely elevated rates of obesity in children aged 3-11 years (36%) and elevated rates in adolescents aged 12-17 years (14%). Since the Canadian Community Health Survey did not distinguish between children and adolescents, we cannot compare it directly to the First Nations Regional Longitudinal Health Survey. However, it seems as though children aged 3-11 years living in First Nations communities may be at increased risk for obesity compared to their counterparts living off-reserve. This may be due to a cohort effect or there may be a change that occurs with puberty onset that decreases excess weight.

Further, studies in remote Aboriginal communities have found prevalence rates of childhood obesity close to 40% in both Ojibwa-Cree youth aged 4-19 years living in northern Manitoba (Ng, Marshall, & Willows, 2006) and Cree children aged 9-12 years living in northern Quebec (Young, Dean, Flett, & Wood-Steiman, 2000).

Taken together, new adult immigrants to Canada have lower rates of overweight but these increase with additional years spent in Canada. Research in the United States has shown that first-generation immigrants have lower rates of overweight than second-generation immigrants for both adults and youth. However, the relationship between generation of immigration and overweight has not been studied in Canadian children and adolescents. In addition, the literature shows that Aboriginal (or non-immigrant) Canadians have higher rates of overweight compared to non-Aboriginal (or immigrant) Canadians. However, previous research has not conceptualized Aboriginal peoples as a distinct generation of immigration and compared their rates of overweight to other generations.

Risk Factors

Acculturation. Acculturation is defined as culture change that results from continuous, first-hand contact between two distinct cultural groups (Redfield, Linton, & Herskovits, 1936). The term psychological acculturation refers to the changes individuals experience as a result of participating in the process of acculturation that one's cultural group is undergoing (Graves, 1967). While in principle each group could influence the other equally, in practice one group tends to be dominant. Therefore, acculturation tends to induce more change in the non-dominant group, termed the acculturating group (Berry, 1989).

Acculturation may play an important role in the development of obesity across generations of immigrants. As individuals in acculturating groups undergo acculturation, they may acquire, in addition to other cultural practices, the lifestyle habits of the dominant group. These lifestyle habits are thought to be instrumental in the development of obesity. In particular, the environments in Canada and the United States are thought be "obesogenic," with sedentary lifestyles, large portion sizes, and heavy advertising of high-fat, energy-dense foods (Gordon-Larsen at al., 2003). The "obesogenicity" of an environment is defined as "the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations" (Swinburn, Egger, & Raza, 1999). Therefore, as immigrants and Aboriginals adopt more North American lifestyles, it is likely that their risk of weight gain will increase.

Another possible pathway to weight gain is through acculturative stress, or stress resulting from culture change (Berry & Annis, 1974). Aboriginal, immigrant, and ethnic groups have been found to experience acculturative stress, with Aboriginal groups experiencing higher levels of stress (Berry, Kim, Minde, & Mok, 1987). In addition, immigrants may experience stress from linguistic isolation, a lack of recognition of work credentials, financial strain, and discrimination (Young, Spitzer, & Pang, 1999), while Aboriginal Canadians may experience stress from marginal socioeconomic and living conditions, trauma and violence, and historical, cultural, and political aspects of being Aboriginal (including forced acculturation; Iwasaki, Bartlett, & O'Neil, 2004). Stress causes central adiposity via activation of the hypothalamic-pituitary-adrenal axis and secretion of cortisol (Dallman, laFleur, Pecoraro, Gomez, Houshyar, & Akana, 2004) and is also related to overall obesity (Bjorntorp, 2001).

Several measures of acculturation have been used to examine its relationship to overweight and obesity. McDonald and Kennedy (2005) assumed that if a large ethnic community is present in a local area, then there are more opportunities for immigrants to maintain their connections to their original culture and fewer pressures or opportunities to adopt Canadian culture. Then, if that ethnic community has a lower weight profile than the Canadian average, they predicted that an individual immigrant of that ethnic group would also be less likely to be overweight. Their predictions were supported; immigrants who resided in a neighbourhood with large ethnic communities (and the ethnic group was less likely to be overweight than Canadians) were less likely to be overweight or obese. One possibility is that delaying the adoption of Canadian "obesogenic" lifestyle is protective against weight gain. Alternatively, fewer pressures for culture change may be associated with less acculturative stress in these immigrants, which in turn is associated with less weight gain.

Gordon-Larsen et al. (2003) explored the acculturation process in relation to overweight in Hispanic immigrant adolescents in the United States by collecting data on two types of acculturation factors: language spoken at home (English vs. non-English) and the proportion of foreign-born neighbours. When the model was adjusted for acculturation factors, the predicted prevalence of overweight increased for foreign-born immigrants, but not for US-born immigrants. Therefore, these variables that tied first-generation adolescent immigrants to their native country were protective against overweight. Acculturation factors explained the lower likelihood of overweight among first-generation Hispanic immigrants to a greater degree than other determinants of overweight, such as television watching, physical activity, dietary practices, and smoking. Therefore, it seems like the increase in overweight and obesity in immigrant adults and children is due in part to the adoption of a North American lifestyle that promotes weight gain.

One study on cardiovascular risk factors in Mexican American adults showed a possible benefit of adopting the dominant culture (Sundquist & Winkleby, 1999). As in other studies, obesity levels were lower for Mexican-born adults than for US-born adults. However, when they split the US-born group into two sub-groups (English- vs. Spanish-speaking), they found that obesity levels were higher for Spanish-speaking US-born adults than for English-speaking US-born adults. They concluded that the Mexican-born adults had lowest levels of obesity due to positive social and cultural influences from their country of birth. English-speaking US-born adults had intermediate obesity levels from the positive benefits that accompany greater adoption of American culture, including opportunities for higher education and income and access to preventive health services, while Spanish-speaking US-born adults benefited less from each of these positive influences.

Ethnicity. Using the 2000/01 and 2003 Canadian Community Health Survey to classify adult respondents as overweight, Tremblay et al. (2005) found that Aboriginal peoples had the highest levels of overweight, followed by Latin American, White, Black, Other, Arab/West Asian, South Asian, and East/Southeast Asian. Respondents were also divided based on their immigrant status: non-immigrant, recent immigrant (0 to 10 years), or long-term immigrant (more than 10 years). For non-immigrants, Aboriginal (1.8) and Other (1.3) had significantly higher odds ratios for being overweight than White (1.0), while East/Southeast Asian (0.5) and South Asian (0.5) had significantly lower odds ratios. For long-term immigrants, Latin American (1.6) had significantly higher and East/Southeast Asian (0.3) and South Asian (0.8) had significantly lower odds ratios for being overweight compared to White (1.0). Finally, for recent immigrants, Latin American (1.6) had significantly higher and East/Southeast Asian (0.3) had significantly lower odds ratios for being overweight. Therefore, ethnicities showed similar likelihood of being overweight across recent, long-term, and non-immigrants.

Shields (2006) analyzed the 2004 Canadian Community Health Survey, which used measured height and weight to calculate BMI and international age- and sex-specific cut-offs to determine overweight and obesity in children and youth aged 2-17 years. By dividing children and youth into five groups based on ethnicity, the prevalence of overweight (including obesity), respectively, was 41% for off-reserve Aboriginal, 29% for Black, 27% for Other, 26% for White, and 17% for Southeast/East Asian.

In American immigrant youth, overweight increased from first- to second-generation immigrants in Hispanic and Asian groups (Popkin & Udry, 1998). The increase in the prevalence of overweight was larger for Asian adolescents (12% to 27%) than for Hispanic adolescents (25% to 32%). Black and White groups were not divided based on generation of immigration, therefore it is not clear whether similar increases were seen in these races. However, it is probable that no differences were observed in these groups, otherwise they likely would have been reported.

Socioeconomic status (SES). Although a large number of studies have examined the relationship between socioeconomic status and overweight/obesity in adults, fewer have been conducted in children. A review of the literature by Sobal and Stunkard (1989) demonstrated a strong inverse relationship between SES and obesity among women in developed societies. However, the relationship is unclear in youth. For both boys and girls, many studies observed no relationship between SES and obesity. Of those that reported a significant relationship, close to half showed a positive relationship. Yang (2001) further investigated this relationship in children in the United States using NHANES III data. The 95^{th} percentile cut-off was used to define obesity and household income was used as a marker for SES. Low-income adolescents (10-18 years) were at a higher risk for obesity than high-income adolescents. However, income was not significantly related to obesity in children aged 6-9 years. Interestingly, when income and urban-rural residence were accounted for, the relationship between ethnicity and obesity became insignificant. This suggests that SES may account for different obesity rates across ethnic groups. Similar relationships were observed when BMI percentile was used as a continuous outcome variable.

According to the 2004 Canadian Community Health Survey, children and adolescents aged 2-17 years in middle-income households had higher levels of overweight/obesity (29%) than those in either low- (25%) or high-income households (23%; Shields, 2006). The relationship between parental education and overweight/obesity was clearer. Overweight/obesity rates were higher in "less than high school education" (31%) than "some postsecondary" (27%) or "postsecondary graduation" (25%). Using Cycle 4 of the National Longitudinal Survey of Children and Youth, Oliver and Hayes (2005) found that higher household income and more parental education were associated with reduced odds of being overweight. They also found that neighbourhood SES was inversely related to overweight in their nationally-representative sample of 5-17 year-olds. Similarly, living in the "most poor" neighbourhood was associated with increasing BMI percentile over time (from ages 2-3 to 10-11 years) compared to living in a "middle" income neighbourhood (Oliver & Hayes, 2008).

Explanations for the inverse relationship between SES and obesity include the low cost of energy-dense (i.e., high sugar, high fat) foods (Drewnowski & Spector, 2004), psychosocial stress (Brunner, 1997), differential pressures to be thin (McLaren, 2007), health-related knowledge (Monteiro, Moura, Conde, & Popkin, 2004), and other behavioural practices (Townsend, Davidson, & Whitehead, 1990).

Beiser, Hou, Hyman, and Tousignant (1998) examined poverty in immigrant children using Cycle 1 of the NLSCY. They divided respondents into immigrants (child born in a foreign country to non-Canadian parents), children of immigrant parents (child born in Canada, with at least one immigrant parent) and non-immigrants (Canadian-born child and Canadian-born parents). Thirty-six percent of immigrant children were living in poverty compared to 14% of children of immigrant parents and 13% of non-immigrant children. However, although children in poor families experience greater risk for mental health problems and immigrant children are more likely to be poor, immigrant children were found to have a mental health advantage over the other groups of children. This paradox may be explained by the meaning of poverty in the context of immigrants. In other words, although new immigrants experience unemployment and poverty during the first few years upon arrival in Canada, the expectation that these difficulties will be overcome may help protect these families from dysfunction that leads to mental health problems. In contrast, in non-immigrant children, parenting and family factors mediated the relationship between poverty and mental health.

Aboriginal peoples have higher rates of unemployment, poverty, and single-family homes than the rest of the Canadian population, according to the 1991 Aboriginal People's survey (MacMillan, MacMillan, Offord, & Dingle, 1996). Similarly, Blackstock, Tocme, and Bennett (2004) found that poverty rates for Aboriginal children are significantly higher than other visible minorities and that the average annual income for an Aboriginal worker was about $10,000 less than for non-Aboriginal workers in Canada.

Summary

The research literature on adult immigrants to Canada suggests that recent immigrants have lower rates of overweight but these increase with additional years spent in Canada. A similar trend has been found in the United States, with additional research showing that first-generation adolescent immigrants have lower rates of overweight than second-generation adolescent immigrants. To date, there is a lack of research on overweight in immigrant youth in Canada. In addition, previous research has not conceptualized Aboriginal peoples as a distinct generation of immigration and compared their rates of overweight to other generations. Previous research has shown that acculturation factors, ethnicity, and socioeconomic status predict overweight in adults and youth. However, these risk factors have not been measured in relation to overweight in Canadian immigrant and Aboriginal youth.

Current Study

The primary goal of this study was to assess the impact of generation of immigration on overweight and obesity in Canadian children and adolescents. A secondary goal was to examine the longitudinal patterns of overweight and obesity across generations of immigrants. The final goal was to examine the influence of various risk factors, including acculturation factors, ethnicity/race, and socioeconomic status, on overweight and obesity across generations of immigrants.

Using data from the National Longitudinal Survey of Children and Youth (Cycles 1-7), six hypotheses were tested. It was hypothesized that: 1) BMI would increase from first- to second- to mixed- to third-generation immigrants to Aboriginals, 2) Longitudinal BMI trajectories would differ across generation of immigration, 3) Ethnicity/race would predict BMI, 4) the relationship between generation of immigration and BMI would be stronger for certain ethnic/racial groups, 5) Speaking a first language other than English or French would be associated with lower BMI, and 6) First language would account for some of the effect of generation of immigration on BMI. Specific hypotheses, with predicted directions, are presented in the Results section.

Method

National Longitudinal Survey of Children and Youth (NLSCY) Sample

Data were from the National Longitudinal Survey of Children and Youth, a nationally representative longitudinal survey of Canadian youth. The original longitudinal cohort was first surveyed in 1994 and then at two-year intervals. Cycles 1 to 7 were available at the time of analysis. The NLSCY sample was originally selected in order to produce reliable estimates for the Canadian population. Sampling was purposefully constructed so there were enough youth from each of the ten provinces and in each of the seven age groups (0-11 months, 1 year, 2-3 years, 4-5 years, 6-7 years, 8-9 years, and 10-11 years). Each youth was assigned a survey weight, which corresponds to the number of persons in the population that that individual represents. Survey weights take into account the probability of selection, non-response, and post-stratification. The original cohort represents children aged 0 to 11 years old that were living in any Canadian province at the time of Cycle 1 data collection (1994/1995). A full description of the NLSCY and sampling design is available elsewhere (Statistics Canada & Human Resources Development Canada, 1995).

Information about the child's generation of immigration, the child's race, the child's first language, parental education, and household income were collected in an interview with the "person most knowledgeable" about the child, and his or her spouse. The "person most knowledgeable" was the child's biological mother (89-91%) or biological father (7-8%). The spouse was the child's biological father (67-72%), stepfather (6-8%), or biological mother (4-5%). There was no spouse for 15-18% of the observations. The "person most knowledgeable" will subsequently be referred to as "parent." Height and weight were collected during the parental interview for children aged 6-11 years and via self-complete paper questionnaire for adolescents aged 12-17 years.

Current Study Sample

The current study examined children and adolescents from the original longitudinal cohort who were aged 6-17 years in Cycles 1 to 7. "Children" refer to observations of youth aged 6-11 years at any cycle. "Adolescents" refer to observations of youth aged 12-17 years at any cycle. Analyses were conducted separately for each age group. These age groups were used because height and weight were reported by parents until 11 years and by adolescents beginning at 12 years. In addition, these age groups have been employed in other studies of overweight in Canadian youth (e.g., Shields, 2006). Youth outside of these age groups were not included because assessing overweight is problematic in children under 6 years due to fluctuations in BMI (Oliver & Hayes, 2005) and the measurement definitions of BMI change at age 18 years. Table 1 shows the cohorts and data collection cycles included in the analyses.

The longitudinal design of the NLSCY allowed for multiple observations from each youth. This was advantageous because it increased the number of observations from groups with small sample sizes and it permitted the examination of trajectories over time. In particular, first-generation immigrants had a small total sample size due to over-sampling of rural regions and smaller provinces in the NLSCY. Longitudinal weights were used for descriptive analyses to derive estimates that were representative of the

Table 1

Age Groups Included in Analyses

	Cycle						
Cohort	1	2	3	4	5	6	7
1	0-1	2-3	4-5	6-7	8-9	10-11	12-13
2	2-3	4-5	6-7	8-9	10-11	12-13	14-15
3	4-5	6-7	8-9	10-11	12-13	14-15	16-17
4	6-7	8-9	10-11	12-13	14-15	16-17	18-19
5	8-9	10-11	12-13	14-15	16-17	18-19	20-21
6	10-11	12-13	14-15	16-17	18-19	20-21	22-23

Note. Age groups without shading were not included in analyses. Age groups with light grey shading were included in "children" (6-11 years) analyses and BMI was parental report. Age groups with dark grey shading were included in "adolescents" (12-17 years) analyses and BMI was self-report.

initial population from which the sample was drawn (i.e., Canadian children aged 0-11 years in 1994/95).

Observations with missing or incomplete information on body mass index, first language, or socioeconomic status were excluded using listwise deletion. Youth with missing or incomplete information on generation of immigration or race were also excluded using listwise deletion. This exclusion process ensured that the same number of youth were included in sequential models (important for model fit indices), but did not require each youth to have an observation at each cycle. After excluding cases with missing data, the final sample yielded 13,657 children aged 6-11 years and 10,467 adolescents aged 12-17 years. Table 2 provides further information on missing data.

Measures

Table 3 depicts an overview of the measured constructs, the NLSCY variables used in the study, the person of interest (who the information pertains to), when the information was collected, and the informant (who reported the information).

Generation of immigration. Youth were classified into one of five generations of immigrants: first-generation immigrants, second-generation immigrants, mixed-generation immigrants, third-generation or higher immigrants, and non-immigrants (Aboriginal peoples). They were categorized based on the parent's country of birth, the spouse's country of birth, and the child's country of birth, as reported by the parent and their spouse in Cycle 1. First-generation immigrants were defined as children who were born in a country other than Canada, regardless of parent and spouse's place of birth. Second-generation immigrants were defined as children who were born in Canada, with both parent and spouse born in a country other than Canada, or parent born in another

Table 2

Missing Data

	Age group	
	6-11	12-17
Total number of youth	18,996	13,250
Excluded youth	5,339	2,783
Missing generation of immigration	647	396
Missing race	4203	463
Total number of observations	39,987	29,245
Excluded observations	7,007	9,723
Missing BMI	6,410	9,049
Missing first language	578	373
Missing education	416	790
Missing income	23	90
Youth included in analyses	13,657	10,467
Completed at least one cycle	13,657	10,467
Completed at least two cycles	9,859	5,998
Completed at least three cycles	5,010	2,195
Observations included in analyses	28,654	19,132

Table 3

Measures Included in Analyses

Construct	NLSCY Variable	Person of interest	Cycle reported	Informant
Generation of immigration	Country of birth	Parent	Cycle 1	Parent
	Country of birth	Spouse	Cycle 1	Spouse
	Country of birth	Child	Cycle 1	Parent
Ethnicity/Race	Race	Child	Cycle 2	Parent
Acculturation	First language	Child	Cycle 1	Parent
Socioeconomic Status	Years of education	Parent	Cycles 1-7	Parent
	Income	Household	Cycles 1-7	Parent/Spouse
Body mass index	Height	Child	Cycles 1-6	Parent
	Weight	Child	Cycles 1-6	Parent
	Height	Adolescent	Cycles 2-7	Adolescent
	Weight	Adolescent	Cycles 2-7	Adolescent

country and no spouse listed. Mixed-generation immigrants were defined as children who were born in Canada, with one parent born in Canada and one parent born in another country. Third-generation or higher immigrants (hereafter referred to as third-generation immigrants) were defined as children who were born in Canada, with both parent and spouse born in Canada or parent born in Canada and no spouse listed. Non-immigrants were defined as children with Aboriginal ancestry (First Nations, Inuit, or Métis). Previous studies have similarly used country of birth to define generation of immigration in adolescents (Gordon-Larsen et al., 2003; Popkin & Udry, 1998).

Ethnicity/Race. Race was determined by the parent's response to the question, "How would you best describe this child's race or colour?" in Cycle 2. Forced choice response categories were 1) White, 2) Chinese, 3) South Asian (e.g., East Indian, Pakistani, Punjabi, Sri Lankan), 4) Black (e.g., African, Haitian, Jamaican, Somali), 5) Native/Aboriginal People (e.g., North American Indian, Metis, or Inuit/Eskimo), 6) Arab/West Asian (e.g., Armenian, Egyptian, Iranian, Lebanese, Moroccan) 7) Filipino, 8) South East Asian (e.g., Cambodian, Indonesian, Laotian, Vietnamese), 9) Latin-American, 10) Japanese, 11) Korean, and 12) Other. These response categories were also used in the Canadian Community Health Survey, except Arab and West Asian were separate groups. Youth were grouped: White (1), East Asian (2, 9, 10), South East Asian (7, 8), South Asian (3), Black (4), Aboriginal (5), Other (6, 9, 12). Groups were aggregated according to geographic and cultural proximity (similar groupings used in Tremblay et al., 2005), as well as to avoid small group sizes and to maintain approximately equal group sizes (excluding White).

Acculturation. Acculturation was defined by parental response to the question, "What is the language that this child first learned at home in childhood and can still understand?" (or "In what language do you speak to the child?" for children who cannot speak yet) in Cycle 1. Response options were: 1) English only, 2) French only, 3) English and French only, 4) English and other, 5) French and other, 6) English and French and other, and 7) neither English nor French. We grouped responses as follows: English and/or French only (1, 2, 3) or Other (4, 5, 6, 7). Language spoken at home (English vs. Other) was included as a self-report acculturation factor in Gordon-Larsen et al.'s (2003) study of overweight in adolescent immigrants to the United States.

Socioeconomic status. Socioeconomic status was measured by two variables in every cycle: household income during the previous 12 months and number of years of education the parent had completed. Household income was derived from open-ended questions answered by the parent and their spouse about various sources of income (e.g., wages and salary, self-employment, social assistance). Parental years of education was derived by recoding two forced choice questions: years of elementary and high school, and highest level of education attained beyond high school. (Note that both household income and years of education were derived by NLSCY analysts.) Household income and parental education are commonly used to measure socioeconomic status and have been used previously in studies based on NLSCY data (e.g., Oliver & Hayes, 2008).

Body mass index (BMI). Body mass index was calculated as weight (kg)/height $(m)^2$. For children aged 6-11 years, the parent reported the child's height and weight. Adolescents aged 12-17 years self-reported their height and weight. Height and weight were reported at each cycle. BMI percentiles were derived using age- and sex-specific values from the Centers for Disease Control and Prevention (Kuczmarski et al., 2000). This method assigns percentile values to age- and sex-adjusted BMI Z-scores. Descriptive statistics are also reported in weight status categories, classified according to international sex- and age-specific BMI cut-off points (Cole, Bellizzi, Flegal, & Dietz, 2000). Although measured height and weight are preferred to calculate BMI, parent- and self-reported heights and weights have been used in previous studies (e.g., Tremblay & Willms, 2003). Compared to measured height and weight, youth self-reports tend to lead to an underestimate of overweight and obesity, while parent-reports tend to lead to an overestimate of overweight and obesity (Shields, 2006).

Analytical Strategy

Multilevel (or hierarchical) modelling techniques were used to fit regression models to the longitudinal data. These models allow for dependency between repeated observations from the same individual and do not require each individual to have an observation at each cycle. To assess the influence of generation of immigration and other risk factors on youth's BMI percentiles, a two-level model was specified in which observations at each time point (level 1) were clustered within individuals (level 2). The level-1 model describes within-individual change over time and the level-2 model assesses whether predictor variables (generation of immigration, acculturation, race/ethnicity, SES, gender, age) are related to between-individual differences in change. Multilevel models were specified using PASW 18.0 software on unweighted data. Separate models were constructed for children and for adolescents.

Seven sequential, a priori defined models were tested for both age groups. Model A was the "null" model, used for comparison with more complex models. Model B was the "base" model that included age, gender, income, and education as standard covariates (control variables) that are commonly used when testing BMI. Model C (base model + generation of immigration) tested hypothesis 1, that generation of immigration would predict BMI. Model D (base model + generation of immigration + age * generation of immigration) tested hypothesis 2, that longitudinal patterns of BMI would differ across generation of immigration. Model E (base model + generation of immigration + race) tested hypotheses 3 and 4, that race would predict BMI and would significantly interact with generation of immigration. Model F (base model + generation of immigration + first language + first language * generation of immigration) tested hypotheses 5 and 6, that first language would predict BMI and would account for some of the relationship between generation of immigration and BMI. Model G was the "best-fitting" model for each age group, which was constructed by including all significant predictors.

Following Statistics Canada's NLSCY data publication guidelines, longitudinal sampling weights were used in all non-hierarchical analyses (i.e., descriptive analyses). Therefore, reported descriptive results are representative of the Canadian population in 1994, when the original cohort was sampled. Coefficients of variation were computed using 1000 bootstrap weights supplied by Statistics Canada in SAS 9.2. These coefficients were used to assess the quality of the estimates obtained using the sampling weights. It is important to use bootstrap weights to obtain variance estimates because these take into account the complex survey design of the NLSCY.

Results

Analyses were conducted on 13,657 children aged 6-11 years and 10,467 adolescents aged 12-17 years. Descriptive statistics for the sample are presented in Table

4. The multi-level models were based on unweighted data and population-representative values were based on weighted data constructed using sampling weights.

Mean BMI percentiles across generation of immigration, stratified by gender and age, are provided in Table 5. Means were calculated using sampling weights and confidence intervals were calculated using bootstrap weights to account for the complex sampling design of the NLSCY. Rates of overweight and obesity across generation of immigration, stratified by gender, are presented in Table 6. Prevalence rates were calculated using sampling weights and confidence intervals were calculated using bootstrap weights. In children aged 6-11 years, Aboriginal and first-generation Canadians had higher overweight and obesity prevalence rates and mean BMI percentiles, while second- and mixed-generation immigrants had lower overweight and obesity prevalence rates and mean BMI percentiles. In adolescents aged 12-17 years, mean BMI percentiles were similar across all generations of immigration, while first-generation immigrants had higher obesity prevalence rates than the other generation groups. Weighted mean BMI percentiles across generation of immigration and age are illustrated in Figure 1.

Results of the multi-level models for children (6-11 years) and adolescents (12-17 years) are provided in Table 7. Seven a priori models were constructed for each age group to test the hypotheses and determine best fitting models. For all models, BMI percentile was the dependent variable. In Model A (null model), an unconditional model with no predictors was used to determine baseline fit statistic estimates. The goodness of fit statistics (-2 log likelihood and Akaike's Information criterion) were used to compare the fit of subsequent models as predictor variables were added sequentially.

Table 4

Descriptive Statistics for Predictors

Predictor	6-11 Unweighted % (*n*)	6-11 Weighted %	12-17 Unweighted % (*n*)	12-17 Weighted %
Gender				
Male	50.3 (6870)	50.8	49.5 (5178)	50.9
Female	49.7 (6786)	49.2	50.5 (5382)	49.1
Age (6-11 / 12-17)				
6 / 12	14.6 (4184)	12.7	20.3 (3785)	17.0
7 / 13	13.3 (3798)	12.9	21.2 (3957)	19.9
8 / 14	17.4 (4988)	16.5	17.6 (3293)	17.5
9 / 15	15.8 (4533)	16.7	16.0 (2988)	17.4
10 / 16	20.3 (5803)	20.6	13.2 (2459)	14.6
11 / 17	18.7 (5348)	20.7	11.8 (2198)	13.6
Generation				
First	1.4 (193)	3.2	1.4 (143)	3.2
Second	4.1 (558)	9.8	3.8 (401)	8.9
Mixed	6.8 (931)	9.7	7.0 (729)	9.9
Third	82.4 (11255)	73.0	82.7 (8654)	73.5
Aboriginal	5.3 (720)	4.5	5.1 (533)	4.5
Race				
White	93.4 (12756)	88.3	94.1 (9838)	89.4
East Asian	0.9 (126)	2.3	0.9 (91)	2.1
South Asian	0.7 (90)	1.3	0.7 (75)	1.3
South East Asian	0.8 (105)	1.9	0.7 (75)	1.8
Black	0.7 (99)	1.7	0.7 (70)	1.6
Aboriginal	2.2 (302)	1.7	1.8 (92)	1.5
Other	1.3 (175)	2.8	1.1 (119)	2.3
First language				
English/French	96.5 (13171)	92.3	96.9 (10139)	93.3
Other	3.5 (483)	7.7	3.1 (321)	6.7
	M (SD)	*M (SD)*	*M (SD)*	*M (SD)*
Household income (in thousands)	59.45 (41.97)	64.02 (48.20)	74.35 (53.11)	79.77 (59.57)
Years of education	12.82 (2.13)	12.94 (2.19)	13.28 (2.26)	13.39 (2.33)

Note. Gender, generation, race, and first language frequencies are based on number of youth, while age frequencies are based on the number of observations. Household income and years of education are grand means across all observations.

Table 5

Mean BMI Percentiles (± 95% Confidence Interval) by Gender, Generation of Immigration, and Age

	Age in years											
Generation	6	7	8	9	10	11	12	13	14	15	16	17
						Males						
First	70.14	82.54	56.28	75.22	64.53	68.53	43.16	71.44	59.68	41.30	72.24	46.19
	(±18.81)	(±14.73)	(±16.57)	(±18.84)	(±15.96)	(±13.65)	(±13.49)	(±14.67)	(±22.53)	(±21.28)	(±20.58)	(±23.73)
Second	69.97	56.51	62.71	61.74	65.19	61.47	58.98	52.85	59.38	57.55	62.44	59.72
	(±11.94)	(±13.43)	(±10.39)	(±11.09)	(±7.68)	(±9.79)	(±11.77)	(±8.68)	(±8.56)	(±10.37)	(±12.59)	(±9.41)
Mixed	52.70	49.98	54.12	57.57	58.74	58.03	60.33	59.66	55.66	62.16	51.92	58.01
	(±8.28)	(±12.81)	(±8.16)	(±8.13)	(±7.17)	(±5.59)	(±6.16)	(±5.99)	(±6.47)	(±8.19)	(±9.57)	(±8.22)
Third	60.34	61.81	62.38	62.02	60.63	59.45	58.77	59.29	58.68	57.59	59.71	56.00
	(±2.68)	(±2.74)	(±2.24)	(±2.39)	(±1.94)	(±2.05)	(±2.20)	(±2.17)	(±2.49)	(±2.35)	(±2.20)	(±2.94)
Aboriginal	54.42	66.09	65.73	68.56	65.79	67.04	59.55	63.51	57.15	56.94	56.38	51.58
	(±10.07)	(±9.69)	(±7.28)	(±8.73)	(±7.13)	(±6.14)	(±7.12)	(±7.03)	(±8.01)	(±8.14)	(±11.06)	(±11.06)
						Females						
First	86.47	58.42	82.21	60.26	50.01	56.35	46.43	54.48	53.12	57.48	68.03	50.20
	(±14.08)	(±23.60)	(±13:43)	(±15.79)	(±14.30)	(±16.54)	(±20.20)	(±23.37)	(±15.22)	(±22.61)	(±18.16)	(±14.14)
Second	56.55	51.99	61.14	46.57	59.95	49.38	53.69	59.90	58.31	48.80	58.36	41.15
	(±14.70)	(±12.68)	(±11.24)	(±11.94)	(±9.05)	(±8.46)	(±7.02)	(±8.02)	(±6.05)	(±12.86)	(±11.63)	(±13.76)
Mixed	64.47	52.24	57.87	57.44	59.82	54.98	58.36	56.19	56.00	55.64	50.57	49.57
	(±7.85)	(±8.31)	(±6.85)	(±7.25)	(±6.16)	(±5.89)	(±7.19)	(±5.86)	(±6.96)	(±6.61)	(±7.30)	(±10.81)
Third	61.02	59.75	59.68	58.21	57.35	53.98	54.90	54.52	55.83	54.53	53.75	54.01
	(±2.52)	(±2.62)	(±2.37)	(±2.22)	(±2.00)	(±2.00)	(±2.16)	(±2.08)	(±2.41)	(±2.32)	(±2.30)	(±2.92)
Aboriginal	61.76	69.27	59.88	62.47	60.27	53.36	54.98	60.08	52.85	59.08	49.50	62.28
	(±14.49)	(±13.47)	(±12.63)	(±10.61)	(±9.46)	(±8.91)	(±10.07)	(±7.35)	(±7.78)	(±11.06)	(±9.94)	(±15.94)

Note. BMI was calculated based on parent-report of height and weight for 6-11 years and based on self-report of height and weight for 12-17 years. BMI percentiles were derived using CDC age- and sex-specific values (Kuczmarski et al., 2000).

Table 6

Prevalence of Overweight and Obesity Status (with 95% Confidence Intervals) by Gender and Generation of Immigration

	6-11				12-17			
Generation	Mean BMI percentile	% normal	% overweight	% obese	Mean BMI percentile	% normal	% overweight	% obese
Males								
First	69.82 (±8.39)	38.9 (±10.42)	29.0 (±10.52)	32.1 (±13.92)	56.70 (±12.59)	71.1 (±15.98)	16.1 (±10.08)	12.8 (±13.68)
Second	63.10 (±4.99)	52.1 (±5.97)	27.9 (±5.67)	20.0 (±5.54)	58.47 (±5.73)	73.7 (±6.95)	18.7 (±5.95)	7.6 (±4.02)
Mixed	55.89 (±3.92)	62.5 (±5.71)	25.5 (±4.61)	12.0 (±3.12)	58.29 (±3.52)	78.2 (±5.99)	16.4 (±5.11)	5.5 (±2.99)
Third	61.03 (±1.22)	56.9 (±1.60)	28.2 (±1.37)	15.0 (±3.41)	58.43 (±1.36)	74.1 (±1.90)	20.3 (±1.60)	5.5 (±0.79)
Aboriginal	65.19 (±3.75)	50.9 (±5.21)	30.1 (±4.29)	19.1 (±4.41)	57.87 (±4.66)	75.2 (±6.35)	18.2 (±5.48)	6.6 (±3.06)
Females								
First	61.47 (±8.81)	46.8 (±11.68)	29.5 (±13.44)	23.7 (±9.04)	55.58 (±11.15)	71.9 (±14.09)	16.2 (±15.61)	11.9 (±9.93)
Second	55.04 (±6.22)	57.1 (±8.17)	24.6 (±5.56)	18.3 (±6.70)	53.44 (±5.86)	81.7 (±6.99)	13.2 (±5.29)	5.1 (±4.13)
Mixed	57.49 (±3.44)	61.8 (±4.54)	25.2 (±11.59)	13.0 (±3.39)	54.48 (±4.39)	82.4 (±5.16)	13.3 (±4.67)	4.2 (±2.61)
Third	57.99 (±1.21)	58.3 (±1.43)	27.0 (±3.73)	14.7 (±1.10)	54.63 (±1.40)	82.5 (±1.47)	13.8 (±1.25)	3.8 (±0.69)
Aboriginal	60.33 (±5.57)	52.1 (±6.43)	30.9 (±6.38)	17.0 (±4.35)	56.49 (±7.06)	81.3 (±6.00)	13.8 (±4.75)	4.9 (±3.19)

Note. BMI was calculated based on parent-report of height and weight for 6-11 years and based on self-report of height and weight for 12-17 years. BMI percentiles were derived using CDC age- and sex-specific values (Kuczmarski et al., 2000) and weight status categories were derived according to international sex- and age-specific BMI cut-off points (Cole, Bellizzi, Flegal, & Dietz, 2000).

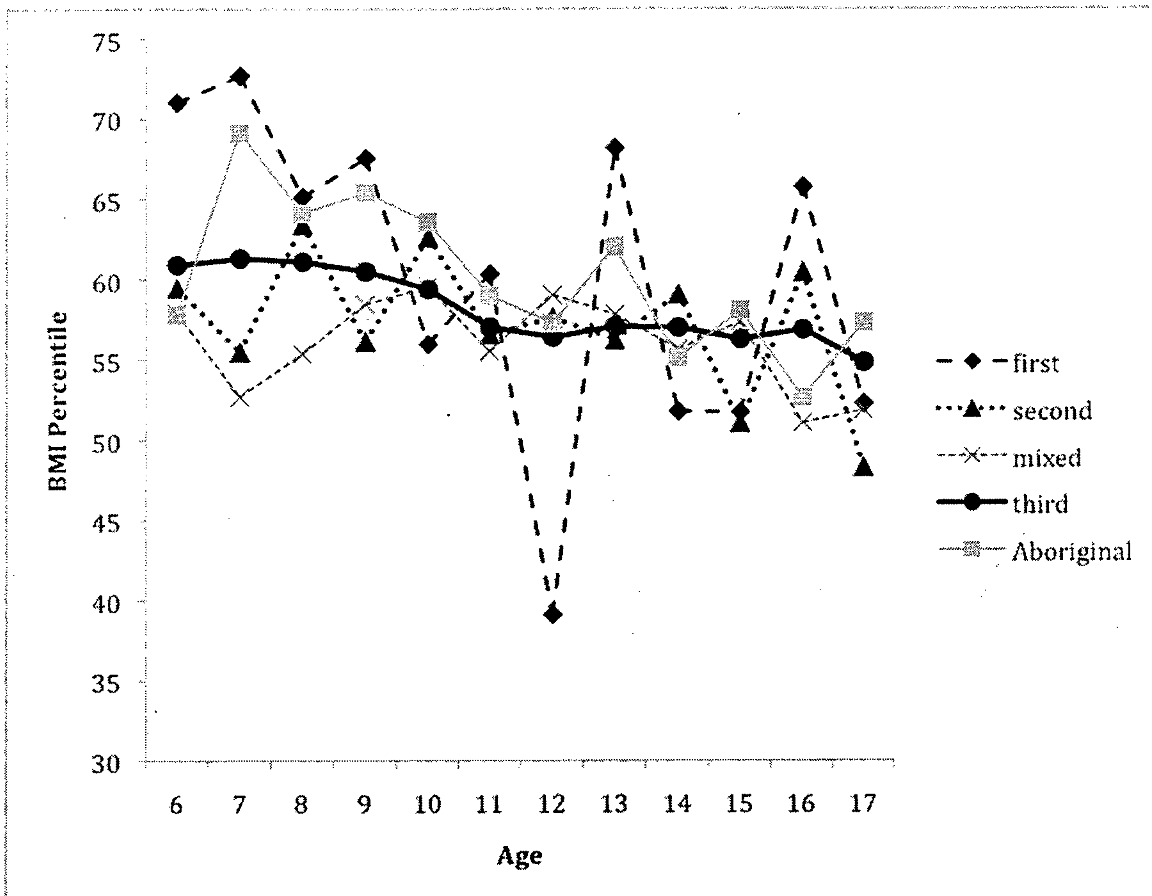

Figure 1. Mean BMI percentile by generation of immigration and age.

Table 7

Multi-level Models

	6-11				12-17			
	Estimate	SE	*t (F)*	*p*	Estimate	SE	*t (F)*	*p*
Model A: Null								
Intercept	61.32	0.24	259.40	< .001	58.31	0.26	227.41	< .001
Fit statistics	-2LL = 279 254.75; AIC = 279 262.75				-2LL = 172 675.84; AIC = 172 683.84			
Model B: Base (Gender, Age, Income, Education)								
Gender			(58.35)	(< .001)			(62.54)	(< .001)
Male	3.59	.47	7.64	< .001	4.03	0.51	7.91	< .001
Female	-	-	-	-	-	-	-	-
Age 6-11 12-17			(11.42)	(< .001)			(3.71)	(.002)
6 12	2.11	0.65	3.23	.001	-0.92	0.66	-1.41	.16
7 13	2.51	0.62	4.07	< .001	0.74	0.55	1.35	.18
8 14	3.38	0.62	5.42	< .001	0.36	0.66	0.54	.59
9 15	3.74	0.55	6.83	< .001	1.13	0.51	2.23	.03
10 16	2.10	0.61	3.62	< .001	-0.41	0.71	-0.58	.56
11 17	-	-	-	-	-	-	-	-
Income	-.02	.005	-3.21	.001	-0.01	0.004	-3.23	.001
Education	-..77	.11	-7.00	< .001	-0.51	0.11	-4.85	< .001
Fit statistics	-2LL = 279 050.37; AIC = 279 074.37				-2LL = 172 549.45; AIC = 172 573.45			
Model C: Base + Generation								
Generation			(6.94)	(< .001)			(3.16)	(.01)
First	-2.42	2.03	-1.24	.21	-0.41	2.19	-0.19	.85
Second	-2.51	1.20	-2.07	.04	-2.83	1.34	-2.11	.04
Mixed	-2.32	0.92	-2.53	0.1	-2.21	1.01	-2.20	.03
Aboriginal	4.12	1.05	3.77	< .001	2.03	1.17	1.74	.08
Third	-	-	-	-	-	-	-	-
Fit statistics	-2LL = 279 022.65; AIC = 279 054.65				-2LL = 172 536.82; AIC = 172 568.82			
Model D: Base + Generation + Generation x Age								
Generation x Age			(1.16)	(.28)			(1.29)	(.18)
Fit statistics	-2LL = 278 999.56; AIC = 279 071.56				-2LL = 172 511.10; AIC = 172 583.10			

Model E: Base + Generation + Race								
Race			(4.70)	(< .001)			(2.20)	(.04)
East Asian	-4.69	2.64	-1.77	.08	-8.25	2.92	-2.82	.005
South East Asian	5.70	3.10	1.84	.07	1.55	3.27	0.47	.64
South Asian	-2.97	2.88	-1.03	.30	3.57	3.26	1.10	.27
Black	2.50	2.86	0.87	.38	0.28	3.22	0.09	.93
Aboriginal	6.31	1.86	3.40	.001	0.11	2.13	0.05	.96
Other	6.16	2.32	2.66	.008	4.01	2.54	1.58	.12
White	-	-	-	-	-	-	-	-
Fit statistics	-2LL = 278 994.46; AIC = 279 038.46				-2LL = 172 523.61; AIC = 172 567.61			
Model F: Base + Generation + First Language + Generation x First Language								
First Language			(1.76)	(.19)			(1.90)	(.17)
English/French	6.63	3.09	2.15	.03	0.21	3.59	0.06	.95
Other	-	-	-	-	-	-	-	-
Generation x First Language			(3.77)	(.005)			(.90)	(.46)
First x English/French	-4.13	5.13	-0.81	.42	-2.47	5.61	-0.44	.66
Second x English/French	-3.85	3.91	-0.99	.33	2.19	4.47	0.49	.63
Mixed x English/French	-15.36	4.98	-3.09	.002	-4.76	6.26	-0.76	.45
Aboriginal x English/French	-24.18	8.94	-2.71	.007	-14.40	11.22	-1.28	.20
Third x English/French	-	-	-	-	-	-	-	-
Fit statistics	-2LL = 278 910.13; AIC = 278 952.13				-2LL = 172 507; AIC = 172 549.14			
Model G: Best Fit (Gender, Age, Education, Income, Generation, Race, First Language, Generation x First Language)					Model G: Best Fit (Gender, Age, Education, Income, Generation, Race)			
Gender			(58.72)	(< .001)			(63.04)	(< .001)
Male	3.59	0.47	7.66	< .001	4.05	0.51	7.94	< .001
Female	-	-	-	-	-	-	-	-
Age 6-11 12-17			(11.63)	(< .001)			(3.71)	(.002)
6 12	2.17	0.65	3.32	.001	-0.91	0.66	-1.39	.17
7 13	2.59	0.62	4.29	< .001	0.76	0.55	1.38	.17
8 14	3.42	0.62	5.49	< .001	0.36	0.66	0.54	.59
9 15	3.77	0.55	6.88	< .001	1.14	0.51	2.25	.02
10 16	2.21	0.61	3.65	.001	-0.41	0.71	-0.59	.56
11 17	-	-	-	-	-	-	-	-
Income	-0.01	0.005	-2.67	.007	-0.01	0.004	-3.05	.002
Education	-0.72	0.11	-6.53	< .001	-0.49	0.11	-4.58	< .001

Generation			(3.26)	(.01)			(2.64)	(.03)
First	0.81	4.33	0.19	.85	-0.69	2.31	-0.30	.77
Second	1.63	3.71	0.44	.66	-3.03	1.58	-1.91	.06
Mixed	12.13	4.89	2.48	.01	-2.24	1.02	-2.20	.03
Aboriginal	22.02	9.06	2.43	.04	1.96	1.30	1.51	.13
Third	-	-	-	-	-	-	-	-
Race			(4.38)	(< .001)			(2.20)	(.04)
East Asian	-4.16	2.69	-1.55	.12	-8.25	2.92	-2.82	.005
South East Asian	6.22	3.11	2.00	.046	1.55	3.27	0.47	.64
South Asian	-2.40	2.91	-0.82	.41	3.57	3.26	1.10	.27
Black	2.24	2.86	0.79	.43	0.28	3.22	0.09	.93
Aboriginal	5.79	1.89	3.08	.002	0.11	2.13	0.05	.96
Other	6.56	2.35	2.80	.005	4.01	2.54	1.58	.12
White	-	-	-	-	-	-	-	-
First Language			(0.82)	(.37)				
English/French	6.49	3.09	2.10	.04				
Other	-	-	-	-				
Generation x First Language			(3.26)	(.01)				
First x English/French	-3.15	5.16	-0.61	.54				
Second x English/French	-3.89	3.94	-0.99	.32				
Mixed x English/French	-15.23	4.98	-3.06	.002				
Aboriginal x English/French	-20.13	9.01	-2.23	.03				
Third x English/French	-	-	-	-				
Fit statistics	-2LL = 278 883.86; AIC = 278 937.86				-2LL = 172 523.61; AIC = 172 567.61			

Note. SE = standard error; -2LL = -2 log likelihood; AIC = Akaike's Information Criterion.

In Model B (base model), a model including standard covariates (gender, age, socioeconomic status) was tested. Cohort was not a significant predictor of BMI percentile in either children or adolescents; therefore, it was not included in the base model. Gender * age interaction was significant for children, but results did not change when all models were run with this interaction term. In order to have consistent covariate base models in each age group, gender * age was not included in the base model. Because the regression coefficients of the standard covariates remained significant and the estimates were largely similar in all subsequent models, they are only reported for the base and final models in Table 7. Results showed that males had higher mean BMI percentiles than females in both age groups. In addition, years of age significantly predicted BMI percentile. Finally, higher household income and more years of education were associated with lower BMI percentile in children and adolescents.

Hypothesis 1, that mean BMI percentile would increase from first- to second- to mixed- to third-generation immigrants to Aboriginals, was tested in Model C (base model + generation of immigration). Generation of immigration was a significant predictor of BMI percentile for both age groups. For children (6-11 years), mean BMI percentiles were (from lowest to highest): first-generation (M = 58.90 percentile), second-generation (M = 58.94 percentile), mixed-generation (M = 59.09 percentile), third-generation (M = 61.46 percentile), and Aboriginal (M = 65.48 percentile). For adolescents (12-17 years), mean BMI percentiles were (from lowest to highest): second-generation (M = 55.71 percentile), mixed-generation (M = 56.31 percentile), first-generation (M = 58.13 percentile), third-generation (M = 58.54 percentile), and Aboriginal (M = 60.57 percentile).

Hypothesis 2, that the weight disparity between first- and second-generation immigrants would decrease with time, was tested in Model D (base model + generation of immigration + age * generation of immigration. This interaction was not significant for either age group; therefore, the longitudinal patterns of BMI were similar across generations of immigration within each age group.

Hypothesis 3, that East, South East, and South Asian ethnicities/races would have lower mean BMI percentiles than White, while Black, Aboriginal, and Other would have higher mean BMI percentiles, was tested in Model E (base model + generation of immigration + race). Race was found to be a significant predictor of BMI percentile in both age groups. In children, East Asian (M = 55.26 percentile) and South Asian (M = 56.98 percentile) groups had lower mean BMI percentiles than White (M = 59.95 percentile), while South East Asian (M = 65.65 percentile), Black (M = 62.44 percentile), Native (M = 66.26 percentile), and Other (M = 66.11 percentile) groups had higher mean BMI percentiles. In adolescents, East Asian had the lowest mean (M = 49.49 percentile), followed by White (M = 57.74 percentile), Black (M = 58.02 percentile), and Native (M = 57.85 percentile), with South East Asian (M = 59.28 percentile) and South Asian (M = 61.32 percentile) groups having the highest mean BMI percentiles.

Hypothesis 4, that the relationship between generation of immigration and BMI would be stronger for certain ethnic/racial groups, was tested by adding a race * generation of immigration interaction to Model 5 (not shown). This interaction was not significant for either age group.

Hypothesis 5, that speaking a first language other than English or French would be associated with lower mean BMI percentile, was tested by Model 6 (base model +

generation of immigration + first language + generation of immigration * first language). In children, the effect of first language was not significant, but generation of immigration * first language significantly predicted BMI percentile. Specifically, in first-, second-, and third-generation children, speaking English or French as a first language was associated with a higher mean BMI percentile (*M* = 60.09 percentile, *M* = 60.16 percentile, and *M* = 61.52 percentile, respectively) than speaking another language (*M* = 57.59 percentile, *M* = 57.38 percentile, and *M* = 54.89, respectively). Conversely, in mixed-generation and Aboriginal children, speaking English or French as a first language was associated with lower BMI percentile (*M* = 58.61 percentile and *M* = 65.21 percentile, respectively) than speaking another language (*M* = 67.35 percentile and *M* = 82.76 percentile, respectively). Neither the main effect of first language nor the generation * first language interaction were significant in adolescents.

Hypothesis 6, that the effect of generation of immigration would decrease with the addition of first language, was tested by adding first language to the model without the generation * first language interaction term (not shown). It was found that the effect of generation of immigration did not decrease when the acculturation variable was added to the model.

Finally, Model G was the full model for both age groups. This model included the base model plus the predictors that were significant when they were added individually in Models C to F. For children, gender, age, income, education, generation, race, and generation * first language were included in the full model, which was the best-fitting model (-2 log likelihood = 278,883.86; Akaike's Information Criterion = 278,937.86). For adolescents, gender, age, income, education, generation, and race were included in the full model, which was the best-fitting model (-2 log likelihood = 172,523.61; Akaike's Information Criterion = 172,567.61).

Discussion

The primary contribution of this study was the examination of the impact of generation of immigration on overweight in Canadian youth. It was hypothesized that overweight would be lowest in the most recent generation of immigration (first-generation), would increase with each additional generation in Canada, and would be highest in non-immigrants (Aboriginal). Generation of immigration was found to predict overweight in children and adolescents. In children, the results partially supported the hypothesis. First-, second-, and mixed-generation immigrants had lower BMI than third-generation immigrants, which had lower BMI than Aboriginal children. However, no differences were observed between the three groups of more recent immigrants. In adolescents, the hypothesized pattern of results was less apparent. As expected, Aboriginal youth had the highest BMI and third-generation immigrants had higher BMI than second- and mixed-generation immigrants. However, first-generation immigrants had a higher BMI than second- and mixed-generations.

The finding that generation of immigration predicts overweight has been previously documented in adolescent immigrants to the United States (Popkin & Udry, 1998) and in adult immigrants to Canada (e.g., McDonald & Kennedy, 2005) and the United States (e.g., Goel et al., 2004). Previous research has shown that foreign-born (i.e., first-generation) immigrants have lower prevalence of overweight than native-born (i.e., second-generation) immigrants. In particular, Popkin and Udry found that first-generation adolescent immigrants had a lower prevalence of overweight than second- or third-generations, and there was no difference between the latter two generations. In contrast, results from the current study showed that first-generation adolescent immigrants had higher BMI than second- or mixed-generation immigrants. Several methodological and measurement differences could account for these findings. First, the countries that were studied (Canada vs. United States) differ in terms of immigration policies and acculturation styles. Given that acculturation factors have been shown to be related to overweight in adolescent immigrants (Gordon-Larsen et al., 2003), it is expected that societal pressures and opportunities to acculturate would influence weight gain in adolescent immigrants. Second, Popkin and Udry (1998) used percentage of overweight as their dependent variable, while the current study used BMI percentiles. Creating BMI categories can exaggerate differences when fluctuations in BMI occur near cut-off points. The continuous measure of overweight using BMI percentiles is more precise. Finally, the American study results were for Asian and Hispanic American immigrants, while the current study examined the impact of generation of immigration across all races. Both child and adolescent results are congruent with previous study findings that Aboriginal youth have a higher prevalence of obesity than non-Aboriginal youth (e.g., Katzmarzyk, 2008).

Longitudinal patterns of overweight across generations of immigrants were also examined. Specifically, it was hypothesized that first-generation immigrants' BMI would increase with additional years in Canada and become more similar to second-generation immigrants. A generation of immigration by age interaction was not observed in either age group. Therefore, BMI trajectories across each age group do not differ between generations of immigrants. However, first-generation immigrants had similar BMI to second- and mixed-generations in children aged 6-11 years, but first-generation had higher BMI than second- and mixed-generations in adolescents aged 12-17 years. In other words, weight relative to second- and mixed-generations was observed in first-generation immigrants from childhood to adolescence. Note that the reporter of height and weight also changed between childhood and adolescents, which may have to the observed differences. This is the first study to examine weight status longitudinally in immigrants, therefore comparable reference studies are not available. However, cross-sectional studies of Canadian adults have reported weight gain in first-generation immigrants with additional years spent in Canada (Cairney & Ostbye, 1998; McDonald & Kennedy, 2005; Tremblay et al., 2005). The longitudinal nature of the current study supports the idea that foreign-born immigrants gain weight relative native-born immigrants with time spent in Canada, rather than the idea that weight differences are due to cohort effects. This idea is further supported by the finding that only first-generation immigrants (not second- or mixed-generation) had a relative increase in BMI from childhood to adolescence. If all three of these generations had shown increases, we may suspect that either puberty or change in reporter of height and weight equalizes BMI across generations. However, it appears that there is something unique occurring with first-generation immigrants. One possibility is that first-generation immigrants may be more likely to undergo culture change due to a greater disparity between original and dominant culture in these youth. This culture change (i.e., adoption of Canadian culture) may lead to weight gain. On the other hand, second- and mixed-generations may undergo less culture change (and therefore have less associated weight gain).

The hypothesis that race would be significantly related to overweight was supported. Specifically, it was hypothesized that Asian groups would have lower BMI percentiles than White, while other races would have higher BMI percentiles. In children, only East and South Asian groups were lower than White, while South East Asian, Black, Native, and Other races were higher. In adolescents, only East Asians had lower BMI than White, while all other races had higher BMI. These results are similar to the 2004 Canadian Community Health Survey, which found that only Southeast/East Asians had lower prevalence of overweight than White youth aged 2 to 17 years (Shields, 2006). The hypothesis that the relationship between generation of immigration and BMI percentile would be stronger for certain ethnic/racial groups was not supported in the current study. Therefore, the observed relationship between generation of immigration and overweight was found to be similar across all racial groups. This is in contrast to the findings in Popkin and Udry (1998), who showed a larger increase in percentage of overweight from first- to second-generation immigrants in Asian compared to Hispanic Americans, and a possible lack of increase in White and Black immigrants (results were not presented). However, the current findings were similar to Tremblay et al.'s (2005) findings, in which each racial group had similar odds of being overweight across non-immigrants, recent immigrants, and long-term immigrants.

In children, generation of immigration moderated the relationship between acculturation factors and overweight. As predicted, speaking English and/or French as a first language was associated with higher BMI than speaking another language in first-, second-, and third-generation immigrants. However, the opposite relationship was observed in mixed-generation and non-immigrants (speaking English and/or French was related to lower BMI). For non-immigrant Aboriginal children, speaking a language other than English or French is likely associated with greater identification with Aboriginal culture. This cultural identification may bring with it some of the dietary and lifestyle practices that place Aboriginal Canadians at risk for obesity (Katzmarzyk, 2008). Alternatively, both off-reserve Aboriginal and mixed-generation immigrant children (with one parent born in Canada and one parent born elsewhere) likely identify with both their heritage culture and the dominant Canadian culture. Speaking a language other than English or French as a first language suggests greater identification with their heritage culture than speaking one of the two national languages. This greater identification with their heritage culture may mean that these children have to navigate between two cultures, which may increase acculturative stress and lead to weight gain through physiological pathways and overeating.

Gordon-Larsen et al. (2003) found a similar effect of acculturation factors in their study of Hispanic immigrant adolescents. They showed that the overall effect of acculturation, measured by language spoken at home and the proportion of foreign-born neighbours, depended on the generation of immigration (foreign- vs. US-born). However, neither individual measure of acculturation significantly predicted overweight alone. In the current study, first language did not significantly predicted BMI percentile in adolescents. It may be that our measure of acculturation (first language) is more relevant in childhood than in adolescence. Alternatively, an additional measure of acculturation may be necessary to reveal an effect in adolescence, as was seen in Gordon-Larsen et al. (2003).

To further investigate the acculturation findings in children, we conducted a post-hoc analysis using a new predictor variable ("language change") that combined first language and language able to conduct a conversation (measured at each cycle). Language change had four levels: 1) first language was English and/or French and still speak this language, 2) first language was English and/or French and another language was learned later, 3) first language was Other and still speak this language, and 4) first language was Other and no longer speak this language. Of particular interest were levels 3 and 4, since these tap into the acculturation process over time. For children, there was a significant interaction between language change and generation of immigration (F = 2.90; $p < .001$). Specifically, mixed-generation immigrants who could still speak their "other" first language had lower mean BMI percentiles than those that could no longer speak it (M = 62.64 percentile vs. M =76.07 percentile). Conversely, first-generation immigrants who could still speak their "other" first language had higher mean BMI percentiles than those that could no longer speak it (M = 61.80 vs. M = 39.89 percentile). In other words, it may be adaptive for mixed-generation immigrant children to retain their first language and for first-generation immigrant children to lose theirs. This may be because mixed-generation immigrant children speak both English and/or French and another language from birth, while first-generation immigrant children may need to learn English or French when they arrive in Canada. These post-hoc findings help to untangle meaning from the first language findings; however small sample sizes preclude definitive conclusions about language change and BMI.

The current study used a nationally representative, longitudinal sample of Canadian children and adolescents, which is a strength of this research. The weighted descriptive findings are representative of the Canadian population from which the original cohort was sampled. In addition, the multilevel modeling findings demonstrate relationships between various predictor variables and overweight in a large, longitudinal sample of youth. Another strength of this study was to contribute to a gap in the literature by examining the relationship between generation of immigration and overweight in Canadian youth. We demonstrated that this relationship exists in Canadian children and adolescents in addition to North American adults and American youth. Furthermore, by dividing youth into five generations, we provided a more detailed analysis of this relationship than previous research. Finally, we showed that the relationship between generation of immigration and overweight remains even when age, gender, SES, race, and acculturation have been accounted for. Overall, this study contributed to literature on the healthy immigrant effect in children and adolescents, which is an understudied area. The current study also examined the relationship between acculturation and overweight, and showed that acculturation is related to overweight in children aged 6-11 years. The finding that this relationship is different across generations of immigration in children increases understanding of the process of weight gain in immigrants. These results evoke questions about the different experience of acculturation, and its impact on overweight, in childhood and in adolescence. Another strength was the longitudinal nature of the study, which allowed for an investigation of BMI trajectories over time. This is an advantage over cross-sectional studies. Finally, as previously mentioned, retaining body mass index as a continuous variable by using BMI percentile as the dependent variable strengthened the precision of the results.

One limitation of this study is the use of parent- and self-reported heights and weights to calculate BMI. These are less accurate and reliable than measured BMI; however, parent- and self-reports have been used previously to document important changes in overweight and obesity in Canadian youth (Tremblay & Willms, 2000). Prevalence rates of overweight and obesity for adolescents in the current study (16.6% and 5.1%) were similar to rates based on adolescent (11-16 years) self-reports from the Canadian component of the 2001/02 Health Behaviour in School-Aged Children Survey (15.0% and 4.6%; Janssen, Katzmarzyk, Boyce, King, & Pickett, 2004). Evidence suggests that parent-reports lead to an overestimation of BMI and youth self-reports lead to an underestimation of BMI (Shields, 2006). The opposite directions of this bias for parent- and self-reports is another reason that these two age groups were kept separate for analyses. The expected bias was found in the current study; parent-reports led to overestimation and self-reports led to underestimation of overweight and obesity compared to results from the 2004 Canadian Community Health Survey, which measured height and weight (Shields). Children (whose parents reported height and weight) in the current study had higher rates of overweight and obesity (27.5%, 15.5% vs. 25.8%, 8.0%), while adolescents (who self-reported height and weight) in the current study had lower rates of overweight and obesity (females = 13.7%, 4.2%; males =19.6%, 6.0% vs. females = 25.8%, 7.4%; males = 32.3%, 11.1%). Therefore, it is important to interpret the current results with this systematic bias in mind. However, parent- and self-reports of height and weight create less bias in mean BMI compared to percentage of overweight or obese (Shields). Therefore, the use of BMI percentiles as the dependent variable in the current study may have minimized the error induced by parent- and self-report.

A second limitation was that the oversampling of rural areas in the NLSCY led to undersampling of first-generation immigrants, even when weights were applied. It is estimated that 15 to 20% of Canadian children are immigrants or refugees, yet less than 2% of the NLSCY sample was not born in Canada. Therefore, the results for the first-generation group are less stable and generalizable. In addition, we were unable to differentiate between country of origin and time since immigration given the small sample size of this group. Similarly, the oversampling of rural areas led to small sample sizes of non-White ethnoracial groups and youth who spoke a language other than English or French as their first language. The current findings suggests that the observed relationships exist, but additional research is needed to confirm these findings. Third, our use of first language as a measure of acculturation may be seen as a limitation. Although language has been used before to measure acculturation, it lacks precision, especially with certain sub-populations (e.g., a French-speaking first-generation immigrant from Haiti). In addition, spoken language is only one facet of culture, and this measure does not tap into subjective differences in acculturation. An additional measure of acculturation, such proportion of immigrant neighbours or an acculturation questionnaire, would help to strengthen the use of first language as an acculturation factor. Fourth, category creation may have influenced results. For instance, the generation of immigration categories were created based on country of birth only. Therefore, it was not possible to distinguish between immigrants, refugees, or those youth who were born in another country for another reason. The acculturation literature defines acculturating groups by three dimensions: voluntariness, movement, and permanence of contact. Ethnic groups (or long-term immigrants) are groups residing in a plural society who have established themselves voluntarily in a new society. Aboriginal peoples are involuntarily involved in the acculturation process and they have not relocated, rather the larger society came to them. There are two types of migrants: immigrants and refugees. Immigrants have voluntarily chosen to leave their country of origin and relocate to a new country. Refugees, on the other hand, have moved involuntarily from one country to another. The final group may be called "sojourners." These are people who have voluntarily relocated to a new country for work or school, but do not plan to remain there permanently. The current study attempted to distinguish between ethnic groups (i.e., higher generations of immigrants), Aboriginal peoples, and migrants (i.e., more recent generations of immigrants); however, immigrants, refugees, and sojouners were all grouped together as "first-generation immigrants," although their acculturation experience is different. It was also assumed that the "person most knowledgeable" and their spouse were the two parents, although the "person most knowledgeable" was not the biological parent in about 3% of observations and the spouse was not the biological parent in about 12% of observations. In addition, having a spouse was not necessary for any categories, except for mixed-generation immigrants (i.e., this was the only generation in which all youth had two "parents"). Finally, exclusion of observations and youth with missing information may have introduced bias into the results. In particular, we had to exclude a large number of children who only participated in Cycle 1 because race was not measured at this cycle.

This study provides many avenues for future research. It will be important to replicate the current results in a Canadian sample with a larger number of first-generation immigrants, non-White youth, and youth that speak languages other than English or French. This could be done by studying large urban centres such as Toronto, Vancouver, or Montreal. In addition, it would be advisable to replicate these results using measured height and weight to decrease bias from self- and parent-report. Future research will facilitate the understanding of the role of acculturation in the relative weight gain of first-generation immigrants from childhood to adolescence. Additional measures of acculturation should be employed in order to better understand this process. For example, it is recommended that, in addition to objective measures of acculturation (i.e., language, cultural composition of the neighbourhood), future studies employ subjective measures of acculturation (i.e., questionnaires) to understand the individual experience of this process. In addition, future study should begin to uncover the process by which acculturation is related to overweight in immigrants. For instance, acculturative stress could be measured to determine whether this is a major pathway toward weight gain. Similarly, cultural practices surrounding eating and food, physical activity, financial resources, and social support may be other important variables that underlie or explain the relationships between acculturation and overweight. Furthermore, additional research on the factors affecting the acculturation process (i.e., original cultural group, type of acculturating group, acculturation style, policies of the receiving society) should be conducted on acculturation in relation to weight gain. Finally, it is important that future research continue to use longitudinal or prospective methods to observe these relationships over time.

In summary, the current study examined the influence of generation of immigration, acculturation, ethnicity/race, and socioeconomic status on overweight in a nationally representative, longitudinal sample of Canadian children and adolescents. Using multi-level modeling, results showed differences in overweight across the generations of immigrants. Of note, first-generation immigrants showed relative weight gain from childhood to adolescence. Using first language as a measure of acculturation, we found that the direction of the relationship between acculturation and BMI depended on the generation of immigration in children. Future research will help to tease apart the relationship between acculturation and BMI across generations of immigration. The implications of these findings are that first-generation immigrant youth may be at risk for weight gain, similar to their adult counterparts. The current study's findings, as well as their limitations, highlight the need for public health research on the health of immigrant youth in Canada. The eventual aim should be to introduce health policy to specifically target recent immigrants with efforts to prevent unhealthy weight gain. Unique intervention and prevention methods for this sub-population would need to take into account the risk factor of acculturation.

References

Beiser, M., Hou, F., Hyman, I., & Tousignant, M. (1998). Growing up Canadian: A study of new immigrant children. *Human Resources Development Canada, W-98-24-E.*

Berry, J. W. (1989). Psychology of acculturation. *Nebraska Symposium on Motivation, 37*, 201-234.

Berry, J. W., & Annis, R. C. (1974). Acculturative stress: The role of ecology, culture and differentiation. *Journal of Cross-Cultural Psychology, 5*, 382-405.

Berry, J. W., Kim, U., Minde, T., & Mok, D. (1987). Comparative studies of acculturative stress. *International Migration Review, 21*, 491-511.

Biddle, N., Kennedy, S., & McDonald, J. T. (2007). Health assimilation patterns amongst Australian immigrants. *Economic Record, 83*, 16-30.

Bjorntorp, P. (2001). Do stress reactions cause abdominal obesity and comorbidities? *Obesity Reviews, 2*, 73-86.

Brunner, E. (1997). Socioeconomic determinants of health: Stress and the biology of inequality. *British Medical Journal, 314*, 1472-1476.

Cairney, J., & Ostbye, T. (1998). Time since immigration and excess body weight. *Canadian Journal of Public Health, 90*, 120-124.

Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: International survey. *British Medical Journal, 320,* 1240-1245.

Dallman, M. F., laFleur, S. F., Pecoraro, N. C., Gomez, F., Houshyar, H., & Akana, S. F. (2004). Minireview: Glucocorticoids – food intake, abdominal obesity, and wealthy nations in 2004. *Endocrinology, 145*, 2633-2638.

Drewsnowski, A., & Specter, S. E. (2004). Poverty and obesity: The role of Energy density and energy costs. *American Journal of Clinical Nutrition, 79*, 6-16.

First Nations Centre. (2005). First Nations Regional Longitudinal Health Survey 2002/03. First Nations Centre at the National Aboriginal Health Organization.

Flynn, M., McNeil, D., Tough, S., Maloff, B., Ford, C., Mutasingwa, D., et al. (2004). Reducing obesity and related chronic disease risk in children and youth: A synthesis of evidence with 'best practice' recommendations. *Project #6795-15-2002/544004.* Health Canada.

Goel, M. S., McCarthy, E. P., Phillips, R. S., & Wee, C. C. (2004). Obesity among US immigrant subgroups by duration of residence. *Journal of the American Medical Association, 292*, 2960-2867.

Gordon-Larsen, P., Mullan Harris, K., Ward, D. S., & Popkin, B. M. (2003). Acculturation and overweight-related behaviors among Hispanic immigrants to the US: the National Longitudinal Study of Adolescent Health. *Social Science & Medicine, 57*, 2023-2034.

Graves, T. D. (1967). Psychological acculturation in a tri-ethnic community. *Southwestern Journal of Anthropology, 23*, 337-350.

Haas, J. S., Lee, L. B., Kaplan, C. P., Sonneborn, D., Phillips, K. A., & Liang, S. (2003). The association of race, socioeconomic status and health insurance status with the prevalence of overweight among children and adolescents. *American Journal of Public Health, 93*, 2105-2110.

Hyman, I. (2001). Immigration and health. *Working Paper 01-05.* Ottawa: Health Canada.

Iwasaki, Y., Bartlett, J., & O'Neil, J. (2004). An examination of stress among Aboriginal women and men with diabetes in Manitoba, Canada. *Ethnicity and Health, 9*, 189-212.

Janssen, I., Katzmarzyk, P. T., Boyce, W. F., King, M. A., & Pickett, W. (2004). Overweight and obesity in Canadian adolescents and their associations with dietary habits and physical activity patterns. *Journal of Adolescent Health, 35,* 360-367.

Katzmarzyk, P. T. (2008). Obesity and physical activity among Aboriginal Canadians. *Obesity, 16*, 184-190.

Kennedy, S., McDonald, J. T., & Biddle, N. (2006). The healthy immigrant effect and immigrant selection: evidence from four countries. *SEDAP Research Paper, 164.*

Kirchengast, S., & Schober, E. (2006). To be an immigrant: A risk factor for developing overweight and obesity during childhood and adolescence? *Journal of Biosocial Science, 38*, 695-705.

Kromeyer-Hausschild, K., Wabitsch, M., Kunze, D., Geller, F., Geiß, H.C., Hesse, V. et al. (2001) Perzentile für den Body mass Index für das Kindes- und Jugendalter unter Heranziehung verschiedener deutscher Stichproben. *Monatsschrift Kinderheilkunde, 149,* 807–818.

Kuczmarski, R.J., Ogden, C.L., Guo, S.S., Grummer-Strawn, L. M., Flegal, K. M., Mei, Z., et al. (2000). CDC growth charts for the United States: Methods and development. National Center for Health Statistics. *Vital Health Statistics, 11,* 246.

MacMillan, H. L., McMillan, A. B., Offord, D. R., & Dinlge, J. L. (1996). Aboriginal health. *Canadian Medical Association Journal, 155*, 1569-1578.

McDonald, J. T., & Kennedy, S. (2005). Is migration to Canada associated with unhealthy weight gain? Overweight and obesity among Canada's immigrants. *Social Science and Medicine, 61*, 2469-2481.

McLaren, L. (2007). Socioeconomic status and obesity. *Epidemiologic Reviews, 29*, 29-48.

Monteiro, C. A., Moura, E. C., Conde, W. L., & Popkin, B. M. (2004). Socioeconomic status and obesity in adults in developing countries: A review. *Bulletin of the World Health Organization, 82*, 940-946.

Ng, C., Marshall, D., & Willows, N. D. (2006). Obesity, adiposity, physical fitness and activity levels in Cree children. *International Journal of Circumpolar Health, 65*, 322-330.

Oliver, L. N., & Hayes, M. V. (2005). Neighbourhood socio-economic status and the prevalence of overweight Canadian children and youth. *Canadian Journal of Public Health, 96*, 415-420.

Oliver, L. N., & Hayes, M. V. (2008). Effects of neighbourhood income on reported body mass index: Am eight year longitudinal study of Canadian children. *BioMed Central Public Health, 8*, 16-25.

Perez, C. E. (2002). Health status and health behaviour among immigrants. *Health Reports, 13*(Suppl.), 1-13.

Popkin, B. M., & Udry, J. R. (1998). Adolescent obesity increases significantly in second and third generation U.S. immigrants: The National Longitudinal Study of Adolescent Health. *Journal of Nutrition, 128*, 701-706.

Redfield, R., Linton, R., & Herskovits, M. J. (1936). Memorandum for the study of acculturation. *American Anthropologist, 38*, 149-152.

Shields, M. (2006). Overweight and obesity among children and youth. *Health Reports, 17*, 27-42.

Singh, G., & Siahpush, M. (2002). Ethnic-immigrant differentials in health behaviors, morbidity, and cause-specific mortality in the United States: An analysis of two national data bases', *Human* Biology, 74, 83–109.

Sobal, J., & Stunkard, A. J. (1989). Socioeconomic status and obesity: A review of the literature. *Psychological Bulletin, 105*, 260-275.

Statistics Canada, & Human Resources Development Canada. (1995). National Longitudinal Survey of Children: Overview of survey intruments for 1994-95 data collection, Cycle 1. Catalogue no. 89F0078XIE.

Sundquist, J., & Winkleby, M. A. (1998). Cardiovascular risk factors in Mexican American Adults: A transcultural analysis of NHANES III, 1988-1994. *American Journal Public Health, 89*, 723-730.

Swinburn, B., Egger, G., & Raza, F. (1999). Dissecting obesogenic environments: The development and application of a framework for identifying and prioritizing environmental interactions for obesity. *Preventive Medicine, 29*, 563-570.

Townsend, P., Davidson, N., & Whitehead, M. (1990). *Inequalities in health: The Black report; the health divide*. London: Penguin.

Tremblay, M. S., Perez, C. E., Ardem, C. I., Bryan, S. I., & Katzmarzyk, P. T. (2005). Obesity, overweight, and ethnicity. *Health Reports, 16*, 23-34.

Tremblay, M. S. & Willms, J. D. (2000). Secular trends in the body mass index of Canadian children. *Canadian Medical Association Journal, 163*, 1429-1433.

Yang, Y. (2001). Cross-national comparison of childhood obesity: The epidemic and the relationship between obesity and socioeconomic status. *International Journal of Epidemiology, 30*, 1129-1136.

Young, D. E., Spitzer, D. L., & Pang. F. (1999). Understanding the health care needs of Canadian immigrants. *Report for the Prairie Centre for Excellence on Immigration and Integration.*

Young, T. K., Dean, H. J., Flett, B., & Wood-Steiman, P. (2000). Childhood obesity in a population at high risk for type 2 diabetes. *Journal of Pediatrics, 136*, 365-369.