Published in final edited form as:

Eur J Epidemiol. 2009 ; 24(10): 611–623. doi:10.1007/s10654-009-9373-4.

CONVERGENCE OF BODY MASS INDEX OF IMMIGRANTS TO THE CANADIAN-BORN POPULATION: EVIDENCE FROM THE NATIONAL POPULATION SURVEY (1994–2006)

Amélie Quesnel-Vallée,

Department of Sociology, Department of Epidemiology, Biostatistics, McGill University

Maninder Singh Setia,

Department of Epidemiology, Biostatistics, and Occupational Health, McGill University, Montreal, Canada

Michal Abrahamowicz,

Department of Epidemiology, Biostatistics, and Occupational Health, McGill University, Montreal, Canada

Pierre Tousignant, and

Department of Epidemiology, Biostatistics, and Occupational Health, McGill University, Montreal, Canada

John Lynch

School of Health Sciences, University of South Australia, Adelaide, Australia

Introduction

Canada is one of the major immigrant countries in the world, and admits more than 200,000 ethnically diverse new permanent residents every year.²⁴³ Partly due to mandatory medical examinations, and also ostensibly because of selection effects (younger, healthier people are more likely to undertake migration as economic class immigrants), at the time of entry new immigrants have fewer chronic conditions and better average health compared with the Canadian-born population.^{5, 243–245} This ‘healthy immigrant effect’ has also been described in other countries (United States and Australia).^{6–7} Previous Canadian studies on immigrant health demonstrate that duration of stay in Canada is an important predictor of poor health among immigrant - recent immigrants had better self-rated and functional health than did those who had immigrated more than 10 years earlier.^{5, 198}

People migrate for various reasons - better economic opportunities, safer political systems, flight from regions of conflict and war, or to experience new cultures and societies.²⁴⁴ Whatever the reason, immigration can be a stressful process. It has been shown that on arrival new immigrants in Canada are more likely to be poor than Canadian born individuals^{9, 87}; this may have an effect on their access to health resources as well as to leisure activities such as exercising in the gym or practicing sports. Even though immigrants may have lower income on arrival, with time they tend to find suitable jobs and their incomes increase, sometimes even faster than the host populations.⁸⁸ With time in adopted country, immigrants may also start adopting native behaviours – diet related, smoking, drinking, and

exercise.^{92, 96, 246} Beiser has termed these as ‘the resettlement stress paradigm’ and ‘the convergence paradigm’ respectively.⁴ These resulting changes in living conditions, dietary habits, exercise, and in financial means may potentially impact the health of these immigrants, including an increase in their body mass index (BMI).¹²⁵

Thus with an increasing length of stay in the new adopted country, immigrants may experience obesity and their BMIs may converge towards those of the host populations.^{6, 105, 247} This increase in BMI may have important cardiovascular and metabolic complications, thus making it an important public health issue.¹²⁸ In support for these hypotheses, previous Canadian studies have shown that the BMI of immigrants increases with additional years in their adopted country.^{109, 113, 117, 245} Though these are important contributions, estimates for these analyses were from cross-sectional, pooling cross-sectional data, or synthetic cohort data. Thus, relatively little is known about the individual longitudinal changes in BMI. Certain ethnic minority immigrants may generally have lower BMIs compared with the white immigrants^{248–249}; however, ethnic minorities also tend to have lower physical activity compared with white immigrants¹²³ - this may influence the changes in BMI in these immigrant groups. Moreover, as previously mentioned, many factors that influence BMI (such as economic conditions, dietary habits, exercise) may change over time in individuals, and particularly among immigrants. Longitudinal analyses that account for these changes in individuals are necessary to examine long term changes in BMI of Canadians and immigrants over time; and assess the convergence (or lack thereof) of immigrant BMI to the Canadian levels. .

Therefore, we set the aim of the present study as the examination of the convergence of immigrant BMI to Canadian levels. To that effect, we evaluated 12-year changes in BMI (and related socio-demographic factors) among white and non-white immigrants, and Canadian-born individuals.

Methods

This study is a longitudinal analysis of secondary data originally collected by Statistics Canada in seven waves of the National Population Health Survey (NPHS).²⁵⁰

Data Source

The NPHS is a longitudinal survey nationally representative of the Canadian population that prospectively collects social, demographic, economic, occupational, environmental, and health information. The first wave of NPHS was in 1994/95, and biennial surveys have been carried on since then, providing 12 years of follow-up, with seven assessments in: 1994/95, 1996/97, 1998/99, 2000/01, 2002/03, 2004/5, and 2006/7. The target population comprises household residents of ten provinces in Canada; it excludes persons living on Indian Reserves and Crown lands and in remote areas of Ontario and Québec, residents of health institutions, and those living on Canadian Force bases. The households were selected in the first cycle (1994/95) and one individual above the age of 12 years was randomly selected from each household to be the respondent for all the seven waves of the survey. The initial longitudinal sample was of 10,992 individuals; of these 5,671 were in the age group of 18–54 years at baseline. We excluded 207 individuals who lacked data for all seven waves.

Thus, finally a total of 2504 males and 2960 females were included for the present analysis (refer to as cohort for future discussion). We have described the details of the sample size calculation in Figure 1. We had a total of 15860 observations (mean 6.3) for males and 18349 (mean 6.2) observations for females across the seven assessment times.

The outcome variable of interest was BMI: weight (kilograms)/[height (metres)]², based on the self reports of height and weight of individuals at each cycle. The independent variable of primary interest was the immigrant status of the individual: Canadian born, White immigrants and Non-white Immigrants. We used socio-demographics and lifestyle factors as explanatory variables in the statistical models to replicate previous research based on Berry's framework for acculturation.¹⁰ The socio-demographic parameters were: age, income category (classified by Statistics Canada as highest, upper middle, lower middle, and lowest), education (primary, secondary, post-secondary, and graduate), marital status (single, married, separated), living conditions (single, with a partner, family with both parents, family with single parent, and other types), province of residence (Ontario, Quebec, British Columbia, and others), and a binary indicator of linguistic minority (individuals living in Quebec and unable to speak/understand French, individuals living in other provinces and unable to speak/understand English). We also measured lifestyle variables that may confound the association between immigrant status and BMI, such were: alcohol intake (never, regular, or former), smoking pattern (never, daily, occasional, or former), and physical activity (infrequent, occasional, and regular). A calendar 'time' variable measured in years since 1994 was also included in the models to account for the longitudinal changes across the seven cycles during the 12 year follow-up period. Finally, we built a model that included only the immigrants to assess the effect of time since immigration on the change in BMI. This variable could not be used in the complete model with all the individuals as it would have no value for Canadian born individuals.

Statistical Analyses

We analysed data on men and women separately. Descriptive statistics included means and standard deviations (SD) for BMI calculated separately for the immigrant sub-groups, socio-demographic characteristics, and lifestyle variables for each cycle of data.

We used a random effects models (RE) for analysis of this longitudinal dataset. While ordinary least squares method is likely to yield biased estimates from data with repeated within-subject measures over time, RE models can estimate both within-individual and between-individual variance, and, thus account for the correlation of the repeated outcomes in the same subject.²⁵¹ The models were built in the following sequence (all with BMI as the outcome): null model with no explanatory variables; crude estimates of changes over time in BMI for each of the variables separately; and a complete model with all the variables. Our RE models accounted for both random intercepts and slopes i.e. accounted for between-subjects variation in both baseline BMI and rate of change of BMI over time. We also used the interaction between immigrant status and time (year) to assess the difference in the rates of change of BMI between different immigrant groups over the 12 year period of data collection. We used the Akaike Information Criteria (AIC) to compare the fit of alternative

models while accounting for the differences in degrees-of-freedom.²⁵² Finally, we used a residual versus fitted values plot to evaluate the model assumptions.

About 118 (5%) males and 95 (3%) females died during the course of the 12-year data collection. After excluding individuals who died during the follow-up, about 93% observations in males and 90% observations in females in our cohort had no missing values, for any of the variables included in these models. To deal with missing data, we performed 20 imputations of the dataset (using all seven waves), without individuals who died, using the ‘Multiple Imputations with Chained Equations’ (MICE) method.^{253–254} The missing values of variables are imputed based on the regression model that uses observed values of all the variables. An imputed value for the missing value is calculated using the parameters from the distribution, with the mean and standard deviation (SD) estimated based on the estimated parameters and their standard errors from this regression model. This procedure was repeated 20 times, and final results for parameters and standard errors accounted for the variation of the estimates across the 20 replications. The difference of the estimates from these models was $< 0.5 \times \text{Standard Error}$ for the primary independent variable of interest. Therefore, we are only reporting the results from the complete dataset with missing data.

We used Stata (version 10) (StataCorp, College Station, Texas, USA) for analyses and conducted the imputations using the *ice* command in Stata.^{255–257}

The study was approved for secondary data analysis by the Institutional Review Board of McGill University.

Results

Of the 2504 males, 2225 (89%) were born in Canada, 174 (7%) were white immigrants, and 105 (4%) were non-white immigrants. Among the females, 2652 (89%) were born in Canada, 201 (7%) were white immigrants, and 107 (4%) were non-white immigrants. Among the 587 immigrants: 20% were from the United Kingdom, 9% were from the United States, 6% were from India, 3% from Mainland China and 4% from Hong Kong. In our study population of 212 non-white immigrants; 31% were ethnically South Asian, 27% were ethnically Chinese, and 21% were ethnically Black. Certain baseline demographic characteristics of Canadian born individuals and immigrants are discussed further in Appendix II (web based).

Descriptive data

Figure 2(a) shows the change in unadjusted mean BMI according to immigrant status over the 12-year period. At baseline, the mean BMI was very similar in white male immigrants (26.3) and in Canadian born males (26.2). In contrast, among non-white male immigrants the mean BMI was lower (24.3) than in the two other groups. Although the mean BMI increased over time in each group, the curve for non-white immigrants remained systematically below those for the other groups (Figure 2a). Even after adjusting for age, the mean BMI in non-white immigrants was about 2 units lower for each year of data collection. In women, the mean BMI at baseline was highest in Canadian born women (24.9), followed by white immigrants (24.3), while non-white immigrants had the lowest mean BMI (23.2) at

baseline. This trend was maintained during all the seven waves of data collection (Figure 2b). As observed in males, even after adjusting for age, female non-white immigrants had the lowest mean BMI for each data collection point.

The comparisons of the mean (SD) BMI according to immigrant status, socio-demographic, and lifestyle variables for each cycle of the 12-year follow-up can be found in Appendix V (web based).

Complete Cohort Models

The crude and adjusted changes in BMI over the 12-year period in the complete cohort are described in Table 1. We refer only to the adjusted estimates in the subsequent discussion.

Adjusting for the covariates, non-white immigrants (both men and women) had lower BMI than Canadian born individuals over the 12-year period (Mean difference for males: -2.27 , 95% CI -3.02 to -1.53 ; Mean difference for females: -1.84 , 95% CI -2.79 to -0.90). In contrast, the mean values of BMI in white male immigrants were similar to Canadian born individuals over this time period (-0.32 , 95% CI -0.91 to 0.27). The interaction between immigrant status and time (year) was statistically significant in men: the mean change in BMI for each year of data collection was higher in white male immigrants (0.03 , 95% CI: 0.00 to 0.07) and lower in non-white male immigrants (-0.05 , 95% CI: -0.09 to 0.00) when compared with the Canadian born population. The interaction between time and immigrant status was not statistically significant in women indicating that there were no systematic differences in the rate of change on BMI across the two immigrant categories.

Immigrant only models

After adjusting for other characteristics (including age), with every additional year since immigration to Canada, the BMI changed by 0.03 units (95% CI: -0.01 to 0.06). In general, across the seven waves of data, female immigrants had lower mean BMI than males (-1.61 , 95% CI: -2.26 to -0.97). Even after adjusting for time since immigration, non-white immigrants had significantly lower mean BMI compared with the white immigrants (-1.21 , 95% CI: -1.96 to -0.46). We tested the interactions between time-since-immigration and sex, age, and immigrant categories; none of these were statistically significant. Selected estimates for the immigrant only models are shown in Table 2.

Discussion

Both male and female non-white immigrants had the lowest BMIs at the beginning of the study and continued to remain about 2 units lower than the Canadian born individuals, over the 12-year period (1994–2006). After adjusting for individual level socio-demographic characteristics, white male immigrants were the only sub-group whose BMIs had converged upward to the Canadian born individuals over the 12-year period. Even after adjusting for time since immigration, non-white immigrants kept their lower BMIs over the 12-year period than white immigrants.

These findings are congruent with previous research from Ross and co-workers, who found while working with the 2000/01 CCHS data, that immigrants (men and women) in general

had lower BMIs irrespective of the time since immigration.¹¹¹ However, another interpretation could be that these aggregate patterns are masking substantial heterogeneity within the immigrant population. Indeed, it has been postulated that ethnic minority immigrants may acculturate more slowly than those from educated urban settings with similar physical characteristics (such as skin colour).²⁵⁸ Thus, the levels of dietary acculturation, a strong contributor to BMI, may vary by ethnic origin. Empirical evidence does tend to support this hypothesis. For instance, McDonald and Kennedy [using the 1996 wave of NPHS and the 2000/01 wave of the Canadian Community Health Survey (CCHS)] predicted that unhealthy weight indicators in immigrants will increase beyond the native-born levels after 20–30 years of immigration.¹⁰⁹ However, they also found that this would not apply to Chinese immigrants. A similar finding was reported by Cairney and Ostbye: using the 1994 wave of NPHS, as they found that respondents from Asia were less overweight/obese than other ethnic groups.¹¹⁷

By following a cohort of immigrants over time, we found that non-white immigrants (both males and females) started and continued to be about two units lower for BMI than the Canadian born individuals - there was no convergence to the BMI levels of the Canadian-born population. By contrast, the male white immigrants appeared to converge to Canadian levels of BMI. Even in the 'immigrant-only' models, after adjusting for time since immigration, non-white immigrants had lower BMI than white immigrants. A potential explanation for the non-convergence of the BMI values among non-white immigrants could be the relatively short follow-up period of 12 years. However, as indicated by the interaction terms in our models, the mean BMI changed positively in white male immigrants per year of data collection and negatively in non-white male immigrants when compared with the Canadian born population - thus suggesting that the mean values in the non-white male immigrants did not appear to converge to the mean values of the Canadian born males. These differences in BMI in various ethnic groups have also been demonstrated in other settings.^{104, 259} However, these results should be interpreted cautiously, as individuals from certain ethnic minority groups (for example, Asian origin individuals) may have higher body fat content for similar or even lower levels of BMI when compared with their European counterparts.^{248–249, 260} BMI may not measure the body fat distribution appropriately; hence other measures such as waist circumference, hip circumference, waist-to-hip ratio, sagittal abdominal diameter, and skinfolds may be more appropriate to measure body fat distribution.²⁶¹ Further, while we have accounted for other variables that may potentially affect both the process of acculturation and BMI (income, education, physical activity etc.), our focus was not on health behaviours per se. Our results most definitely suggest that these are important determinants of BMI, health and potentially convergence, and they should be examined in their own right.

Two major limitations of this study were the self-reported nature of height and weight (used to calculate BMIs) and the overall small sample sizes. Though we followed the same individual over a period of 12 years, there is a possibility of over reporting of height and underreporting of weight. Moreover, these trends may also vary between men and women.²⁶² Though BMI has its limitations in measuring body fat distribution, it is an important anthropometric measure and has a very high applicability in large population studies such as this one.²⁶¹ Further, a collaborative analysis of 57 prospective studies demonstrated that

BMI is in itself a strong predictor of mortality above and below the optimum levels (22.5 to 25 kg/m²).²⁶³ In addition, low BMI could indeed be illness-induced, rather than indicative of good health, thus carrying with it a potential health selection bias. We did not include extremes of age in our sample population. Our population composed of 18–54 year old individuals, and with a 12-year follow-up, we estimate that they are unlikely to be in the group subject to illness-induced weight loss. Another potential limitation is that non-white immigrants represent a heterogeneous group. However, because of small numbers we could not classify them further (e.g., Asian, South Asian, Black etc.). We also did not have information on the class of immigration - economic class, family class, or refugees. Future Canadian surveys should include sufficient numbers of individuals in ethnic minority groups and have information on the class of immigration. This will help us understand the differences in weight gain between these groups.

Despite these limitations, the study provides useful information. First, it adds a longitudinal dimension to the existing literature on immigrants and BMI changes in Canada. We have followed the same individuals over a period of 12 years (the longest duration of follow-up for BMI in immigrants) and estimates have accounted for both within-subject and between-subject variation of the outcome. Second, it demonstrates that though there was an increase in BMI levels in all three immigrant categories (Canadian born, white immigrants, non-white immigrants) over the 12-year period, the mean BMIs of non-white immigrants remained consistently lower than those of the Canadian born individuals or white immigrants. Among males, non-white immigrants showed a negative mean change in BMI per year compared with the Canadian born population. Thus, from an epidemiological perspective, not all immigrant groups show the loss of ‘*healthy immigrant effect*’ with regard to *convergence of BMI values to native Canadian levels*. Nevertheless, from a public health perspective, ethnic minority immigrants may continue to be at risk of developing obesity-related complications due to their high body fat content even with lower levels of BMI, as shown by other authors.^{248–249, 260} Although we did not have better measures of fat distribution, future surveys should attempt to collect this information. Finally, public prevention programmes such as exercise and dietary habits should be applicable to all these groups to prevent obesity related morbidity in an increasingly multiethnic Canada.

References

1. Facts and figures: immigration overview permanent and temporary residents. Ottawa: Citizenship and Immigration Canada; 2006. p. 1-114.
2. Migration in interconnected world: new directions for action. Switzerland: Global Commission on International Migration; 2005. <http://www.gcim.org/attachements/gcim-complete-report-2005.pdf> [Accessed 15 Feb 2009]
3. Chen J, Ng E, Wilkins R. The health of Canada's immigrants in 1994–95. Health Rep. 1996; 7(4): 33–45. 37–50. [PubMed: 8679956]
4. Deri, C. Working Papers. Department of Economics, University of Ottawa; 2004. Understanding the ‘Health Immigrant Effect’ in Canada. (Working Paper # 0502E). <http://www.sciencesociales.uottawa.ca/eco/pdf/cahiers/0502E.pdf> [Accessed 15 Feb 2009]
5. Antecol H, Bedard K. Unhealthy assimilation: why do immigrants converge to American health status levels? Demography. 2006; 43(2):337–60. [PubMed: 16889132]
6. Strong K, Trickett P, Bhatia K. The health of overseas-born Australians, 1994–1996. Aust Health Rev. 1998; 21(2):124–33. [PubMed: 10181680]

7. Gee EM, Kobayashi KM, Prus SG. Examining the healthy immigrant effect in mid- to later life: findings from the Canadian Community Health Survey. *Can J Aging*. 2004; 23(Suppl 1):S61–9. [PubMed: 15660311]
8. Beiser M, et al. Poverty, family process, and the mental health of immigrant children in Canada. *Am J Public Health*. 2002; 92(2):220–7. [PubMed: 11818295]
9. DeVoretz, D., editor. *Diminishing returns: the economics of Canada's recent immigration policy*. Toronto: C.D. Howe Institute; 2001.
10. Duleep HO, Dowhan DJ. Research on immigrant earnings. *Soc Secur Bull*. 2008; 68(1):31–50. [PubMed: 18837270]
11. Bethel JW, Schenker MB. Acculturation and smoking patterns among Hispanics: a review. *Am J Prev Med*. 2005; 29(2):143–8. [PubMed: 16005811]
12. Varghese S, Moore-Orr R. Dietary acculturation and health-related issues of Indian immigrant families in Newfoundland. *Can J Diet Pract Res*. 2002; 63(2):72–9. [PubMed: 12084184]
13. Zemore SE. Acculturation and alcohol among Latino adults in the United States: a comprehensive review. *Alcohol Clin Exp Res*. 2007; 31(12):1968–90. [PubMed: 18034692]
14. Beiser M. The health of immigrants and refugees in Canada. *Can J Public Health*. 2005; 96(Suppl 2):S30–44. [PubMed: 16078554]
15. Gordon-Larsen P, et al. Acculturation and overweight-related behaviors among Hispanic immigrants to the US: the National Longitudinal Study of Adolescent Health. *Soc Sci Med*. 2003; 57(11):2023–34. [PubMed: 14512234]
16. Fuentes-Afflick E, Hessol NA. Acculturation and body mass among Latina women. *J Womens Health (Larchmt)*. 2008; 17(1):67–73. [PubMed: 18240983]
17. Kaplan MS, et al. The association between length of residence and obesity among Hispanic immigrants. *Am J Prev Med*. 2004; 27(4):323–6. [PubMed: 15488363]
18. Bray GA. Medical consequences of obesity. *J Clin Endocrinol Metab*. 2004; 89(6):2583–9. [PubMed: 15181027]
19. Cairney J, Ostbye T. Time since immigration and excess body weight. *Can J Public Health*. 1999; 90(2):120–4. [PubMed: 10349219]
20. McDonald JT, Kennedy S. Is migration to Canada associated with unhealthy weight gain? Overweight and obesity among Canada's immigrants. *Soc Sci Med*. 2005; 61(12):2469–81. [PubMed: 15972242]
21. Tremblay MS, et al. Obesity, overweight and ethnicity. *Health Rep*. 2005; 16(4):23–34. [PubMed: 16190322]
22. Appropriate body-mass index for Asian populations and its implications for policy and intervention strategies. *Lancet*. 2004; 363(9403):157–63. [PubMed: 14726171]
23. Deurenberg P, Deurenberg-Yap M, Guricci S. Asians are different from Caucasians and from each other in their body mass index/body fat per cent relationship. *Obes Rev*. 2002; 3(3):141–6. [PubMed: 12164465]
24. Tremblay MS, et al. Physical activity and immigrant status: evidence from the Canadian Community Health Survey. *Can J Public Health*. 2006; 97(4):277–82. [PubMed: 16967745]
25. Statistics Canada. [Accessed 15 Feb 2009] National Population Health Survey. 2008. <http://www.statcan.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SurvId=3225&SurvVer=0&InstaId=15280&InstaVer=5&SDDS=3225&lang=fr&db=IMDB&db1=E&adm=8&dis=2>
26. Berry J. Immigration acculturation and adaptation. *Appl Psychol: Int Rev*. 1997; 46:5–33.
27. Snijders, TAB., Bosker, RJ. *Multilevel analysis: an introduction to basic and advanced multilevel modeling*. London: Sage; 2004. p. 1-266.
28. Akaike H. A new look at the statistical model identification. *IEEE Trans Automat Contr*. 1974; 19(6):716–23.
29. Van Buuren S, Boshuizen HC, Knook DL. Multiple imputation of missing blood pressure covariates in survival analysis. *Stat Med*. 1999; 18(6):681–94. [PubMed: 10204197]
30. Van Buuren S, Oudshoorn K. Flexible multivariate imputation by MICE (TNO report PG/VGZ/99.054). 1999; 3–19 [Accessed 15 Feb 2009] <http://www.multiple-imputation.com/>.

31. Carlin J, Galati J, Royston P. A new framework for managing and analyzing multiply imputed data in Stata. *Stata J.* 2008; 8(1):49–67.
32. Royston P. Multiple imputation of missing values: update. *Stata J.* 2005; 5(2):188–201.
33. Royston P. Multiple imputation of missing values: update of ice. *Stata J.* 2005; 5(4):527–36.
34. Ross NA, et al. Body mass index in urban Canada: neighborhood and metropolitan area effects. *Am J Public Health.* 2007; 97(3):500–8. [PubMed: 17267734]
35. Satia-Abouta J, et al. Dietary acculturation: applications to nutrition research and dietetics. *J Am Diet Assoc.* 2002; 102(8):1105–18. [PubMed: 12171455]
36. Goel MS, et al. Obesity among US immigrant subgroups by duration of residence. *JAMA.* 2004; 292(23):2860–7. [PubMed: 15598917]
37. Kumar BN, et al. Ethnic differences in body mass index and associated factors of adolescents from minorities in Oslo, Norway: a cross-sectional study. *Public Health Nutr.* 2004; 7(8):999–1008. [PubMed: 15555201]
38. Rush E, et al. Body size, body composition, and fat distribution: a comparison of young New Zealand men of European, Pacific Island, and Asian Indian ethnicities. *N Z Med J.* 2004; 117(1207):U1203. [PubMed: 15608799]
39. Snijder MB, et al. What aspects of body fat are particularly hazardous and how do we measure them? *Int J Epidemiol.* 2006; 35(1):83–92. [PubMed: 16339600]
40. Gorber SC. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. *Obes Rev.* 2007; 8(4):307–26. [PubMed: 17578381]
41. Whitlock G, et al. Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. *Lancet.* 2009; 373(9669):1083–96. [PubMed: 19299006]

Appendices

Table 3

Certain baseline demographic characteristics according to immigrant status in 2504 males and 2960 females (1994), Canada

Characteristics	Canadian born	White Immigrants	Non-white immigrants
Mean age (SD) years	36.1 (9.8)	40.2 (9.1)	37.6 (9.0)
Sex			
Males	2225 (46)	174 (46)	105 (50)
Females	2652 (54)	201 (54)	107 (50)
Marital Status			
Single	1242 (25)	49 (13)	44 (23)
Married	3063 (63)	282 (75)	138 (65)
Separated	572 (12)	44 (11)	26 (12)
Education			
Primary	848 (17)	36 (10)	31 (15)
Secondary	804 (17)	63 (17)	33 (16)
Post-Secondary	1382 (28)	105 (28)	50 (24)
Graduate	1838 (38)	171 (46)	97 (46)
Income category			
Highest	743 (16)	89 (25)	17 (8)
Upper Middle	1964 (41)	142 (40)	72 (36)
Lower Middle	1292 (27)	82 (23)	72 (36)
Lowest	746 (16)	44 (12)	41 (20)

Table 4

Mean (SD) of body mass index in 2,504 men and 2,960 women for each year of the data collection cycle over a 10-year period (1994–2006), Canada

	Males		Females	
	Multiple Imputations Adjusted estimates Estimate (95% CI)	Only living Adjusted estimates Estimate (95% CI)	Multiple Imputations Adjusted estimates Estimate (95% CI)	Only living Adjusted estimates Estimate (95% CI)
Immigrant status				
Canadian-born	reference	reference	reference	reference
White immigrants	−0.37 (−0.96, 0.23)	−0.35 (−0.95, 0.25)	−1.09 (−1.77, −0.41)	−1.06 (−1.76, −0.36)
Non-white immigrants	−2.11 (−2.86, −1.36)	−2.09 (−2.85, −1.34)	−1.96 (−2.91, −1.01)	−1.93 (−2.90, −0.95)
Age	0.23 (0.19, 0.27)	0.24 (0.20, 0.27)	0.24 (0.19, 0.29)	0.24 (0.19, 0.28)
Age²	−0.002 (−0.003, −0.002)	−0.002 (−0.003, −0.002)	−0.002 (−0.002, −0.001)	−0.002 (−0.002, −0.001)
Time	0.09 (0.08, 0.11)	0.09 (0.08, 0.11)	0.09 (0.07, 0.11)	0.09 (0.07, 0.11)
Education				
Primary	reference	reference	reference	reference
Secondary	−0.39 (−0.72, −0.05)	−0.23 (−0.57, 0.12)	−0.29 (−0.77, 0.18)	−0.26 (−0.67, 0.15)
Post-secondary	−0.22 (−0.51, 0.07)	−0.09 (−0.38, 0.21)	−0.33 (−0.72, 0.05)	−0.33 (−0.68, 0.01)
Graduate	−0.14 (−0.44, 0.15)	−0.04 (−0.34, 0.26)	−0.26 (−0.65, 0.12)	−0.24 (−0.60, 0.11)
Province				
Other provinces	reference	reference	reference	reference
Ontario	−0.24 (−0.50, 0.01)	−0.24 (−0.50, 0.01)	−0.20 (−0.53, 0.12)	−0.26 (−0.55, 0.04)
Quebec	−0.82 (−1.19, −0.46)	−0.83 (−1.20, −0.47)	−1.05 (−1.49, −0.62)	−0.82 (−1.22, −0.42)
British Columbia	−0.13 (−0.45, 0.19)	−0.16 (−0.48, 0.16)	−0.50 (−0.91, −0.08)	
Marital Status				
Single	reference	reference	reference	reference
Married	0.35 (0.17, 0.52)	0.27 (0.09, 0.44)	−0.03 (−0.30, 0.24)	0.06 (−0.15, 0.28)
Separated	0.18 (−0.03, 0.39)	0.11 (−0.09, 0.31)	−0.26 (−0.56, 0.03)	−0.14 (−0.38, 0.09)
Linguistic major				
No	reference	reference	reference	reference
Yes	−0.03 (−0.22, 0.15)	−0.01 (−0.19, 0.18)	−0.13 (−0.44, 0.18)	−0.04 (−0.27, 0.18)
Income category				
Highest	reference	reference	reference	reference
Upper middle	−0.04 (−0.13, 0.04)	−0.04 (−0.12, 0.04)	0.15 (0.02, 0.29)	0.08 (−0.02, 0.18)
Lower middle	−0.11 (−0.22, 0.00)	−0.13 (−0.23, −0.02)	0.30 (0.12, 0.47)	0.12 (−0.01, 0.25)
Lowest	−0.27 (−0.43, −0.10)	−0.22 (−0.38, −0.07)	0.43 (0.19, 0.66)	0.31 (0.14, 0.48)
Living Condition				

	Males		Females	
	Multiple Imputations Adjusted estimates Estimate (95% CI)	Only living Adjusted estimates Estimate (95% CI)	Multiple Imputations Adjusted estimates Estimate (95% CI)	Only living Adjusted estimates Estimate (95% CI)
Lives alone	reference	reference	reference	reference
Partner	0.06 (−0.12, 0.24)	0.11 (−0.06, 0.29)	0.15 (−0.14, 0.43)	0.25 (0.03, 0.47)
Family both	0.06 (−0.10, 0.23)	0.12 (−0.04, 0.27)	0.20 (−0.08, 0.47)	0.27 (0.07, 0.48)
Family single	−0.10 (−0.31, 0.10)	−0.05 (−0.25, 0.15)	−0.01 (−0.27, 0.24)	−0.05 (−0.24, 0.14)
Other types	0.01 (−0.14, 0.17)	0.04 (−0.11, 0.19)	0.14 (−0.12, 0.41)	0.14 (−0.05, 0.33)
Alcohol status				
Never alcohol	reference	reference	reference	reference
Regular alcohol	0.11 (−0.03, 0.25)	0.15 (0.01, 0.28)	−0.15 (−0.34, 0.04)	−0.15 (−0.29, −0.01)
Former alcohol	0.15 (0.00, 0.29)	0.21 (0.07, 0.35)	0.12 (−0.5, 0.29)	0.07 (−0.06, 0.19)
Smoking status				
No smoke	reference	reference	reference	reference
Daily smoker	−0.50 (−0.66, −0.33)	−0.53 (−0.69, −0.37)	−0.55 (−0.81, −0.29)	−0.69 (−0.90, −0.49)
Occasional smoker	−0.11 (−0.30, 0.08)	−0.17 (−0.35, 0.02)	−0.04 (−0.36, 0.28)	−0.22 (−0.45, 0.02)
Former smoker	0.17 (0.04, 0.30)	0.12 (0.00, 0.24)	0.33 (0.12, 0.53)	0.21 (0.05, 0.37)
Physical activity				
Infrequent	reference	reference	reference	reference
Regular	−0.11 (−0.19, −0.02)	−0.12 (−0.21, −0.04)	−0.31 (−0.45, −0.16)	−0.23 (−0.33, −0.12)
Occasional	0.06 (−0.03, 0.15)	0.04 (−0.04, 0.13)	−0.13 (−0.27, 0.02)	−0.03 (−0.14, 0.07)
Constant	21.4 (20.5, 22.3)	21.1 (20.2, 22.1)	19.5 (18.2, 20.7)	19.4 (18.4, 20.5)
Interaction terms				
White immigrant*time	0.04 (0.01, 0.08)	0.03 (0.00, 0.07)		
Non-white immigrant*time	−0.03 (−0.08, 0.01)	−0.05 (−0.09, 0.00)		

	1994				1996				1998			
	Males		Females		Males		Females		Males		Females	
	n	BMI	n	BMI	n	BMI	n	BMI	n	BMI	n	BMI
Total	2504		2960		2487		2944		2464		2925	
Dead					17		16		23		19	
<i>Individual Characteristics</i>												
Immigrant status												
Canadian born	2225	26.2 (3.9)	2652	24.9 (5.2)	2210	26.5 (4.0)	2640	25.2 (5.1)	2189	26.8 (3.9)	2625	25.6 (5.3)
White Immigrants	174	26.3 (4.0)	201	24.3 (4.7)	174	26.5 (3.8)	201	24.4 (4.5)	173	26.8 (4.0)	199	24.8 (4.6)
Non-white Immigrants	105	24.3 (3.4)	107	23.2 (4.1)	103	24.5 (3.3)	103	23.6 (3.6)	102	24.8 (3.7)	101	23.6 (3.8)
Education												

	1994				1996				1998			
	Males		Females		Males		Females		Males		Females	
	n	BMI	n	BMI	n	BMI	n	BMI	n	BMI	n	BMI
Primary	454	26.4 (4.2)	461	26.0 (5.5)	413	26.7 (4.2)	433	26.3 (5.2)	396	27.0 (4.2)	408	26.7 (5.3)
Secondary	408	26.2 (3.8)	492	24.7 (4.8)	378	26.6 (3.8)	461	25.1 (5.0)	356	27.0 (3.8)	439	25.5 (5.0)
Post-Secondary	681	26.1 (4.0)	856	24.6 (5.3)	707	26.3 (3.9)	872	24.7 (5.1)	687	26.7 (4.1)	846	25.4 (5.3)
Graduate	960	26.1 (3.9)	1146	24.6 (4.9)	989	26.3 (3.9)	1176	24.9 (4.9)	1024	26.6 (3.8)	1230	25.1 (5.1)
Income category												
Highest	439	26.3 (3.7)	410	24.0 (4.2)	414	26.6 (3.7)	414	24.3 (4.3)	645	27.0 (3.9)	655	24.6 (4.3)
Upper Middle	1007	26.3 (3.9)	1171	24.7 (4.8)	1066	26.5 (3.9)	1147	24.8 (4.7)	1007	26.8 (3.9)	1120	25.5 (5.0)
Lower Middle	660	26.1 (4.1)	786	25.0 (5.2)	639	26.3 (4.0)	790	25.5 (5.5)	530	26.6 (4.1)	690	25.7 (5.5)
Lowest	311	25.6 (4.2)	520	25.6 (6.1)	262	25.8 (4.2)	472	25.8 (5.8)	193	26.0 (3.9)	374	26.4 (6.3)
Marital Status												
Single	655	25.2 (4.0)	684	24.4 (5.4)	589	25.5 (4.1)	614	24.9 (5.6)	488	26.0 (4.0)	538	25.4 (5.8)
Married	1650	26.5 (3.9)	1833	24.9 (4.8)	1688	26.7 (3.9)	1880	25.0 (4.7)	1761	27.0 (3.9)	1924	25.4 (4.9)
Separated	199	26.3 (3.7)	443	25.4 (5.7)	210	26.3 (3.5)	450	25.6 (5.6)	215	26.5 (3.9)	463	25.8 (5.5)
Living Condition												
Single	394	25.9 (4.1)	388	25.7 (6.2)	402	25.9 (4.1)	379	25.9 (6.3)	382	26.3 (4.1)	380	26.2 (6.3)
Partner	432	26.4 (4.0)	499	24.8 (4.8)	459	27.0 (4.0)	590	24.8 (4.4)	526	27.3 (4.3)	632	25.5 (4.6)
Family - both	1329	26.2 (3.9)	1402	24.6 (4.8)	1285	26.4 (3.8)	1346	24.9 (4.7)	1227	26.7 (3.7)	1278	25.2 (5.0)
Family - single	120	25.9 (3.8)	399	25.0 (5.5)	112	26.5 (3.8)	370	25.2 (5.4)	102	26.8 (3.6)	372	25.4 (5.2)
Other types	221	25.8 (4.0)	265	24.7 (5.1)	229	26.1 (4.3)	259	25.1 (5.0)	227	26.6 (4.3)	263	26.0 (5.4)
Province												
Ontario	586	26.1 (4.1)	662	24.9 (5.2)	583	26.4 (4.1)	660	25.1 (5.2)	583	26.7 (4.0)	670	25.4 (5.2)
Quebec	457	25.7 (3.8)	520	23.9 (4.4)	458	25.7 (3.7)	521	23.9 (4.5)	455	26.0 (3.7)	514	24.2 (4.7)
British Columbia	231	26.0 (3.6)	284	24.1 (4.4)	234	26.1 (3.5)	289	24.5 (4.4)	237	26.4 (3.8)	286	25.1 (4.7)
Others	1230	26.4 (4.0)	1494	25.3 (5.2)	1212	26.7 (4.0)	1474	25.6 (5.2)	1189	27.1 (4.0)	1455	26.3 (5.3)
Linguistic major												
Yes	2262	26.2 (4.0)	2693	24.9 (5.1)	2285	26.5 (3.9)	2710	25.2 (5.1)	2243	26.8 (3.9)	2695	25.6 (5.2)
No	242	25.6 (3.9)	267	23.9 (4.8)	202	25.6 (3.9)	234	23.8 (4.0)	221	25.9 (3.9)	228	24.5 (4.9)
<i>Life style factors</i>												
Alcohol status												
No alcohol	318	26.4 (4.5)	491	25.3 (5.5)	292	26.7 (4.4)	551	25.9 (6.0)	332	26.9 (4.3)	571	26.6 (6.0)
Regular alcohol	1870	26.0 (3.7)	1634	24.4 (4.6)	1863	26.2 (3.7)	1527	24.4 (4.6)	1787	26.7 (3.8)	1557	24.7 (4.4)
Former alcohol	315	26.8 (4.7)	835	25.5 (5.8)	329	27.0 (4.6)	864	25.7 (5.6)	343	26.8 (4.2)	796	26.3 (5.6)
Smoking status												
No smoke	876	26.1 (3.8)	1146	24.7 (5.2)	835	26.3 (3.7)	1165	24.9 (5.0)	742	26.6 (3.7)	1073	25.3 (5.0)
Daily smoker	764	25.9 (3.9)	815	24.6 (5.1)	771	26.0 (4.0)	770	24.8 (5.0)	714	26.3 (4.1)	730	25.2 (5.2)
Occasional smoker	141	25.8 (3.6)	150	24.3 (4.5)	100	25.9 (3.6)	94	24.5 (5.3)	84	26.5 (3.6)	120	25.3 (5.0)
Former smoker	723	26.7 (4.2)	849	25.3 (5.2)	781	27.0 (4.1)	914	25.6 (5.1)	923	27.2 (4.0)	1001	26.0 (5.4)
Physical activity												
Infrequent	496	26.3 (4.4)	623	25.6 (6.1)	529	26.4 (4.4)	558	25.8 (5.9)	401	26.9 (4.5)	469	26.5 (6.1)

	1994				1996				1998			
	Males		Females		Males		Females		Males		Females	
	n	BMI	n	BMI	n	BMI	n	BMI	n	BMI	n	BMI
Regular	1264	25.9 (3.7)	1589	24.5 (4.6)	1383	26.2 (3.5)	1761	24.7 (4.7)	1506	26.6 (3.7)	1885	25.1 (4.8)
Occasional	608	26.6 (4.2)	697	25.1 (5.2)	558	26.8 (4.4)	615	25.4 (5.1)	537	26.9 (4.0)	564	26.0 (5.6)

	2000				2002				2004			
	Males		Females		Males		Females		Males		Females	
	n	BMI	n	BMI	n	BMI	n	BMI	n	BMI	n	BMI
Total	2446		2910		2429		2896		2409		2882	
Dead	18		14		17		14		20		14	
<i>Individual Characteristics</i>												
Immigrant status												
Canadian born	2172	27.3 (4.2)	2612	26.0 (5.5)	2157	27.6 (4.4)	2599	26.4 (5.6)	2140	27.7 (4.3)	2589	26.5 (5.7)
White Immigrants	172	27.5 (4.6)	199	25.2 (4.5)	170	27.7 (4.6)	198	25.5 (4.5)	165	28.1 (4.6)	194	25.6 (4.9)
Non-white Immigrants	102	24.8 (3.8)	99	24.1 (4.4)	102	25.2 (3.8)	99	24.9 (5.2)	101	25.2 (3.6)	99	24.7 (4.4)
Education												
Primary	379	27.3 (4.2)	385	26.8 (5.3)	363	27.9 (4.6)	372	27.5 (5.6)	356	27.9 (4.4)	363	27.4 (5.6)
Secondary	341	27.6 (4.5)	409	26.0 (5.4)	335	27.8 (4.2)	397	26.4 (5.5)	312	27.7 (4.1)	384	26.7 (5.5)
Post-Secondary	663	27.3 (4.5)	821	26.0 (5.6)	662	27.6 (4.5)	790	26.4 (5.6)	650	27.7 (4.4)	777	26.6 (5.8)
Graduate	1051	26.9 (4.1)	1278	25.5 (5.3)	1055	27.2 (4.3)	1318	25.8 (5.3)	1069	27.4 (4.3)	1338	26.0 (5.5)
Income category												
Highest	857	27.3 (4.2)	790	25.1 (4.7)	968	27.5 (4.0)	915	25.4 (4.8)	1090	27.7 (4.1)	1007	25.6 (5.0)
Upper Middle	954	27.3 (4.3)	1121	26.0 (5.6)	877	27.7 (4.5)	1070	26.4 (5.4)	795	27.7 (4.5)	1030	26.5 (5.6)
Lower Middle	387	26.9 (4.6)	586	26.4 (5.5)	357	27.1 (4.5)	534	26.9 (5.9)	281	27.4 (4.6)	475	27.3 (6.1)
Lowest	134	26.4 (4.1)	268	26.9 (6.3)	109	26.5 (5.0)	230	27.7 (6.8)	98	25.8 (3.6)	209	28.1 (6.9)
Marital Status												
Single	432	26.3 (4.6)	461	25.9 (6.0)	385	26.7 (4.9)	396	26.8 (6.5)	348	26.7 (4.8)	350	27.2 (6.8)
Married	1791	27.4 (4.2)	1968	25.8 (5.2)	1826	27.7 (4.3)	2002	26.1 (5.2)	1826	27.8 (4.1)	2005	26.2 (5.4)
Separated	223	27.1 (3.9)	481	26.1 (5.4)	234	27.3 (4.3)	498	26.5 (5.7)	234	27.6 (4.6)	523	26.6 (5.5)
Living Condition												
Single	377	26.7 (4.7)	382	26.5 (6.1)	372	27.0 (4.8)	387	27.1 (6.4)	351	27.3 (4.9)	390	27.3 (6.4)
Partner	539	27.9 (4.4)	676	26.0 (5.0)	616	28.1 (4.4)	732	26.4 (4.8)	654	28.1 (4.3)	770	26.5 (5.1)
Family - both	1216	27.1 (3.9)	1240	25.7 (5.4)	1141	27.4 (4.1)	1198	25.8 (5.4)	1105	27.5 (4.0)	1164	25.9 (5.4)
Family - single	94	26.8 (4.4)	359	25.6 (5.5)	100	27.4 (5.2)	332	26.3 (5.6)	107	27.6 (5.1)	339	26.4 (5.6)
Other types	220	27.0 (4.4)	253	26.0 (5.2)	200	27.5 (4.7)	247	26.9 (5.8)	192	27.1 (4.4)	218	27.2 (6.0)
Province												
Ontario	585	27.2 (4.5)	664	25.9 (5.6)	578	27.4 (4.7)	666	26.2 (5.5)	580	27.6 (4.7)	656	26.5 (5.7)
Quebec	452	26.5 (3.9)	516	24.6 (4.9)	448	26.9 (4.2)	511	25.0 (5.0)	443	27.0 (4.0)	514	25.3 (5.1)
British Columbia	239	26.9 (3.8)	280	25.5 (5.1)	239	27.1 (3.8)	271	25.9 (5.3)	234	27.0 (3.7)	281	25.6 (5.1)
Others	1170	27.5 (4.3)	1450	26.5 (5.5)	1158	27.9 (4.4)	1443	26.8 (5.6)	1145	28.0 (4.3)	1424	27.0 (5.7)

	2000				2002				2004			
	Males		Females		Males		Females		Males		Females	
	n	BMI	n	BMI	n	BMI	n	BMI	n	BMI	n	BMI
Linguistic major												
Yes	2218	27.2 (4.2)	2666	26.0 (5.4)	2217	27.6 (4.4)	2666	26.3 (5.5)	2190	27.7 (4.4)	2654	26.5 (5.6)
No	228	26.6 (4.4)	240	24.7 (4.9)	210	27.0 (4.6)	225	25.3 (5.1)	218	27.0 (4.0)	226	25.5 (5.1)
<i>Life style factors</i>												
Alcohol status												
No alcohol	323	27.4 (4.8)	559	26.6 (6.0)	288	28.0 (5.3)	504	27.1 (6.4)	331	27.8 (4.9)	533	27.4 (6.4)
Regular alcohol	1777	27.1 (4.1)	1576	25.2 (4.8)	1834	27.4 (4.2)	1649	25.4 (4.8)	1774	27.5 (4.1)	1606	25.6 (4.9)
Former alcohol	332	27.5 (4.4)	764	26.9 (5.9)	292	27.7 (4.5)	729	27.6 (6.1)	283	28.3 (5.1)	729	27.5 (6.1)
Smoking status												
No smoke	699	27.0 (3.9)	1019	25.7 (5.1)	672	27.4 (4.2)	1004	26.0 (5.3)	643	27.6 (4.1)	967	26.2 (5.3)
Daily smoker	628	26.5 (4.4)	647	25.6 (5.7)	519	26.8 (4.3)	558	25.9 (5.8)	495	26.7 (4.1)	538	25.9 (5.6)
Occasional smoker	109	26.6 (3.5)	119	25.6 (5.7)	119	26.7 (4.2)	114	25.8 (5.1)	101	27.4 (3.9)	90	24.9 (4.6)
Former smoker	1006	27.8 (4.4)	1121	26.3 (5.4)	1099	28.0 (4.4)	1203	26.6 (5.5)	1153	28.1 (4.5)	1272	26.9 (5.8)
Physical activity												
Infrequent	470	27.3 (5.1)	518	27.0 (6.1)	364	27.5 (5.0)	405	27.7 (6.8)	388	28.0 (5.3)	447	27.5 (6.4)
Regular	1402	27.1 (3.9)	1795	25.5 (5.0)	1545	27.4 (4.0)	2026	25.9 (5.0)	1506	27.5 (4.0)	1977	26.0 (5.3)
Occasional	527	27.3 (4.4)	580	26.2 (5.9)	481	28.0 (4.8)	449	26.8 (6.0)	485	27.5 (4.2)	438	27.1 (5.9)

	2006			
	Males		Females	
	n	BMI	n	BMI
Total	2386		2865	
Dead	23		17	
<i>Individual Characteristics</i>				
Immigrant status				
Canadian born	2120	27.9 (4.3)	2575	26.9 (5.9)
White Immigrants	165	28.0 (4.8)	193	26.2 (5.7)
Non-white Immigrants	101	25.7 (3.8)	97	24.5 (3.9)
Education				
Primary	336	28.3 (4.6)	346	28.0 (5.8)
Secondary	302	28.0 (4.1)	372	27.0 (6.0)
Post-Secondary	629	27.8 (4.4)	767	26.8 (6.2)
Graduate	1070	27.7 (4.2)	1330	26.3 (5.5)
Income category				
Highest	1200	27.9 (4.1)	1146	25.9 (5.1)
Upper Middle	689	27.9 (4.7)	937	26.8 (5.7)
Lower Middle	215	27.2 (4.3)	368	28.2 (7.3)
Lowest	86	27.1 (4.7)	166	28.6 (6.8)
Marital Status				
Single	317	27.1 (4.9)	323	27.8 (6.9)

	2006			
	Males		Females	
	n	BMI	n	BMI
Married	1818	28.0 (4.2)	2020	26.5 (5.5)
Separated	251	27.7 (4.4)	521	27.1 (6.2)
Living Condition				
Single	359	27.5 (4.7)	417	27.7 (6.7)
Partner	716	28.2 (4.5)	819	26.7 (5.3)
Family - both	1024	27.8 (3.9)	1123	26.1 (5.4)
Family - single	107	27.2 (5.2)	296	27.1 (6.4)
Other types	178	28.1 (4.5)	210	28.1 (6.7)
Province				
Ontario	577	28.0 (4.7)	648	26.7 (6.0)
Quebec	435	27.2 (4.0)	512	26.0 (5.4)
British Columbia	237	27.5 (3.9)	286	26.0 (5.4)
Others	1126	28.1 (4.3)	1410	27.3 (5.9)
Linguistic major				
Yes	2175	27.9 (4.4)	2632	26.8 (5.8)
No	210	27.4 (4.0)	230	25.8 (5.9)
<i>Life style factors</i>				
Alcohol status				
No alcohol	300	28.3 (5.1)	471	27.6 (6.7)
Regular alcohol	1753	27.7 (4.0)	1679	26.0 (5.1)
Former alcohol	261	28.5 (5.4)	637	28.3 (6.5)
Smoking status				
No smoke	641	27.8 (4.2)	940	26.4 (5.5)
Daily smoker	453	27.1 (4.2)	493	26.1 (5.8)
Occasional smoker	103	27.1 (4.7)	100	27.1 (5.4)
Former smoker	1130	28.2 (4.4)	1274	27.2 (6.1)
Physical activity				
Infrequent	258	28.6 (5.5)	315	28.5 (7.4)
Regular	1573	27.7 (4.1)	2075	26.4 (5.4)
Occasional	438	28.0 (4.5)	379	27.6 (6.4)

Figure 1.
The sample size for the current study to assess the 12-year change in body mass index according to immigrant status, National Population Health Survey, Canada (1994–2006)

(a) Males

(b) Females

Figure 2.
Changes in Body Mass Index in 2504 men and 2960 women according to immigration status (Canadian born, White Immigrants and Non-White immigrants) in Canada from 1994–2006

Table 1

Random Effects models showing the Crude and Adjusted estimates for prediction of body mass index in 2504 men and 2960 women over a 12-year period (1994–2006), Canada

	Crude estimates		Adjusted estimates	
	Males estimate (95% CI)	Females estimate (95% CI)	Males estimate (95% CI)	Females estimate (95% CI)
Immigrant status				
White Immigrants	0.08 (−0.51, 0.67)	−0.74 (−1.44, −0.03)	−0.32 (−0.91, 0.27)	−1.05 (−1.74, −0.35)
Non-white Immigrants	−2.10 (−2.84, −1.35)	−1.50 (−2.45, −0.54)	−2.28 (−3.02, −1.53)	−1.84 (−2.79, −0.90)
Canadian born	reference	reference	reference	reference
Age	0.30 (0.27, 0.33)	0.27 (0.23, 0.31)	0.23 (0.20, 0.27)	0.24 (0.20, 0.29)
Age²	−0.002 (−0.003, −0.002)	−0.001 (−0.002, −0.001)	−0.002 (−0.003, −0.002)	−0.002 (−0.002, −0.001)
Time	0.15 (0.14, 0.15)	0.17 (0.16, 0.18)	0.09 (0.07, 0.11)	0.09 (0.06, 0.11)
Education				
Graduate	0.37 (0.07, 0.67)	0.11 (−0.25, 0.46)	−0.02 (−0.32, 0.28)	−0.24 (−0.59, 0.11)
Post-Secondary	0.15 (−0.15, 0.45)	−0.10 (−0.45, 0.24)	−0.07 (−0.36, 0.22)	−0.34 (−0.68, 0.01)
Secondary	−0.26 (−0.62, 0.10)	−0.40 (−0.81, 0.02)	−0.21 (−0.56, 0.13)	−0.28 (−0.69, 0.13)
Primary	reference	reference	reference	reference
Income category				
Lowest	−0.75 (−0.89, −0.60)	−0.39 (−0.56, −0.23)	−0.22 (−0.37, −0.07)	0.30 (0.13, 0.47)
Lower Middle	−0.54 (−0.65, −0.44)	−0.36 (−0.48, −0.23)	−0.14 (−0.24, −0.03)	0.11 (−0.02, 0.24)
Upper Middle	−0.30 (−0.38, −0.22)	−0.18 (−0.28, −0.09)	−0.05 (−0.13, 0.03)	0.08 (−0.02, 0.18)
Highest	reference	reference	reference	reference
Marital Status				
Married	0.90 (0.76, 1.04)	0.80 (0.63, 0.97)	0.26 (0.09, 0.44)	0.07 (−0.15, 0.28)
Separated	0.73 (0.53, 0.92)	0.46 (0.23, 0.68)	0.11 (−0.10, 0.31)	−0.13 (−0.36, 0.10)
Single	reference	reference	reference	reference
Living Condition				
Partner	0.36 (0.23, 0.49)	0.39 (0.22, 0.55)	0.11 (−0.07, 0.28)	0.24 (0.03, 0.46)
Family both	0.28 (0.15, 0.40)	0.31 (0.15, 0.48)	0.12 (−0.04, 0.27)	0.28 (0.07, 0.48)
Family single	−0.06, (−0.26, 0.14)	−0.16 (−0.35, 0.03)	−0.03 (−0.23, 0.17)	−0.05 (−0.24, 0.14)
Other types	0.12 (−0.02, 0.26)	0.08 (−0.10, 0.25)	0.05 (−0.10, 0.20)	0.13 (−0.06, 0.32)
Lives alone	reference	reference	reference	reference
Province				
Ontario	−0.16 (−0.42, 0.10)	−0.24 (−0.53, 0.05)	−0.22 (−0.48, 0.03)	−0.25 (−0.54, 0.04)
Quebec	−0.66 (−1.01, −0.30)	−0.62 (−1.01, −0.23)	−0.83 (−1.19, −0.47)	−0.81 (−1.21, −0.40)
British Columbia	−0.05 (−0.38, 0.28)	−0.66 (−1.04, −0.28)	−0.17 (−0.49, 0.15)	−0.67 (−1.04, −0.29)
Others	reference	reference	reference	reference
Linguistic major				
Yes	0.08 (−0.09, 0.25)	0.11 (−0.10, 0.31)	0.02 (−0.16, 0.20)	−0.06 (−0.27, 0.16)
No	reference	reference	reference	reference
Alcohol status				

	Crude estimates		Adjusted estimates	
	Males estimate (95% CI)	Females estimate (95% CI)	Males estimate (95% CI)	Females estimate (95% CI)
Regular alcohol	0.11 (−0.02, 0.24)	−0.20 (−0.33, −0.06)	0.14 (0.01, 0.28)	−0.15 (−0.28, −0.01)
Former alcohol	0.15 (0.01, 0.28)	0.00 (−0.12, 0.12)	0.20 (0.06, 0.34)	0.07 (−0.06, 0.20)
Never alcohol	reference	reference	reference	reference
Smoking status				
Daily smoker	−0.48 (−0.64, −0.33)	−0.68 (−0.88, −0.47))	−0.55 (−0.71, −0.39)	−0.71 (−0.91, −0.50)
Occasional smoker	−0.07 (−0.25, 0.12)	−0.18 (−0.41, 0.05)	−0.20 (−0.39, −0.02)	−0.23 (−0.47, 0.00)
Former smoker	0.35 (0.23, 0.47)	0.40 (0.25, 0.56)	0.12 (−0.01, 0.24)	0.21 (0.05, 0.37)
No smoke	reference	reference	reference	reference
Physical activity				
Regular	−0.04 (−0.12, 0.05)	−0.11 (−0.21, −0.01)	−0.11 (−0.20, −0.03)	−0.22 (−0.32, −0.12)
Occasional	0.08 (−0.01, 0.16)	0.00 (−0.11, 0.10)	0.05 (−0.04, 0.14)	−0.02 (−0.13, 0.08)
Infrequent	reference	reference	reference	reference
Constant	26.5 (26.4, 26.7)	25.1 (25.0, 25.3)	21.1 (20.1, 22.0)	19.3 (18.3, 20.4)
AIC			66933.4	86350.8
Interaction terms				
White immigrant*time			0.03 (0.00, 0.07)	NS
Non-white immigrant*time			−0.05 (−0.09, 0.00)	NS

Table 2

Random Effects models showing the Crude and Adjusted estimates for prediction of Body Mass Index in 587 immigrants in Canada (1994–2006)*

	Crude estimates estimate (95% CI)	Adjusted estimates estimate (95% CI)
Immigrant status		
Non-white Immigrants	−1.38 (−2.05, −0.71)	−1.21 (−1.96, −0.46)
White Immigrants	reference	reference
Age	0.20 (0.11, 0.29)	0.09 (−0.01, 0.19)
Age²	−0.001 (−0.002, 0.000)	−0.001 (−0.002, 0.000)
Sex		
Females	−1.55 (−2.20, −0.91)	−1.61 (−2.25, −0.97)
Males	reference	
Time	0.14 (0.12, 0.16)	0.10 (0.05, 0.14)
Time-since-immigration	0.11 (0.09, 0.12)	0.03 (−0.01, 0.06)
Education		
Graduate	−1.60 (−2.60, −0.58)	−1.69 (−2.71, −0.68)
Post-Secondary	−0.86 (−1.75, 0.32)	−1.15 (−2.04, −0.27)
Secondary	−0.83 (−1.72, 0.07)	−1.31 (−2.20, −0.42)
Primary	reference	reference
Income category		
Lowest	−0.32 (−0.51, −0.12)	0.34 (−0.01, 0.69)
Lower Middle	−0.29 (−0.55, −0.04)	0.12 (−0.14, 0.38)
Upper Middle	−0.24 (−0.57, 0.10)	−0.07 (−0.27, 0.12)
Highest	reference	reference
Marital Status		
Married	0.99 (0.51, 1.46)	0.57 (0.05, 1.09)
Separated	1.03 (0.46, 1.61)	0.41 (−0.19, 1.03)
Single	reference	reference
Linguistic Major		
Yes	−0.14 (−0.65, 0.07)	−0.08 (−0.70, 0.55)
No	reference	reference
Interaction terms		
Non-white immigrants * time-since immigration		NS
Females * time-since-immigration		NS
AIC		16226.61

* = The adjusted model also included variables which formed a part of the complete cohort models (living conditions, province, smoking, alcohol use, physical activity)