ELSEVIER

Social Science & Medicine 61 (2005) 2469–2481

SOCIAL SCIENCE & MEDICINE

www.elsevier.com/locate/socscimed

Is migration to Canada associated with unhealthy weight gain? Overweight and obesity among Canada's immigrants

James Ted McDonald*, Steven Kennedy

Department of Economics, University of New Brunswick, PO Box 4400, Fredericton, NB, Canada E3B 5A3

Available online 21 June 2005

Abstract

This paper aims to address a gap in our understanding of immigrant health issues by examining the determinants of excess weight—an important indicator of current and future health. The paper combines data drawn from recent large health surveys to identify how the weight of recent immigrants compares with that of native-born people, and how the likelihood of becoming overweight or obese changes with additional years in Canada. We find evidence that on average, immigrants are substantially less likely to be obese or overweight upon arrival in Canada. These measures converge slowly to native-born levels, but there is marked variation by the ethnicity of the immigrant. Since changes in weight will reflect choices with respect to diet and activity, the extent to which overweight and obesity rates change with years in Canada may reflect the extent to which immigrants interact with or are influenced by members of their ethnic group who reside in the same area. We find evidence that ethnic group social network effects exert a quantitatively important influence on the incidence of being overweight and obese for members of most ethnic minorities, tempering the process of adjustment to Canadian lifestyle norms that may be driving excess weight gain with additional years in Canada.

Keywords: Immigrants; Health; Body mass index; Obesity; Acculturation; Canada

Introduction and literature review

Recent research has found compelling evidence that the physical health of immigrants to Canada is significantly better at time of migration than comparable native-born people. Equally notable is the finding that immigrant health appears to deteriorate with additional years in Canada and eventually converges to native-born levels. (See Perez, 2002; Newbold & Danforth, 2003; McDonald & Kennedy, 2004. Gee, Kobayashi, and Prus (2003) find similar results for immigrants aged 45–64 at migration.)

The existence of what has come to be known as the 'healthy immigrant effect' (HIE) is an interesting policy issue, since a majority of Canada's recent immigrants belong to visible minorities who have come from developing countries where mortality and morbidity indicators are worse than in Canada.[1] A number of

[1]The proportion of Canadian residents who identify as a visible minority has increased significantly in the last 20 years, and this has been driven almost entirely by the changing composition over time of immigrants by country of origin. According to data from the Canadian Censuses and from Citizenship and Immigration Canada, 6.4% of Canada's population belonged to a visible minority in 1986. In that year, the United States was the largest single source country for new immigrants with 7.3% of the total, the UK was 6th with 5.1% and China was not in the top ten. By 2001, the percentage of

*Corresponding author. Tel.: +1 506 447 3210; fax: +1 506 453 4514.

E-mail address: tedmcdon@unb.ca (J.T. McDonald).

0277-9536/$ - see front matter © 2005 Elsevier Ltd. All rights reserved.
doi:10.1016/j.socscimed.2005.05.004

possible reasons for the initial health gap have been cited in the literature, including healthy behaviors in the home country, health screening by immigration officers, and immigrant self-selection whereby the healthiest and wealthiest are the ones most likely to migrate. (See Jasso, Massey, Rosenzweig, & Smith, 2004, for additional discussion.) Related to this, possible reasons for why immigrants subsequently lose their health advantage are immigrant acculturation, in which recent immigrants take on typically native-born behaviors related to diet, exercise and other behaviors key to health (Beiser, Dion, Gotowiec, & Hyman, 1997; Hyman, 2001; Salant & Lauderdale, 2003); increased exposure to common environmental factors (Stephen, Foote, Hendershot, & Schoenborn, 1994); persistent language, cultural or economic barriers to the use of health services (Leclere, Jensen, & Biddlecom, 1994); and the under-reporting of chronic conditions by recent immigrants (Jasso et al., 2004; McDonald & Kennedy, 2004).

Much of the recent Canadian research has simply aimed to document the existence and nature of the healthy immigrant effect and less attention has been focused on identifying reasons for the apparent deterioration in immigrant health. If changes in the health behaviors of immigrants after arrival in Canada are driving the healthy immigrant effect, then it would be expected that such changes would also significantly affect other manifestations of physical status, the most direct being excess weight. If changes in the incidence of excess weight of immigrants after arrival in Canada are similar to what is observed for direct measures of physical health, then such a finding is evidence that changes in lifestyle choices such as diet and exercise underpin the healthy immigrant effect. Just as importantly, such an observed correlation might also be causal: it is well-known that excess weight poses serious health risks, and in particular, obesity has been strongly linked to increased risk of a range of conditions, including high blood pressure, arthritis, diabetes, heart disease, asthma, and some cancers. (See for example, Patterson, Frank, Kristal, and White (2004)). Thus, if the incidence of excess weight increases with years in Canada, more rapid deterioration of immigrants' physical health might follow.

The literature on the determinants of excess weight typically uses measures of excess weight derived from an individual's body mass index (BMI). BMI is the ratio of a person's weight in kilograms to the square of the person's height in meters. A BMI that exceeds 25 is taken to indicate that the person is overweight, while a BMI exceeding 30 is taken to indicate that the person is obese. Recent research by Antecol and Bedard (2003) in the US indicates patterns resembling the healthy immigrant effect—the obesity rate of female immigrants to the US converges to the obesity rate of native-born white women after 15 years of US residence, while obesity rates of male immigrants close one half of the obesity gap in the same period.

For Canada, comparatively few papers have used population-based data to study immigrant overweight/obesity rates. Pomerleau and Ostbye (1997) use the 1990 Ontario Health Survey to study dietary intakes of immigrants and Canadian-born residents and find that immigrants consume relatively less fat in their diets. Cairney and Ostbye (1999) analyze the 1994–1995 wave of the National Population Health Survey (NPHS) and find that although the incidence of excess body weight among both immigrant men and women is generally lower than for comparable native-born Canadians, it increases with time in Canada. Perez (2002) analyzes the Canadian Community Health Survey (CCHS) from 2000–2001 and finds that immigrant men are less likely to be overweight than native-born men, while immigrant women in Canada more than 10 years are no less likely to be overweight than native-born women.

Changes in lifestyle will no doubt in part be shaped by an individual's social and cultural environment. The process of acculturation suggests that the health behaviors of immigrants should converge to native-born levels with additional years in Canada, as immigrants adopt characteristically 'Canadian' ways of living. However, the extent of acculturation is likely to depend on the concentration and behaviors of people in the same geographic area who are of similar ethnic background, culture and language to the immigrant. In other words, if a recent immigrant resides in an area with a high concentration of people of his or her own ethnic group who make lifestyle choices different from the majority population, then acculturation might be delayed or inhibited. There is a large body of literature on acculturation and health among immigrants and minority groups (see Beiser et al., 1997; Salant & Lauderdale, 2003, for recent surveys), and recent work that focuses specifically on acculturation and weight-related behavior in other countries includes Cardoso, Hamada, deSouza, Tsugane, and Tokudome (1997) and Gordon–Larsen, Mullan Harris, Ward, and Popkin (2003).

It should be emphasized that channels through which individual behavior might be affected by proximity to majority and minority ethnic groups are not limited to differences in cultural mores. For example, changes in diet after arrival in Canada might reflect the increased

(*footnote continued*)
Canada's population that belonged to a visible minority more than doubled, to 13.4%. In that year, China was the largest single source country for new immigrants with 16.1% of the total, while the UK was 10th with 2.1% and the US was not in the top ten. In our pooled health dataset for 1996–01, 13.4% of people aged 21–65 belonged to a non-native visible minority.

availability and/or lower price of particular goods that were not otherwise attainable in the immigrant's home country. Chiswick and Miller (2004) suggest that retaining traditional behavior is easier in areas with higher concentrations of particular ethnic groups since the market for traditional goods is large enough to support merchants who can supply those goods locally and at reasonable cost.

The rest of the paper is as follows. First, we set out the empirical framework used to identify the determinants of being overweight and being obese, and the method used to estimate the influence of social networks on these indicators. Then we describe the data sources used in the analysis and outline the construction of the data series used, in particular the construction of the ethnic network variables. In Section 4, we present and discuss the main results. Our final section concludes.

Empirical methodology

We follow the literature and express the dependent variable as a function of a set of demographic and socio-economic variables including age, education level, marital status, presence of young and school-aged children, and variables to reflect socio-economic status (home ownership, type of dwelling, receipt of dividend and interest income, family income).[2] We also include a set of provincial indicator variables, and indicator variables for whether the individual resides in a Census Metropolitan Area (CMA) or in a rural area. Given differences in the physiology of men and women and differences in how explanatory variables such as age and education might affect each gender, we estimate the determinants of being overweight or obese separately for men and women.[3]

To this basic specification, we add two sets of controls. The first is a set of variables for immigrant year of arrival and years since migration. Following McDonald and Kennedy (2004), we include an indicator variable FB that takes the value 1 if the person was born outside of Canada and zero otherwise, and linear-quadratic years-since-migration (YSM) terms to capture the (possibly nonlinear) effect of an extra year in Canada. A positive coefficient on YSM implies that with additional years in Canada, immigrants are getting heavier relative to a native-born person (holding constant age and other factors). To allow for arrival period effects, we include a set of indicator variables C_{ik} for a sequence of five-year arrival periods to reflect the period in which the immigrant arrived in Canada. This is similar to the approach used by Antecol and Bedard (2003).

The second set of controls is intended to capture the presence and influence of ethnic social networks. We employ the method for measuring and identifying network effects described in Bertrand, Luttmer, and Mullainathan (2000)—hereafter BLM—in their study of the effects of ethnic networks on immigrant welfare use in the United States. The BLM approach is essentially a fixed-effects specification that includes two key variables: the proportion of the local population that belong to a particular ethnic group, and an interaction of that variable with the BMI or weight profile of others from the same ethnic group. Indicator variables for neighborhood of residence and individual ethnicity are also included.

Controlling for both ethnic and neighborhood fixed effects helps address the endogeneity of location choice (Manski, 1993; Oakes, 2004) by including fixed effects to control for neighborhood-specific unobserved factors common to all residents of the neighborhood (such as proximity of walking trails or fast food outlets) and ethnic group unobserved factors (such as genetic predisposition in terms of height and weight, or cultural restrictions on the consumption of certain foods). Further, the direct effect of the ethnic group neighborhood density will control for unobserved individual factors that lead people of particular ethnicities to live in high or low ethnic group density neighborhoods and that might also be correlated with overweight/obesity rates. Thus the main variable of interest is the interaction of local ethnic group density with ethnic-group measures of excess weight.

We estimate specifications such as (1):

$$Y^{ijk} = z^i\alpha + N^{jk}\gamma_1 + N^{jk}Y^j\gamma_2 + \sum_k D^k\beta_k + \sum_k E^j\eta_j + \varepsilon^{ijk}, \quad (1)$$

where

$$z^i\alpha = \alpha_1 \mathrm{age}_i + \alpha_2 \mathrm{age}_i^2 + X_i\delta + \beta_0 \mathrm{FB}_i + \beta_1 \mathrm{YSM}_i + \beta_2 \mathrm{YSM}_i^2 + \sum_{k=1}^{K-1} \lambda 0_k C_{ik} + \varepsilon_i. \quad (2)$$

The dependent variable Y is either an indicator variable for whether the individual is overweight (BMI 25 or more) or an indicator variable for whether the

[2] It is possible that measures of current income and labour market status may be endogenous. For example, recent research by Cawley and Danziger (2004) find that high body weight is a barrier to employment and earnings for former and current US welfare recipients.

[3] Zhang and Wang (2004) find that the relationship between socio-economic status and obesity also varies significantly by ethnicity. However, allowing for the effects of our controls for socio-economic status to vary by region of origin and age at arrival does not change the main results. This is consistent with Crimmins, Hayward and Seeman (2004), who report that controlling for socio-economic status does little to eliminate the health differences in the incidence of serious diseases among ethnic groups resident in the US.

individual is obese (BMI 30 or more). The explanatory variables include neighborhood fixed effects D^k, ethnic group fixed effects E^j, neighborhood ethnic group concentration, N^{jk}, and the interaction of this term with the ethnic group average BMI: $[N^{jk}(Y^j - Y_{\text{pop}})]$. Y_{pop} is the gender-specific average BMI measure of the Canadian population. Eq. (2) includes the socio-economic and immigrant controls discussed earlier. All of the immigrant terms are set to zero for any individual born in Canada. However, the measures of ethnicity are not specific to immigrants and so will reflect the ethnicity of Canadian-born as well as foreign-born people. The controls for local ethnic group size and characteristics are set equal to zero for White individuals, including immigrants. Estimation is by Probit.

Data sources and variable definitions

The data underpinning this paper come from two sources. Individual data on BMI and the other personal characteristics come from pooled cross-sections of two large unit record datasets published by Statistics Canada. These are the 1996 wave of the National Population Health Survey (NPHS) and the 2000–2001 wave of the Canadian Community Health Survey (CCHS).[4] The NPHS and CCHS are population-based surveys that are comparable in terms of survey design and collection, and contain survey questions and response categories that are also almost identical between the surveys. (See McDonald & Kennedy, 2004, for further discussion of the comparability of the datasets.) Pooling multiple cross-sections of data allows time series variation in measures of ethnic group concentration that enhances identification of the social network control variables. As well, a large sample size allows the analysis to be based on more disaggregated ethnic and neighborhood groups, which should further enhance identification of any ethnic social network effects.

Measures of local ethnic concentration are computed using data from the 1996 and 2001 Canadian Census files. In determining the population concentration of the local ethnic community in a particular neighborhood, it is first necessary to specify what is meant by both ethnicity and neighborhood. These definitions must also be consistent across the individual unit record health files and both census files. Our main measure of interest is visible minority status, and ten minority groups can be identified in the data: Black, Hispanic, Arab/West Asian, Chinese, Korean, Japanese, South Asian, South-East Asian, Filipino, and Other. (We omit indigenous Canadians from the sample.) Another measure of ethnicity available in both datasets is mother tongue, and we briefly discuss the results generated using this measure of ethnicity to provide different insights into the presence and importance of ethnic networks.

The most disaggregated level of geographic location in the census data for which ethnic group population counts are available is the census subdivision (CSD). CSDs are intended to reflect particular municipalities and are typically defined in terms of municipal boundaries. There are 5147 CSDs identified in the 2001 census file. For each CSD and for both 1996 and 2001, we determine the total population of the CSD and the minority population of the CSD in the year, for each ethnic group. We then use these data to compute measures of ethnic group concentration.

Using these population counts, we compute the proportion of the total adult population residing in the CSD that belong to a particular ethnic group, for each ethnic group in each CSD. We then deflate the proportion of each CSD population that belongs to a particular ethnic group by that ethnic group's share of the total Canadian population. This adjustment controls for the under-weighting of smaller ethnic groups. We refer to the resulting measure as the relative ratio (see Borjas, 1999; Bertrand et.al., 2000). In constructing the measures of ethnic group excess weight, we use the health data to compute year- and gender-specific but national measures of proportion of overweight individuals and proportion of obese individuals for each ethnic group. We compute these figures at the national level owing to the fact that relatively small sample sizes for some ethnic groups in more disaggregated regions would likely yield unreliable estimates of average ethnic group characteristics in those regions. As well, BLM argue that CSD specific ethnic group measures may reflect unobserved factors common to both the individual and his or her local ethnic group, so that the measure of local ethnic network characteristics might also be endogenous.

Thus, for each individual in the health data, we assign two variables to capture the effect of local ethnic networks on the incidence of excess weight: (1) the relative ratio concentration measure specific to that person's (year-specific) ethnic group in his or her CSD of residence, and (2) the product of the relative ratio and the national (year-specific) measures of excess weight specific to the individual's own ethnic minority group.

In specifying the final dataset used for estimation, we restrict attention to individuals aged 21–65 who are not self-identified as belonging to one of Canada's First Nations peoples. We also exclude individuals who report either belonging to multiple ethnic groups or who report

[4]We use the 1996–97 cycle of the NPHS rather than other waves because the 1996–97 NPHS contains a significantly larger sample size. Due to provincial buy-ins by Alberta, Ontario, and Manitoba for that year, the 1996–97 NPHS sample size of adults aged 20–65 (our focus group) is 73,402 compared to 17,626 in the 1994–95 NPHS.

belonging to the 'other' ethnic group (usually an amalgam of smaller groups). Finally, we exclude individuals for whom either height or weight is missing, and a very small number of individuals with extreme values of BMI. The final sample consists of 64,615 women and 62,181 men.

Results and analysis

Descriptive statistics

Table 1 presents the percentage overweight and obese for women and men by immigrant status and ethnicity (as measured by visible-minority status). Non-white female immigrants have lower overweight and obesity rates than native-born female whites, although white immigrants are comparable to native-born whites. There are pronounced differences across different ethnic groups, with East Asian (Chinese, Japanese, and Korean) and Southeast Asian female immigrants having the lowest overweight and obesity rates. These rates are also lower than those of native-born women of the same ethnicity. For both white and non-white women immigrants, more years in Canada mean increased probability of being overweight. White immigrants reach native-born levels only after 20 years in Canada, while non-white immigrants remain below native-born levels regardless of years in Canada.

Non-white men immigrants tend to be less overweight than immigrant or native-born whites. Non-white immigrants are, for most ethnic groups, also less likely to be obese or overweight than native-born men from the same groups. For white immigrant men, additional years in Canada are associated with increased overweight and obesity rates, and in both cases, these rates exceed native-born levels after 20 years in Canada. In contrast to the results for women, an increasing trend in years in Canada for non-white immigrant men is not evident.

Of course, none of these descriptive statistics control for individual characteristics such as age that might be important determinants of excess weight. Most visible minority groups are on average younger than white

Table 1
BMI, Overweight and obesity by visible minority group and immigrant status (pooled 1996 and 2001 data)

	Women				Men			
	% overweight		% obese		% overweight		% obese	
	Native-born	Foreign-born	Native-born	Foreign-born	Native-born	Foreign-born	Native-born	Foreign-born
All	39.3	34.6	13.7	10.0	58.8	50.5	15.6	10.8
White	39.6	39.5	13.8	12.0	59.1	62.1	15.6	14.9
Non-white	25.4	29.7	9.8	8.1	42.9	39.0	9.7	6.7
Black	39.0	51.0	17.2	14.4	50.5	49.0	16.1	9.8
Chinese	13.0	9.6	4.2	1.1	28.5	24.5	3.1	3.9
South Asian	17.2	36.7	9.1	9.5	50.1	44.0	10.4	6.4
SE Asian	*	24.1	*	4.9	41.9	37.3	6.2	2.8
Korean	33.7	9.8	9.0	0	51.3	24.9	14.2	3.2
Japanese	11.8	6.9	3.0	1.0	50.4	19.4	5.4	0
Hispanic	*	44.3	*	15.3	*	62.7	*	13.0
Arab/West Asian	44.2	33.6	28.7	10.7	17.1	50.1	7.3	9.6
Filipino	*	21.5	*	8.6	*	28.6	*	2.7
Other	30.1	44.8	7.2	16.4	56.6	51.4	13.1	13.9
White								
YSM 1–4	n/a	22.2	n/a	4.3	n/a	45.3	n/a	11.9
YSM 5–9		28.2		5.9		51.3		14.1
YSM 10–19		32.3		10.2		62.8		16.9
YSM 20+		44.7		14.1		65.4		15.7
Non-white								
YSM 1–4		23.7		6.6		34.6		7.8
YSM 5–9		23.1		5.6		31.5		5.4
YSM 10–19		31.9		10.1		39.0		5.5
YSM 20+		35.8		8.9		47.4		8.0

*Value suppressed due to small sample size (less than 30 observations).

residents, are more likely to have a university degree, and are much more likely to reside in one of Canada's largest urban areas. They are also overwhelmingly likely to be immigrants—80% of blacks are immigrants, while 90% or more of all other visible minority groups except Japanese and Koreans are immigrants. The figures for these latter two groups are 47% and 67%, respectively. (Tables are available on request from the author.) Nevertheless, the descriptive statistics point to very large differences in overweight and obesity rates by ethnicity, immigrant status and years in Canada.

Before proceeding to the econometric analysis, it is first useful to give some idea of the settlement patterns of the different ethnic groups. Examination of the census data confirms the well-known feature that immigrants are much more likely to be resident in Canada's largest cities—Toronto, Vancouver, and Montreal. At the CSD level, the most populous CSD contains 3.5% of Canada's total population, while the top 20 most populous CSDs in Canada contain 30.6% of Canada's total population. In contrast, 16.3% of Chinese people reside in a single CSD (Vancouver city), and over 80% of this group resides in just 20 CSDs. A similar pattern of highly concentrated ethnic populations is also true for the other ethnic groups. It is also the case that the total populations of some CSDs show significant minority group concentrations. For example, 32.7% of the population of one CSD (Richmond, BC) is Chinese, while 13.2% of one CSD (York, Ontario) is Black. Thus, minority ethnic groups are much less dispersed than the Canadian population, and this concentration results in significant proportions of some CSDs being made up of these ethnic groups.

This raises the issue about the effect on an individual's likelihood of being overweight or obese from residing in an area that also has a high concentration of one's own ethnic group peers. Our hypothesis is that if acculturation leads to convergence in overweight/obesity rates, then the extent of acculturation might be expected to vary with the exposure an individual has to his or her own ethnic community.

Regression results

We estimate specification (1), using Probit analysis for the dichotomous indicators, overweight, and obese. All standard errors have been adjusted for heteroskedasticity arising from clustering by CSD. The results are presented in three parts: first, coefficient estimates for the immigrant and ethnic group variables are presented in Table 2a and b; second, the predicted time paths of the overweight and obesity measures are then plotted for a representative individual in order to show the quantitative relationships between these measures and ethnicity and immigrant status; and third, simulations are presented to illustrate the magnitude of effect of ethnic neighborhood effects.

The first three columns of Table 2a correspond to the probability that a woman is overweight and the second three to the probability of being obese. For each dependent variable, the first column excludes controls for period of immigration to Canada, while the second column includes a set of these arrival cohort variables. In the presence of minority ethnic group indicator variables, the default immigrant group is white. The third column of results for overweight and obesity include ethnic neighborhood controls.

Considering first the specification without ethnic neighborhood variables, it can be seen that the results are qualitatively similar across the two measures of excess weight. The significant differences in the coefficients on the ethnicity controls confirm the wide variation in overweight/obesity rates across different ethnic groups evident in the descriptive statistics. The negative coefficient on FB indicates that, other things equal, women immigrants (including white immigrants) arrive in Canada weighing significantly less than comparable native born individuals. More interesting is the positive coefficients on the YSM variables that indicate that the incidence of being overweight or obese increases with additional years in Canada (over and above any effects due to general ageing), a result that is consistent with the idea that changes in lifestyle and environment after migration result in weight gain. Adding in arrival cohort terms does not reveal any clear relationship between arrival period and overweight and obesity rates, although the YSM and cohort terms are jointly significantly different from zero in every case.

Table 2b gives the results for men. There is evidence of significant positive YSM effects for being overweight when cohort variables are excluded, but adding cohort effects reduces the overall significance of the immigrant terms. There is no evidence of a systematic relationship between year of arrival/YSM and the probability of being obese, although the results for being overweight show significant increases with YSM.

Other explanatory variables have directions of effect that are consistent with expectations. (Results are available on request.) Overweight and obesity incidence rates increase with age and (for men) being married, and decrease with more education and with living in an urban area. Other proxies for socio-economic status including home ownership and dividend income are also significant and indicate higher socio-economic status is associated with less excess weight. As well, the indicator variable for 2001 is positive and significant for both measures for women and for the rate of obesity for men, confirming the secular increase in weight over time.

To get a clearer picture of the time paths of being overweight and obese for immigrants, we use the results in Tables 2a and b to predict the incidence of being

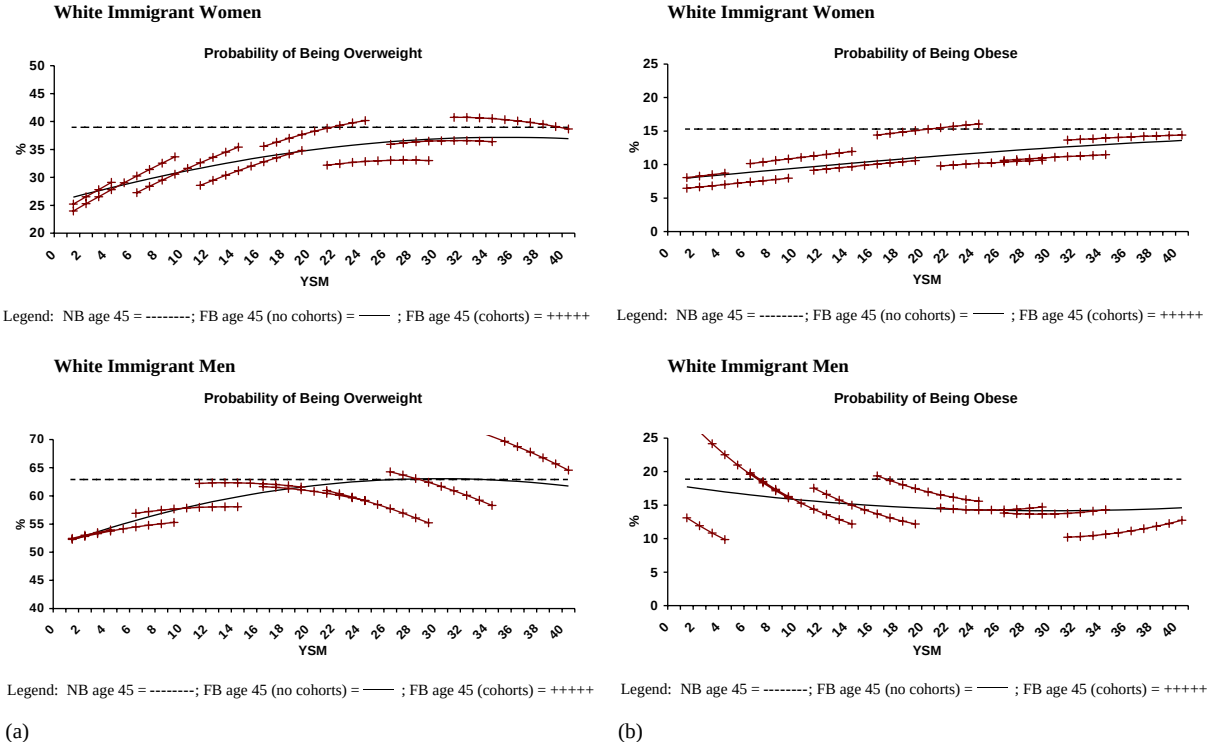
Table 2
Selected determinants of overweight and obesity

Variable	Overweight	Overweight	Overweight	Obese	Obese	Obese
(a) *Women (probit)*						
Foreign born	−0.365	−0.818	−0.217	−0.393	−0.551	−0.295
	(0.083)	(0.340)	(0.348)	(0.110)	(0.553)	(0.548)
Years-since-migration	0.018	0.042	0.025	0.012	0.015	0.001
	(0.007)	(0.020)	(0.020)	(0.009)	(0.033)	(0.032)
Years-since-migration^2	0.000	−0.001	−0.001	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Arrived 1996–2001		0.389	−0.066		0.158	−0.066
		(0.305)	(0.311)		(0.493)	(0.490)
Arrived 1991–1995		0.350	−0.092		0.042	−0.119
		(0.235)	(0.240)		(0.347)	(0.346)
Arrived 1986–1990		0.263	−0.092		0.214	0.106
		(0.185)	(0.185)		(0.279)	(0.277)
Arrived 1981–1985		0.148	0.005		0.093	0.032
		(0.132)	(0.140)		(0.170)	(0.170)
Arrived 1976–1980		0.223	−0.061		0.308	0.276
		(0.100)	(0.109)		(0.130)	(0.128)
Arrived 1966–1970		0.095	0.093		0.039	0.052
		(0.102)	(0.104)		(0.119)	(0.113)
Arrived pre-1966		0.203	0.428		0.159	0.206
		(0.152)	(0.205)		(0.185)	(0.183)
Ethnicity						
Chinese	−0.910	−0.916	−0.529	−0.873	−0.886	−0.594
	(0.089)	(0.089)	(0.104)	(0.128)	(0.126)	(0.167)
Japanese	−1.060	−1.048	−0.512	−0.959	−0.948	−0.749
	(0.185)	(0.184)	(0.204)	(0.322)	(0.321)	(0.334)
Korean	−0.590	−0.588	−0.463	−0.605	−0.615	−0.613
	(0.173)	(0.175)	(0.152)	(0.190)	(0.193)	(0.196)
South Asian	0.031	0.034	−0.367	0.029	0.027	0.088
	(0.083)	(0.083)	(0.094)	(0.114)	(0.114)	(0.122)
Arab/West Asian	−0.026	−0.021	−0.167	0.076	0.076	0.060
	(0.120)	(0.120)	(0.109)	(0.126)	(0.126)	(0.146)
Black	0.392	0.396	−0.192	0.229	0.231	0.148
	(0.077)	(0.078)	(0.102)	(0.094)	(0.094)	(0.142)
Hispanic	0.058	0.051	0.011	0.143	0.132	0.117
	(0.142)	(0.142)	(0.146)	(0.191)	(0.184)	(0.194)
Southeast Asian	−0.348	−0.351	−0.412	−0.349	−0.353	−0.200
	(0.102)	(0.101)	(0.120)	(0.193)	(0.192)	(0.210)
Filipino	−0.386	−0.406	−0.607	−0.101	−0.168	−0.126
	(0.174)	(0.168)	(0.140)	(0.296)	(0.279)	(0.270)
Neighborhood effects						
Relative concentration in CSD (RR)			0.069			0.015
			(0.025)			(0.031)
RR × group BMI			0.404			0.902
			(0.098)			(0.377)
Hypothesis tests						
Cohort effects (p-value)	—	0.358	0.4169	—	0.1965	0.1401
Cohort/YSM effects (p-value)	0.0023	0.0087	0.0183	0.0197	0.0519	0.0441
(Pseudo) R-squared	0.0649	0.0652	0.0760	0.0496	0.0503	0.0667
Sample size	64,615	64,615	64,615	64,615	64,615	64,615

Table 2 (*continued*)

Variable	Overweight	Overweight	Overweight	Obese	Obese	Obese
(b) *Men (probit)*						
Foreign born	−0.297	−0.071	−0.217	−0.041	0.691	0.595
	(0.084)	(0.361)	(0.348)	(0.161)	(0.616)	(0.556)
Years-since-migration	0.020	0.015	0.025	−0.011	−0.061	−0.054
	(0.007)	(0.021)	(0.020)	(0.012)	(0.036)	(0.032)
Years-since-migration^2	0.000	−0.001	−0.001	0.000	0.001	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)
Arrived 1996–2001		−0.211	−0.066		−0.869	−0.787
		(0.321)	(0.311)		(0.537)	(0.482)
Arrived 1991–1995		−0.217	−0.092		−0.335	−0.288
		(0.244)	(0.240)		(0.346)	(0.323)
Arrived 1986–1990		−0.155	−0.092		−0.327	−0.280
		(0.190)	(0.185)		(0.291)	(0.264)
Arrived 1981–1985		−0.045	0.005		−0.197	−0.171
		(0.142)	(0.140)		(0.204)	(0.191)
Arrived 1976–1980		−0.058	−0.061		0.033	0.038
		(0.111)	(0.109)		(0.156)	(0.155)
Arrived 1966–1970		0.102	0.093		−0.028	−0.038
		(0.105)	(0.104)		(0.115)	(0.113)
Arrived pre-1966		0.432	0.428		−0.207	−0.212
		(0.201)	(0.205)		(0.167)	(0.165)
Ethnicity						
Chinese	−0.811	−0.803	−0.529	−0.685	−0.716	−0.583
	(0.085)	(0.085)	(0.104)	(0.213)	(0.194)	(0.201)
Japanese	−0.487	−0.489	−0.512	−0.851	−0.849	−0.712
	(0.197)	(0.200)	(0.204)	(0.242)	(0.243)	(0.254)
Korean	−0.524	−0.514	−0.463	−0.450	−0.413	−0.417
	(0.150)	(0.149)	(0.152)	(0.182)	(0.183)	(0.182)
South Asian	−0.318	−0.312	−0.367	−0.417	−0.408	−0.379
	(0.075)	(0.074)	(0.094)	(0.101)	(0.099)	(0.106)
Arab/West Asian	−0.074	−0.065	−0.167	−0.208	−0.183	−0.219
	(0.099)	(0.098)	(0.109)	(0.126)	(0.123)	(0.137)
Black	−0.141	−0.130	−0.192	−0.093	−0.107	−0.171
	(0.086)	(0.086)	(0.102)	(0.141)	(0.135)	(0.156)
Hispanic	0.218	0.233	0.011	−0.016	0.003	−0.086
	(0.128)	(0.128)	(0.146)	(0.152)	(0.152)	(0.160)
Southeast Asian	−0.492	−0.480	−0.412	−0.836	−0.849	−0.732
	(0.109)	(0.109)	(0.120)	(0.196)	(0.196)	(0.197)
Filipino	−0.760	−0.758	−0.607	−0.897	−0.896	−0.736
	(0.153)	(0.158)	(0.140)	0(.213)	(0.220)	(0.221)
Neighborhood effects						
Relative concentration in CSD (RR)			0.069			0.059
			(0.025)			(0.043)
RR × Group BMI			0.404			0.861
			(0.098)			(0.476)
Hypothesis tests						
Cohort effects (*p*-value)	—	0.6025	0.5687	—	0.1855	0.1860
Cohort/YSM effects (*p*-value)	0.0082	0.0931	0.0937	0.675	0.2603	0.2612
(Pseudo) *R*-squared	0.0561	0.0565	0.0684	0.0384	0.0395	0.0545
Sample size	62,181	62,181	62,180	62,181	62,181	62,180

overweight and obese for a 'baseline' individual who is 45 years old, has finished high school, lives in Toronto, is single with no children, and lives in a rented house. In order to focus attention on YSM effects, we predict both measures holding all other factors constant, including age. For ease of presentation, we also restrict prediction



(a) (b)

Fig. 1. (a) Overweight probability by immigrant status, (b) obesity probability by immigrant status.

to white immigrants in these figures, although we allow for separate YSM profiles by ethnic group in the next section.

The probability that the 'baseline' white immigrant is overweight is predicted in Fig. 1a. Immigrant white women are around 15% less likely to be overweight on arrival than comparable native-born non-minority women, and this gap closes after between 20–30 years in Canada when immigrant rates of being overweight reach native-born levels. A similar pattern is evident for men, although the initial gap is smaller (around 10%). Thus there is clear evidence of a healthy immigrant effect in terms of being overweight, with an initial gap that narrows slowly with additional years in Canada. Also notable is the finding that male immigrants arriving prior to 1966 have significantly higher probability of being overweight. This is consistent with McDonald and Kennedy (2004) who find that this same cohort of immigrants is in relatively worse physical health than more recent immigrants and native-born men, ceteris paribus.

For the probability of being obese (in Fig. 1b), immigrant women are around 7% less likely to be obese on arrival in Canada, a figure comparable with what is reported in Antecol and Bedard (2003) for immigrant women on arrival in the United States. Convergence to native-born levels is slow and again occurs after between 20–30 years in Canada. Patterns for immigrant men across different arrival cohorts are more divergent although most arrival cohorts have obesity rates lower than native-born levels. If the general pattern is one of convergence to native-born levels, then the fact that obesity rates for recent immigrants are already at the native-born level suggests that there will be no significant change in obesity rates with YSM.

The basic specification of Eq. (1) is somewhat restrictive in that although it includes a set of ethnic group fixed effects, it imposes a constant YSM profile for all immigrants regardless of ethnic group. To allow the YSM profile to vary by ethnic group, we re-estimate specification (1) (but without the cohort effects) for immigrants belonging to specific ethnic groups. For comparison purposes, we also included native-born whites and individuals of the same ethnic group in each sub-sample where sample sizes permit, so it was possible to compare overweight/obesity profiles for each immigrant ethnic group to native-born people of the same ethnic group and to native-born whites. For brevity, we do not report estimation results of this exercise but instead briefly discuss some key results. As well, because of a very low incidence of obesity for some ethnic groups, we limit the discussion to overweight.

Chinese women immigrants are 30% less likely to be overweight than native-born white women on arrival in Canada (and 10% less likely to be overweight than native-born Chinese women), and in contrast to the pooled results, there is very little change even after many years in Canada. Southeast Asian women immigrants are similarly less likely to be overweight than native-born whites or Southeast Asians, and although there is a gradual increase with YSM, immigrant levels remain substantially below native-born overweight levels. A similar pattern is evident for Filipino immigrants and Arab immigrants.

In contrast, the other ethnic immigrant groups show significant convergence in overweight rates with YSM to native-born levels. South Asian immigrant women are initially around 10% less likely to be overweight than native-born whites and this gap is closed within 15 years. Black immigrant women are marginally less likely to be overweight on arrival in Canada and Hispanic women are over 20% less likely to be overweight on arrival, but overweight rates for both groups increase markedly with YSM and reach 60% after around 20 years in Canada. White immigrants display similar patterns—they are around 15% less likely to be overweight on arrival in Canada, and overweight incidence converges slowly to native-born white levels after around 30 years in Canada. Results for the incidence of being overweight for men are generally similar, except that Arab immigrant men also surpass native-born white overweight levels after around 12 years in Canada.[5]

Ethnic social network results

While differences in overweight and obesity rates across ethnic groups can be due to a myriad of factors, differences in the time path of rates are likely due in large part to differences in behavioral choices with respect to diet and activity levels, and these dimensions may well depend on the behavior of others in one's local area. If a large and close-knit ethnic community is present in a local area, then opportunities for recent immigrants to maintain their connections to home country language and culture are greater, and opportunities and/or pressures to acculturate are less. If the weight profile of the ethnic community is less than average, one might then expect an individual immigrant of that ethnic group also to be less likely to be overweight.

The key econometric results are contained in the lower part of columns 3 and 6 in Tables 2a and b. For both men and women, and for each measure, the pattern is the same: the coefficient on relative concentration is positive, though sometimes not significant, and the coefficient on the ethnic network interaction term is uniformly positive and significant. The positive and significant sign implies two things. First, the higher is the ethnic group incidence of being overweight or obese, the greater are the chances that an individual of the same ethnic group is overweight or obese. Note that this result is significant *after* controlling for ethnic group fixed effects as well as local area fixed effects, observable socio-economic and demographic factors, and selection effects of ethnic groups into particular neighborhoods. Second, the higher is the ethnic group concentration in a CSD, the more likely a member of that ethnic group is to be overweight/obese *if* the average incidence of being overweight/obese for the group is higher than for the overall Canadian population. (Recall that the interaction term is the product of relative concentration and the difference between the group's incidence of being overweight and the overall population's incidence of being overweight.) Including network effects reduces the magnitude of all of the immigrant and ethnic group variables, implying that at least some of the differences between immigrant minority groups and native-born whites are due to the role of local ethnic group effects.

To get some idea of the magnitude of the ethnic social network effects, we use the results reported in Tables 2a and b to predict rates of being overweight and obese in three hypothetical scenarios. The first is what the likelihood of each condition would be for an individual of a particular ethnic group if that individual lived in a CSD with a relatively high concentration of people of the same ethnic group. The second is what the likelihood would be for the same individual who lived in a CSD that has a low concentration of people from the same ethnic group. The third is what the likelihood would be for the same individual who lived in a high concentration CSD but with the average rate of being overweight or obese for that person's ethnic group set instead to the Canadian average. Table 3a reports predictions of the probability that a base-case immigrant is overweight, while Table 3b contains predictions of the probability that a base-case immigrant is obese. For brevity, we restrict discussion to women, though the general conclusions are similar for men.

Comparing the first two columns of Table 3a, it can be seen that a Chinese immigrant woman is almost twice as likely to be overweight if she lives in an area with a relatively small local Chinese community than if she lives in an area with a relatively large Chinese community (11.9% compared to 6% when YSM = 5).

[5]If mother tongue is used to identify ethnic groups, white immigrants can be disaggregated into specific European language groups. Immigrants with English as their mother tongue are around 6% less likely to be overweight on arrival in Canada compared to native-born English speakers, and this is true for both men and women. The results also indicate increasing rates of being overweight as YSM increases, but the rate of increase is smaller and the YSM terms are jointly significant only for men.

Table 3
Predicted percentage by ethnic group and relative concentration

	Chinese			South Asian			Black		
Concentration	High	Low	High	High	Low	High	High	Low	High
Incidence of obesity	Average FB Chinese	Average FB Chinese	Average all Canadians	Average FB S.Asian	Average FB S.Asian	Average all Canadians	Average FB Black	Average FB Black	Average all Canadians
(a) *Overweight*[a]									
Women									
YSM = 5	6.0	11.9	15.7	33.8	31.2	35.9	52.2	40.7	45.0
YSM = 10	7.0	13.5	17.6	36.6	33.9	38.7	55.3	43.7	48.0
YSM = 15	7.0	13.5	17.5	36.6	33.9	38.7	55.2	43.6	48.0
YSM = 20	9.6	17.6	22.3	43.2	46.3	45.4	61.9	50.5	54.8
% overweight	10.3	10.3	38.5*	35.6	35.6	38.5*	48.0	48.0	38.5*
Men									
YSM = 5	26.4	37.7	55.1	50.1	45.6	61.4	58.5	52.7	67.7
YSM = 10	28.8	40.5	57.9	53.0	48.5	64.1	61.3	55.5	70.4
YSM = 15	33.5	45.7	63.0	58.2	53.7	69.0	66.3	60.7	74.8
YSM = 20	31.1	43.0	60.4	55.6	51.0	66.5	63.8	58.1	72.6
% overweight	25.8	25.8	57.0*	45.2	45.2	57.0*	46.7	46.7	57.0*
(b) *Obese*[b]									
Women									
YSM = 5	0.8	2.5	3.4	9.2	10.8	12.7	16.2	12.4	14.0
YSM = 10	1.4	4.2	5.6	13.7	15.7	18.2	22.5	17.8	19.9
YSM = 15	1.2	3.7	4.9	12.2	14.1	16.5	20.6	16.1	18.0
YSM = 20	2.2	6.2	8.0	18.1	20.5	23.5	28.4	23.0	25.3
% obese	2.0	2.0	13.1*	9.6	9.6	13.1*	14.8	14.8	13.1*
Men									
YSM = 5	4.0	6.0	11.9	8.5	9.1	16.4	16.1	13.4	22.1
YSM = 10	2.6	4.1	8.5	5.9	6.4	12.1	11.9	9.7	16.9
YSM = 15	2.3	3.7	7.9	5.5	5.9	11.3	11.1	9.0	15.8
YSM = 20	3.0	4.7	9.6	6.7	7.2	13.5	13.2	10.8	18.5
% obese	3.7	3.7	14.8*	7.2	7.2	14.8*	10.5	10.5	14.8*

Note: High concentration denotes a relative ratio of ethnic population concentration of 6.0, sufficient to rank the CSD among the top five CSDs for that ethnic group. * Indicates that the figure is the adult Canadian average rate.

[a]Low concentration denotes a relative ratio of 0.5.

[b]Low concentration denotes a relative ratio of 0.5.

That is, a large local ethnic community of Chinese, who are less likely to be overweight than the average Canadian, exerts an economically significant negative influence on the probability that an immigrant Chinese women who resides in that area will be overweight. If instead, the incidence of being overweight of the Chinese community was equal to the Canadian average, the likelihood that a Chinese immigrant is overweight is even larger: 15.7% when YSM = 5. A similar though less pronounced pattern is evident for Southeast Asians.

For black immigrant women, the fact that their ethnic community is more likely to be overweight than the typical Canadian woman means that the probability that a recent black immigrant is overweight is substantially higher than native-born levels, at 52.2%. A lower relative concentration mitigates the effects of the ethnic network on the probability that a recent black immigrant is overweight: if the immigrant resided in an area with a low concentration of her ethnic group, then the likelihood of being overweight would be 40.7%, a figure that is close to the Canadian average.

Conclusion

In this paper, we find that for most immigrants to Canada, the probability of being overweight or (for women) obese is lower on arrival than for comparable native-born Canadians, but increases gradually with additional years in their new country. After approximately 20–30 years in Canada, these indicators of unhealthy weight meet or exceed native-born levels.

This evidence of a 'healthy immigrant effect' in terms of weight mirrors what has been found in recent studies of physical health and well-being. We also find that the increasing incidence of excess weight with years in Canada is tempered by the presence of significant ethnic social network effects: if an individual resides in a neighborhood with a relatively large ethnic community and the ethnic group is less likely to be overweight or obese than the average Canadian, then the individual is also less likely to be overweight or obese.

These are important results for health policy. The increasing rates of being overweight and obese among recent immigrants with years in Canada may well contribute to deteriorating physical health for immigrants in future years. This is likely to be especially true in terms of physical conditions most closely associated with excess weight, such as diabetes, high blood pressure, heart disease, and arthritis. The results of this paper are also important because they provide some evidence on the current debate about what actually underpins the observed deterioration in immigrant health with years in Canada. Since changes in weight over time likely reflect lifestyle choices related to diet and activity, the results suggest evidence of acculturation whereby ethnic minority groups take on characteristically Canadian ways of living. The significance of our specific controls for local ethnic neighborhood effects also supports this contention. Thus, our results imply that it is changes in lifestyle choices rather than health access or other issues that might be contributing to the narrowing of new immigrants' health advantage with respect to comparable native-born Canadians.

One notable result that warrants future research is that the immigrants of Chinese ethnicity exhibit little change in weight with increasing years in Canada. These immigrants have the lowest rates of being overweight and obese, and unlike what was found for other immigrants, overweight and obesity rates show no significant increase over time relative to native-born individuals. Chinese Canadians as a group are the most populous of the visible minority groups, and they are also the most geographically concentrated. One explanation for the absence of changes in weight with YSM that is consistent with our econometric results is that local Chinese-Canadian communities are sufficiently large and well-established that the impetus to acculturate is significantly reduced.

Acknowledgements

We would like to thank Nick Biddle, Brian Ferguson, Emmanuel Pierard, participants at the 2004 CEA meetings in Toronto and two anonymous referees for helpful comments. We also thank Yingfeng Sun for excellent research assistance. Financial assistance from SSHRC (grant # 410-2002-1357) is gratefully acknowledged. The econometric analysis in this paper was conducted at the Statistics Canada-CRISP Research Data Centre at the University of New Brunswick.

References

Antecol, H., & Bedard, K. (2003). Unhealthy assimilation: Do immigrants converge to American weights?, unpublished paper.

Beiser, M., Dion, R., Gotowiec, A., Hyman, I., & Vu, N. (1997). Immigration, acculturation and health. *Final report*. National Health Research and Development Program.

Bertrand, M., Luttmer, E., & Mullainathan, S. (2000). Network effects and welfare cultures. *The Quarterly Journal of Economics*, *115*, 1019–1055.

Borjas, G. (1999). Immigration and welfare magnets. *Journal of Labor Economics*, *17*(4), 607–637.

Cairney, J., & Ostbye, T. (1999). Time since immigration and excess body weight. *Canadian Journal of Public Health*, *90*(2), 120–124.

Cardoso, M., Hamada, G., deSouza, J., Tsugane, S., & Tokudome, S. (1997). Dietary patterns in Japanese migrants to Southeastern Brazil and their descendants. *American Journal of Epidemiology*, *7*, 198–204.

Cawley, J., & Danziger, S. (2004). Obesity as a barrier to the transition from welfare to work. *NBER working paper w10508*.

Chiswick, B., & Miller, P. (2004). Do enclaves matter in immigrant adjustment? *Paper presented at the 2004 midwest economics association meetings in Chicago*.

Crimmins, E., Hayward, M., & Seeman, T. (2004). Race/ethnicity, socioeconomics status, and health. In Anderson, Bulatao, & Cohen (Eds.), *Critical perspectives on racial and ethnic differences in health in late life, committee on population, National Research Council*. Washington, DC: The National Academies Press (Chapter 9).

Gee, E., Kobayashi, K., & Prus, S. (2003) Examining the "Healthy Immigrant Effect" in later life: Findings from the Canadian Community Health Survey. *SEDAP research paper #98*, McMaster University.

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

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

Jasso, G., Massey, D., Rosenzweig, M., & Smith, J. (2004). Immigrant health—selectivity and acculturation. In A. Anderson, A. Bulatao, & A. Cohen (Eds.), *Critical perspectives on racial and ethnic differences in health in late life, committee on population, National Research Council*. Washington DC: The National Academies Press (Chapter 7).

Leclere, F., Jensen, L., & Biddlecom, A. (1994). Health care utilization, family context, and adaptation among

immigrants to the United States. *Journal of Health and Social Behavior*, *35*(4), 370–384.

Manski, C. (1993). Identification of endogenous social effects: The reflection problem. *Review of Economic Studies*, *60*, 531–542.

McDonald, J. T., & Kennedy, S. (2004). Insights into the 'healthy immigrant effect': Health status and health service use of immigrants to Canada. *Social Science and Medicine*, *59/8*, 1613–1627.

Newbold, K. B., & Danforth, J. (2003). Health status and Canada's immigrant population. *Social Science and Medicine*, *57*(10), 1981–1995.

Oakes, J. M. (2004). 'The (mis)estimation of neighborhood effects: Causal inference for a practicable social epidemiology. *Social Science and Medicine*, *58*, 1929–1952.

Patterson, R., Frank, L., Kristal, A., & White, E. (2004). A Comprehensive examination of health conditions associated with obesity in older adults. *American Journal of Preventative Medicine*, *27*(5), 385–390.

Perez, C. (2002). Health status and health behaviour among immigrants. *Health reports*, *13*(Supplement).

Pomerleau, J., & Ostbye, T. (1997). The relationship between place of birth and some health characteristics in Ontario. *Canadian Journal of Public Health*, *88*(5), 337–345.

Salant, T., & Lauderdale, D. (2003). Measuring culture: A critical review of acculturation and health in Asian immigrant populations. *Social Science and Medicine*, *57*, 71–90.

Stephen, E., Foote, K., Hendershot, G., & Schoenborn, C. (1994). Health of the foreign-born population. *Advance Data from Vital and Health Statistics*, *241*, 1–10.

Zhang, Q., & Wang, Y. (2004). Socioeconomic inequality of obesity in the United States: Do gender, age, and ethnicity matter? *Social Science and Medicine*, *58*, 1171–1180.