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ORIGINAL ARTICLE

Socio-demographic influences on food purchasing among Canadian households

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Objective: To characterize the relationships between selected socio-demographic factors and food selection among Canadian households.
Design: A secondary analysis of data from the 1996 Family Food Expenditure survey was conducted ($n=10\,924$). Household food purchases were classified into one of the five food groups from *Canada's Food Guide to Healthy Eating.* Parametric and non-parametric modelling techniques were employed to analyse the effects of household size, composition, income and education on the proportion of income spent on each food group and the quantity purchased from each food group.
Results: Household size, composition, income and education together explained 21–29% of the variation in food purchasing. Households with older adults spent a greater share of their income on vegetables and fruit ($P<0.0001$), whereas households with children purchased greater quantities of milk products ($P<0.0001$). Higher income was associated with purchasing more of all food groups ($P<0.0001$), but the associations were nonlinear, with the strongest effects at lower income levels. Households where the reference person had a university degree purchased significantly more vegetables and fruit, and less meat and alternatives and 'other' foods ($P<0.0001$), relative to households with the lowest education level.
Conclusions: Household socio-demographic characteristics have a strong influence on food purchasing, with the purchase of vegetables and fruit being particularly sensitive. Results reinforce concerns about constraints on food purchasing among lower income households. Furthermore, the differential effects of income and education on food choice need to be considered in the design of public health interventions aimed at altering dietary behaviour.
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Introduction

In order to explore the role of diet in socio-economic differentials in health and disease, relationships between socio-economic status (SES) and different aspects of the diet have been examined in several different countries (Smith and Baghurst, 1992; Irala-Estevez *et al*., 2000; Dubois and Girard, 2001; Groth *et al*., 2001; Giskes *et al*., 2002). Associations between SES and diet have also been examined along with various other factors (e.g., family status) in order to gain a better understanding of food consumption patterns in relation to dietary recommendations (Roos *et al*., 1998; Perez, 2002). The measures of SES employed in these studies vary, where a single variable, such as income, education, occupation or a composite measure based on all three, is used as an indicator of SES (Roos *et al*., 1998; Irala-Estevez *et al*., 2000; Dubois and Girard, 2001; Giskes *et al*., 2002), or two or three variables (e.g., income and education) are included together in one model (Smith and Baghurst, 1992; Groth *et al*., 2001; Perez, 2002). A number of studies conducted in different countries have shown income and education to have similar effects on food consumption, where higher income and higher education are associated with greater consumption of vegetables and fruit (Billson *et al*., 1999; Nayga *et al*., 1999; Irala-Estevez *et al*., 2000; Groth *et al*., 2001; Giskes *et al*., 2002; Perez, 2002), and with diets more in accord with dietary guidelines (Roos *et al*., 1998; Mancino *et al*., 2004). However, a few studies have

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found income and education to have different effects on the consumption of certain food groups (e.g., grains and milk products) (Smith and Baghurst, 1992; Nayga *et al*., 1999).

Some studies indicate that marital and family status are also important in explaining variations in food consumption among adults (Roos *et al*., 1998; Billson *et al*., 1999; Perez, 2002; Mancino *et al*., 2004), and that accounting for these factors can attenuate socio-economic differences in diet (Martikainen *et al*., 2003). Among adults, being married has been associated with the consumption of more vegetables and fruit (Billson *et al*., 1999; Perez, 2002), and being married or married with children has been associated with greater compliance with dietary guidelines (Roos *et al*., 1998; Mancino *et al*., 2004), although the strength of these associations varies by gender.

Given that food choices are not solely the domain of the individual, but are also influenced by the family context, decisions around food at the level of the household are important determinants of food consumption. Studies conducted at the household level have shown that higher income or higher education is associated with greater purchasing of recommended foods (i.e., vegetables and fruit, low-fat milk, and high-fibre foods) (James *et al*., 1997; Trichopoulou *et al*., 2002; Kirkpatrick and Tarasuk, 2003), consistent with studies of individual intakes. Examinations of US household food expenditure surveys have shown that household composition, household income and education level of household head all influence food purchasing, albeit in different ways (Paulin, 1998; Huang and Lin, 2000; Curry Raper *et al*., 2002; Stewart *et al*., 2003), but inferences from these studies are limited by their singular focus on food spending (Paulin, 1998; Curry Raper *et al*., 2002), and by methodological problems with one of the expenditure surveys (Milans, 1991; Huang and Lin, 2000).

This study was undertaken to characterize the relationships between different socio-demographic factors (i.e., household size and composition, household income and education) and food selection among Canadian households.

Methods

Family Food Expenditure survey

In Canada, household food expenditures are monitored through the Family Food Expenditure (FOODEX) survey, which is conducted periodically by Statistics Canada.

The survey sample is selected from the Canadian Labour Force Survey sampling frame through stratified multistage sampling, and is representative of the non-institutionalized Canadian population, excluding persons living on native reserves (Statistics Canada, 1999). The sample is drawn for the whole year and then divided into monthly subsamples to allow for seasonal variation and other changes throughout the year that may affect food expenditures. Socio-demographic data are collected through an interview with the household reference person, the person mainly responsible for the household's financial maintenance. The reference person maintains a diary of household food expenditures over a 2-week period, recording the type and quantity of food and beverages purchased from stores, price paid and the type of store where food was purchased (e.g., supermarket, convenience store, specialty store). Information on food expenditures at restaurants locally and on day trips is recorded on a weekly basis, as are the number of meals served to guests and received free. Food expenditures at restaurants and stores while away from home overnight or longer are estimated for the previous month and converted to a weekly expenditure. Details on the types of foods and the composition of meals obtained in restaurants, received free or served to guests are not recorded.

We used data from the 1996 FOODEX survey, as this was the most recent survey containing detailed socio-demographic information on each household.

Analytical sample

A total of 10 924 households were sampled in the 1996 survey. Households were excluded if they did not report income or if they reported zero income; if they did not report education level; if they reported purchases for only 1 week; or, if they reported zero food expenditures at stores. In total, 955 households were excluded (9% of the original sample), resulting in a final analytical sample size of 9969 households. Compared to included households, excluded households were more likely to be one-person households, less likely to be in the higher income quintiles, and the household reference person was less likely to have post-secondary education (data not shown). Food purchasing patterns among excluded households who reported food purchases were similar to those found among included households (data not shown).

Measures

Food purchased in stores was categorized by Statistics Canada using 200 different food codes (Statistics Canada, 1999). We classified 182 food codes into five food groups (i.e., grain products, vegetables and fruit, milk products, meat and alternatives, and 'other' foods), based on the food categories in *Canada's Food Guide to Healthy Eating* (*CFGHE*) (Health Canada, 1992) (Table 1). The 18 remaining food codes, which together comprised only 7% of food expenditures at stores, were omitted from the analysis as they did not fit into any one food group. Recognizing that there are marked differences in nutritional and other qualitative characteristics of foods within the *CFGHE* groups, we subdivided the five food groups into 17 smaller food groups, differentiating foods in terms of nutritional quality insofar as the existing coding in FOODEX permitted such differentiation (Table 1). However, as divisions of food groups become more refined (i.e., dividing milk products into lower fat milk, higher fat milk, cheese/yogourt and ice cream/other)

Table 1 Description of food groups used in analyses

Food group and food group subdivisions[a]	*Types of foods included*
Grain products (9)	Breads, pasta, rice, grains, breakfast cereals
Grains (8)	Breads, pasta, rice, grains
Breakfast cereals (1)	Ready-to-eat breakfast cereals
Vegetables and fruit (59)	Fresh, frozen, and canned, including juices
'ABC-rich' (31)	Containing amounts of vitamin A, C and folate at or above the 75th percentile level
'Other' (28)	Containing amounts of vitamin A, C and folate below the 75th percentile level
Milk products (18)	Milk, cheese, yogourt, ice cream
Lower fat milk (3)	Skim and 1% fluid milks
Higher fat milk (4)	2 and 3.2% fluid milks
Cheese/yogourt (7)	Regular and processed cheeses, yogourt
Ice cream/other (4)	Ice cream and ice milk novelties
Meat and alternatives (58)	Beef, pork, poultry, fish, eggs, beans, nuts
Lower fat meat (18)	Fat content less than or equal to the 50th percentile level
Higher fat meat (15)	Fat content more than the 50th percentile level
Poultry/fish (17)	Chicken, turkey, fish
Eggs (1)	
Nuts/beans (7)	Variety of nuts, peanut butter, legumes
'Other' foods (38)	Fats and oils, sugars/sweeteners, desserts and savory snacks, non-alcoholic beverages
Oils (6)	Butter, margarine, cooking/salad oils
Sugars (5)	Sugars, syrups, jams/jellies, candies
Desserts/snacks (19)	Pies, cakes, cookies, chips
Non-alcoholic beverages (8)	Coffee, tea, fruit drinks, carbonated beverages

[a]Numbers in parentheses denote the number of food codes included in that food group.

estimates become less precise partly because of the occurrence of more zeroes in the food purchase measures (i.e., more households not purchasing particular foods over a 2-week period). Thus, we were limited in the extent to which we could subdivide food groups for analyses.

Average weekly expenditures and quantities purchased were calculated for each food group and subgroup. All quantities were calculated as 'edible quantities' using conversion factors obtained from Agriculture and Agri-Food Canada, which account for trim and cooking losses (L Robbins, 2001, personal communication). In order to examine proportional allocations to different food groups, food expenditure shares were calculated as the ratio of average weekly expenditures multiplied by 52 to total annual household income (before tax).

Statistical analysis

All statistical analyses were performed using SAS/PC Version 8.02 (SAS Institute, Cary, NC, USA) or S-Plus Version 6.2 (Insightful Corporation). Each household in the FOODEX survey was assigned a weight by Statistics Canada to account for unequal probabilities of selection, non-response bias and population demographics (Statistics Canada, 1999). Descriptive statistics for our analytical sample were calculated using analytic weights, obtained by dividing the originally assigned weight by the average of the original weights for those households included in our sample. The weighted sample is designed to be nationally representative.

Multiple regression analysis was used to estimate the relationships between household socio-demographic characteristics and food purchasing. Quantities of food purchased and expenditure shares were the two dependent variables modelled for the five food groups, but only quantity was examined in the analyses of the smaller subgroups. Quantities of food were log-transformed to improve model fit. Because in some cases, zero quantities were purchased, a constant (one) was added to avoid taking the logarithm of zero. The explanatory variables were household size and composition, per capita income (i.e., household income/household size), and education level of the reference person. Both the household size and per capita income variables were log-transformed. See Appendix A for details. Preliminary analyses testing different types of models, including linear and polynomial regression models, indicated that a model based on the above-mentioned log-transformations provided the best fit for the data. Household composition was represented by two variables: the proportion of household members less than 15 years of age and the proportion of household members over 65 years of age. Dummy variables were entered for education, representing four increasing levels of education, with the lowest level being omitted as the reference group. Households with food expenditure shares greater than one were omitted as

implausible. These constituted less than 0.5% of the analytical sample.

The amounts and types of foods purchased in stores could be influenced by what food is obtained in other ways by household members (i.e., in restaurants, workplaces). A variable 'meals out' was constructed, representing the average weekly number of meals received free and purchased from restaurants (e.g., table service, fast food, cafeterias) locally and while away from home overnight or longer. Once the final regression model had been developed, this 'meals out' variable was added to adjust for the effects of eating out and was found to have no impact on the relationships between socio-demographic characteristics and food purchasing.

Two additional analyses were conducted to further explore the impacts of income and education on food purchasing. There is some evidence indicating that the effects of income on food purchasing diminish as income increases (Horton and Campbell, 1991). As there is a limit to the amount of food that can be consumed, we expected income effects to level off at a certain point. For these reasons, income/quantity relationships were examined further using a partial linear model in order to capture any nonlinearities in the effects of income. See Appendix A for details.

In our main analyses, the education level of the household head (i.e., reference person) was used as the indicator for household education; however, given the evidence that an individual's dietary choices can be influenced by the spouse's social position (Martikainen *et al*., 2003), additional analyses were conducted among households with a married couple to determine whose education level had the strongest effect on food purchasing. We used multiple regression analysis, similar to that described above, where the education levels of both the male and female were included in the model, rather than the reference person's education level. As spousal education levels were correlated ($r = 0.58$, $P < 0.0001$), differential education effects may be difficult to detect.

Results

Socio-demographic characteristics and purchasing patterns of the analytical sample

The mean annual household income before taxes was \$46 960 (s.d. = \$37 083, median = \$39 600), with income ranging from \$300 to \$848 000. The majority of households were composed of at least two people age 25–64 years (Table 2), and in 41% of the households either the reference person, spouse, or both had completed post-secondary education (Table 3). A comparison of our weighted sample to the Canadian population, based on 1996 census data (Statistics Canada, 1997), indicated our sample was unbiased with regards to household size, income and education (Table 3), and therefore retained its national representativeness, even after exclusions.

Table 2 Household composition characteristics of the analytical sample

Age category (years)	*% Households (n = 9969)*		
	0 persons	*1 person*	*⩾2 persons*
⩾65	77	15	8
25–64	19	26	55
15–24	75	15	10
<15	70	13	17

Table 3 Comparison of selected socio-demographic characteristics of the analytical sample with those of the Canadian population

	Analytical sample (n = 9969 households)	*Canadian population*[a] *(n = 10 820 055 households)*
Household size (%)		
1	23	24
2	32	32
3	16	17
4	18	17
5 or more	10	10
Household income (mean, \$)		
Households with 1 person	23 545	24 549
Households with 2 or more persons	54 110	54 949
Education level (%)		
Post-secondary graduates	41[b]	40[c]

[a](Statistics Canada, 1997).
[b]Percentage of households in which either the reference person, spouse or both are post-secondary graduates.
[c]Percentage of population 15 years and over who are post-secondary graduates.

Food expenditures in stores comprised 76% of total food expenditures (s.d. = 22%, median = 80%), with the remaining 24% being spent at restaurants (s.d. = 22%, median = 20%). On average, 13% of household income was spent on food in stores (s.d. = 25%, median = 9.6%). The largest average share of income was allocated to the meat and alternatives food group (3.7%), which may be because of the high cost of these foods, as suggested by the high level of expenditure and low quantity purchased, relative to the rest of the food groups (Table 4).

Associations between food purchasing and household socio-demographic characteristics

Household size, composition, income and education together explained a substantial portion of the variation in food purchasing (21–29%) (Tables 5 and 6). The variables with the greatest statistical significance were household size and (per-capita) income. An increase in household size was associated with purchasing more from all food groups (Table 5), although declines in expenditure shares indicated

Table 4 Reported purchase, average weekly quantities, expenditures and expenditure shares for the major food groups and food subgroups, $n = 9969$

Food group	*Percent households reporting purchase*	*Weekly quantity* [a]	*Weekly expenditure*	*Expenditure share* [b]
		Mean ± s.d. (median) (kg)	*Mean ± s.d. (median) ($)*	*Mean ± s.d. (median) (%)*
Grain products	95.7	3.61 ± 3.74 (2.61)	8.78 ± 7.29 (7.07)	1.43 ± 2.36 (0.96)
Grains	94.8	3.30 ± 3.56 (2.31)	6.93 ± 5.89 (5.59)	1.15 ± 2.18 (0.75)
Breakfast cereals	46.3	0.32 ± 0.56 (0)	1.86 ± 2.94 (0)	0.28 ± 0.56 (0)
Vegetables and fruit	96.5	8.49 ± 7.53 (6.77)	16.03 ± 2.79 (13.35)	2.63 ± 6.59 (1.72)
'ABC-rich'	92.6	3.65 ± 3.78 (2.73)	7.75 ± 7.15 (5.98)	1.26 ± 2.96 (0.78)
'Other'	94.4	4.84 ± 4.98 (3.65)	8.27 ± 7.05 (6.83)	1.37 ± 3.88 (0.88)
Milk products	96.8	7.29 ± 7.47 (5.17)	11.26 ± 8.96 (9.20)	1.82 ± 3.42 (1.22)
Lower fat milk	35.6	1.57 ± 3.71 (0)	1.35 ± 2.69 (0)	0.19 ± 0.61 (0)
Higher fat milk	73.6	4.25 ± 6.27 (2.39)	3.59 ± 4.42 (2.29)	0.64 ± 1.34 (0.32)
Cheese/yogourt	75.0	0.68 ± 0.88 (0.43)	4.66 ± 5.22 (3.23)	0.72 ± 1.54 (0.41)
Ice cream/other	53.8	0.79 ± 1.32 (0.15)	1.67 ± 2.49 (0.75)	0.27 ± 1.28 (0.07)
Meat and alernatives	95.5	3.06 ± 3.19 (2.35)	22.99 ± 21.98 (17.93)	3.69 ± 7.96 (2.34)
Lower fat meat	60.4	0.61 ± 1.50 (0.23)	5.86 ± 10.64 (2.58)	0.92 ± 2.55 (0.32)
Higher fat meat	84.4	1.17 ± 1.41 (0.79)	8.29 ± 8.78 (6.09)	1.36 ± 3.29 (0.79)
Poultry/fish	70.8	0.61 ± 1.10 (0.30)	6.70 ± 10.41 (3.58)	1.05 ± 2.47 (0.48)
Eggs	60.5	0.40 ± 0.54 (0.35)	1.06 ± 1.28 (0.92)	0.20 ± 1.21 (0.08)
Nuts/beans	41.2	0.28 ± 0.63 (0)	1.08 ± 2.09 (0)	0.17 ± 0.47 (0)
'Other' foods	95.7	7.70 ± 9.33 (4.73)	16.79 ± 14.26 (13.43)	2.73 ± 5.93 (1.81)
Oils	62.2	0.66 ± 1.01 (0.39)	2.50 ± 3.72 (1.68)	0.43 ± 1.46 (0.20)
Sugars	40.1	0.52 ± 1.17 (0)	0.99 ± 1.85 (0)	0.17 ± 0.52 (0)
Desserts/snacks	86.3	1.28 ± 1.59 (0.82)	7.67 ± 8.24 (5.25)	1.17 ± 2.39 (0.72)
Beverages	80.1	5.26 ± 8.23 (2.37)	5.82 ± 6.28 (4.07)	0.99 ± 3.32 (0.53)

[a]All quantities have been converted to edible quantities to account for losses because of trimming and cooking.
[b]Expenditure Share = ((Average weekly expenditure on food group × 52)100)/(Total annual household income).

Table 5 Associations between household socio-demographic characteristics and quantity of food purchased from each of the five major food groups, $n = 9921$[a]

	Log (quantity purchased) *Beta*[b] *(standard error)*, P-*value*				
	Grain products	*Vegetables and fruit*	*Milk products*	*Meat and alternatives*	*'Other' foods*
Log (household size)[c]	0.658 (0.014)****	0.775 (0.017)****	0.776 (0.017)****	0.645 (0.013)****	0.842 (0.020)****
Proportion less than 15 years[d]	−0.116 (0.039)***	−0.213 (0.047)****	0.303 (0.046)****	−0.307 (0.036)****	−0.302 (0.054)****
Proportion over 65 years[d]	0.075 (0.019)****	0.259 (0.023)****	0.148 (0.022)****	0.043 (0.018)*	−0.130 (0.026)****
Log (per-capita income)[e]	0.038 (0.010)****	0.164 (0.013)****	0.083 (0.012)****	0.068 (0.010)****	0.081 (0.014)****
Education[f] *(% households)*					
<9 years (ref) (13)	—	—	—	—	—
Secondary (40)	−0.010 (0.020)	−0.011 (0.025)	0.035 (0.024)	−0.040 (0.019)*	0.010 (0.028)
Some post-secondary (14)	−0.007 (0.025)	0.015 (0.030)	0.007 (0.029)	−0.090 (0.023)****	−0.056 (0.034)
Post-sec non-university (19)	0.007 (0.023)	0.060 (0.028)*	0.064 (0.028)*	−0.073 (0.022)**	0.009 (0.033)
University degree (15)	0.030 (0.026)	0.142 (0.031)****	0.092 (0.030)**	−0.128 (0.024)****	−0.137 (0.036)****
Adjusted R^2	0.238	0.207	0.279	0.229	0.221

[a]Households with expenditure shares greater than one ($n = 48$) were omitted from analytical sample.
[b]Obtained from multiple regression models including all socio-demographic variables.
[c]Beta × 100 is the percent change in quantity purchased when household size doubles, controlling for household composition, income and education effects.
[d]Beta × (change in proportion) is the corresponding percent change in quantity purchased, controlling for household size, income and education effects.
[e]Beta × 10 is the percent change in quantity purchased when income increases by 10%, controlling for household size, composition and education effects.
[f]Beta × 100 is the percent change in quantity purchased relative to the reference group, controlling for household size, composition and income effects.
****$P < 0.0001$, ***$P < 0.001$, **$P < 0.01$, *$P < 0.05$.

'economies of scale' (i.e., larger households spend less per person than smaller ones, holding per capita income constant) (Table 6).

Households with the same number of people, but with more older adults (over 65 years) than younger adults (age 15–64 years) purchased significantly more from all food

Table 6 Associations between household socio-demographic characteristics and expenditure shares allocated to each of the five major food groups, $n = 9921$[a]

	Expenditure shares *Beta*[b] *(standard error)*, P-*value*				
	Grain products	*Vegetables and fruit*	*Milk products*	*Meat and alternatives*	*'Other' foods*
Log (household size)[c]	−0.294 (0.031)****	−0.543 (0.052)****	−0.429 (0.038)****	−0.404 (0.081)****	−0.424 (0.057)****
Proportion less than 15 years[d]	−0.133 (0.084)	−0.781 (0.140)****	0.054 (0.102)	−1.824 (0.218)****	−0.722 (0.155)****
Proportion over 65 years[d]	0.029 (0.041)	0.632 (0.068)****	0.012 (0.050)	−0.063 (0.106)	−0.003 (0.075)
Log (per-capita income)[e]	−1.251 (0.022)****	−1.905 (0.037)****	−1.595 (0.027)****	−2.813 (0.058)****	−2.210 (0.041)****
Education[f] *(% households)*					
<9 years (ref) (13)	—	—	—	—	—
Secondary (40)	0.057 (0.044)	0.026 (0.074)	0.151 (0.054)**	−0.347 (0.001)**	0.198 (0.082)*
Some post-secondary (14)	0.125 (0.054)*	0.165 (0.090)	0.235 (0.065)****	−0.399 (0.001)**	0.176 (0.099)
Post-sec non-university (19)	0.136 (0.051)**	0.314 (0.085)****	0.230 (0.062)****	−0.307 (0.001)*	0.301 (0.094)**
University degree (15)	0.345 (0.056)****	0.823 (0.092)****	0.527 (0.067)****	−0.040 (0.144)	0.403 (0.102)****
Adjusted R^2	0.269	0.244	0.29	0.222	0.253

[a]Households with expenditure shares greater than one ($n = 48$) were omitted from analytical sample.
[b]Obtained from multiple regression models including all socio-demographic variables.
[c]Beta × 100 is the change in expenditure share when household size doubles, controlling for household composition, income and education effects.
[d]Beta × (change in proportion) is the corresponding change in expenditure share, controlling for household size, income and education effects.
[e]Beta × 10 is the change in expenditure share when income increases by 10%, controlling for household size, composition, and education effects.
[f]Change in expenditure share relative to the reference group, controlling for household size, composition and income effects.
****$P < 0.0001$, **$P < 0.01$, *$P < 0.05$.

groups, except 'other' foods, from which they purchased less (Table 5). Moreover, the share of income spent on vegetables and fruit was larger in these households (Table 6). Further examination of selections made within the food groups indicated that the negative relationship found for 'other' foods was primarily because of purchasing lower quantities of beverages (Table 7). These types of households were also found to purchase less higher fat meat. A greater proportion of children in the household (less than 15 years old) was associated with lower quantities purchased in all food groups, with the exception of milk products, where greater quantities were purchased (Table 5). Differences in milk product purchasing could be attributed to the greater purchasing of higher fat milk among these types of households (Table 7). Although purchasing from grain products and 'other' foods declined as the proportion of children in the household increased, within these food groups, purchasing of breakfast cereals and desserts/snacks increased (Table 7).

Higher income was associated with purchasing more from all food groups (Table 5), although the share of income devoted to each food group declined strongly with income, with the largest declines for meat and alternatives and 'other' foods, regardless of household size, composition and education level (Table 6). The purchase of grain products was the least responsive to income – a 10% increase in per capita income resulted in only a 0.38% increase in the quantity of grain products purchased (Table 5). At the other extreme, the purchase of vegetables and fruit was the most responsive to income – a 10% increase in per capita income increased purchasing by 1.6%.

The weak relationship found for grain products was driven mainly by the purchase of greater quantities of breakfast cereals with higher income (Table 7). Higher income was associated with purchasing more from all food subgroups, with the exception of higher fat milk, eggs and sugars, where lower quantities were purchased.

Further examination of income/quantity relationships revealed that the quantities of vegetables and fruit purchased increased steadily with income, consistent with the results from the log-linear model, whereas purchasing of the rest of the food groups increased only up to a certain level of per capita income (approximately $10 000–$15 000) (Figure 1). Furthermore, at higher income levels, purchasing of 'other' foods appeared to show a slight downward trend. Purchasing patterns within the food groups were similar (i.e., steady increases in purchasing from both subgroups within the vegetables and fruit group) (data not shown), with the exception of the milk products and meat and alternatives groups. The threshold effect for milk products could be attributed to declines in fluid milk purchasing below a certain level of income (Figure 2). Although purchasing of milk levelled off above a certain level of income, there was a tendency towards choosing lower fat milk over higher fat milk with greater income. Within the meat and alternatives group, there was a very slight increase in the purchase of lower fat meat and poultry/fish with higher income (data not shown).

Higher education was associated with purchasing greater quantities of vegetables and fruit and milk products, and smaller quantities of meat and alternatives and 'other' foods (Table 5), regardless of income, household size and

Table 7 Associations between household socio-demographic characteristics and quantity of food purchased from each of the food subgroups, $n = 9921$[a]

	Log (quantity purchased) Beta[b] (standard error), P-value								
	Grains	*Breakfast cereals*	*'ABC-rich' veg and fruit*	*'Other' veg and fruit*	*Lower fat milk*	*Higher fat milk*	*Cheese/Yogourt*	*Ice cream/other*	
Log (household size)[c]	0.625 (0.014)****	0.176 (0.007)****	0.587 (0.016)****	0.678 (0.017)****	0.292 (0.019)****	0.559 (0.022)****	0.254 (0.009)****	0.302 (0.012)****	
Proportion less than 15 years[d]	−0.161 (0.039)****	0.099 (0.019)****	−0.316 (0.042)****	−0.070 (0.045)	−0.062 (0.051)	0.435 (0.058)****	−0.003 (0.024)	0.047 (0.034)	
Proportion over 65 years[d]	0.034 (0.019)	0.093 (0.009)****	0.237 (0.021)****	0.186 (0.022)****	0.058 (0.025)*	0.135 (0.028)****	0.001 (0.012)	0.101 (0.016)****	
Log (Per-capita income)[e]	0.019 (0.011)	0.023 (0.005)****	0.160 (0.012)****	0.112 (0.012)****	0.162 (0.014)****	−0.083 (0.016)****	0.079 (0.006)****	0.049 (0.009)****	
Education[f] (% households)									
< 9 years (ref) (13)	—	—	—	—	—	—	—	—	
Secondary (40)	−0.022 (0.020)	0.022 (0.010)*	0.000 (0.022)	−0.027 (0.024)	0.091 (0.027)**	−0.066 (0.030)*	0.015 (0.012)	0.021 (0.018)	
Some post-secondary (14)	−0.022 (0.025)	0.044 (0.012)****	0.059 (0.027)*	−0.028 (0.029)	0.193 (0.033) ****	−0.194 (0.037)****	0.049 (0.015)**	0.045 (0.021)*	
Post-sec non-university (19)	−0.013 (0.024)	0.049) (0.012)****	0.082 (0.026)**	0.018 (0.027)	0.194 (0.031)****	−0.123 (0.035)****	0.053 (0.014)****	0.054 (0.020)**	
University degree (15)	0.003 (0.026)	0.089 (0.013)****	0.230 (0.028)****	0.051 (0.030)	0.301 (0.034)****	−0.215 (0.038)****	0.109 (0.016)****	0.083 (0.022)****	
	Lower fat meat	*Higher fat meat*	*Poultry/fish*	*Eggs*	*Nuts/beans*	*Oils*	*Sugars*	*Desserts/snacks*	*Beverages*
Log (household size)[c]	0.251 (0.010)****	0.401 (0.011)****	0.273 (0.009)****	0.177 (0.007)****	0.131 (0.007)****	0.282 (0.009)****	0.234 (0.011)****	0.429 (0.011)****	0.693 (0.023)****
Proportion less than 15 years[d]	−0.206 (0.027)****	−0.100 (0.030)**	−0.176 (0.025)****	−0.099 (0.019)****	−0.073 (0.019) ****	−0.202 (0.025)****	−0.171 (0.029)****	0.159 (0.031)****	−0.335 (0.063)****
Proportion over 65 years[d]	0.028 (0.013)*	−0.035 (0.015)*	0.051 (0.012)****	0.022 (0.009)*	0.007 (0.009)	0.066 (0.012)****	0.110 (0.014)****	0.081 (0.015)****	−0.377 (0.030)****
Log (per-capita income)[e]	0.036 (0.007)****	0.022 (0.008)**	0.035 (0.007)****	−0.012 (0.005)*	0.015 (0.005)**	0.004 (0.007)	−0.031 (0.008)****	0.082 (0.008)****	0.059 (0.017)**
Education[f] (% households)									
< 9 years (ref) (13)	—	—	—	—	—	—	—	—	—
Secondary (40)	−0.033 (0.014)*	−0.038 (0.016)*	−0.020 (0.013)	−0.020 (0.010)*	−0.002 (0.010)	−0.012 (0.013)	−0.012 (0.015)	0.021 (0.016)	−0.014 (0.033)
Some post-secondary (14)	−0.061 (0.017)****	−0.082 (0.019)****	−0.009 (0.016)	−0.031 (0.012)**	−0.006 (0.012)	−0.047 (0.016)**	−0.042 (0.015)*	0.044 (0.020)*	−0.080 (0.040)*
Post-sec non-university (19)	−0.057 (0.016)****	−0.075 (0.018)****	0.008 (0.015)	−0.038 (0.011)**	−0.001 (0.011)	−0.029 (0.015)	−0.016 (0.018)	0.081 (0.019)****	−0.029 (0.038)
University degree (15)	−0.085 (0.018)****	−0.162 (0.020)****	0.028 (0.017)	−0.038 (0.012)**	0.022 (0.013)	−0.046 (0.017)**	−0.002 (0.019)	0.047 (0.020)*	−0.204 (0.041)****

[a]Households with expenditure shares greater than one ($n = 48$) were omitted from analytical sample.
[b]Obtained from multiple regression models including all socio-demographic variables.
[c]Beta × 100 is the percent change in quantity purchased when household size doubles, controlling for household composition, income and education effects.
[d]Beta × (change in proportion) is the corresponding percent change in quantity purchased, controlling for household size, income and education effects.
[e]Beta × 10 is the percent change in quantity purchased when income increases by 10%, controlling for household size, composition and education effects.
[f]Beta × 100 is the percent change in quantity purchased relative to the reference group, controlling for household size, composition and income effects.
****$P < 0.0001$, **$P < 0.01$, *$P < 0.05$.

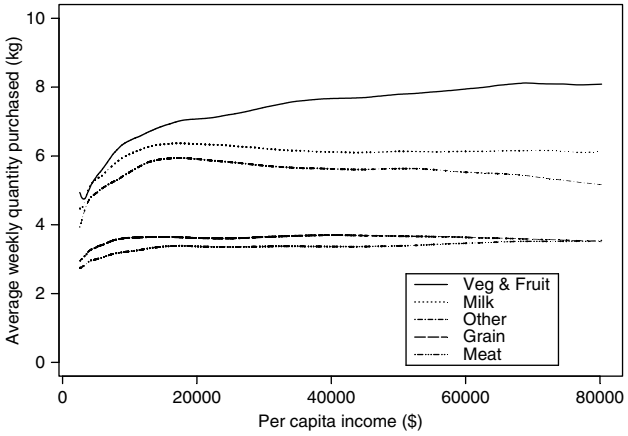

Figure 1 Relationships between quantity purchased (kg) and per capita income ($) for the five major food groups, based on partial linear model and holding other variables constant (Equation (A.2), Appendix A.).

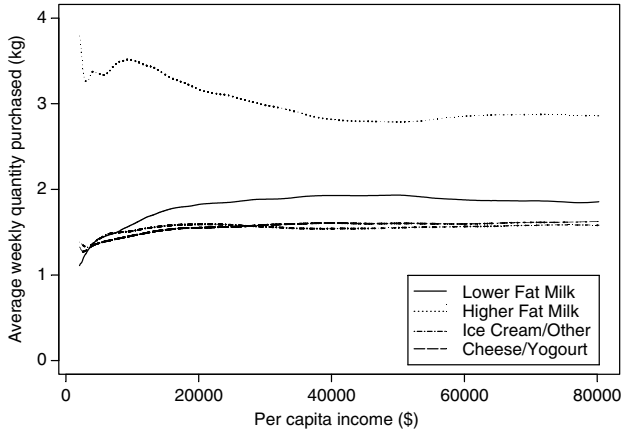

Figure 2 Relationships between quantity purchased (kg) and per capita income ($) for the milk product subgroups, based on partial linear model and holding other variables constant (Equation (A.2), Appendix A.).

composition. Interestingly, post-secondary education, and in particular a university degree, had by far the largest impacts on purchasing patterns. For example, households where the reference person had completed post-secondary education purchased 6% more fruit and vegetables than those with less than 9 years schooling. Households where the reference person had a university degree purchased 14.2% more fruit and vegetables. In contrast, having secondary or some post-secondary education had no significant impact on quantities of fruit and vegetables purchased. A similar pattern was observed for the quantities of milk products. Quantities of meat and alternatives generally declined with increasing education.

Subsequent examination of purchasing within the various food groups revealed that the positive relationship found between education and vegetables and fruit purchasing was due to greater purchasing of 'ABC-rich' vegetables and fruit among more highly educated households (Table 7). Although purchasing of most milk products increased with higher education, purchasing of higher fat milk declined. Furthermore, declines in meat and alternatives purchasing could be attributed to the lower quantities of red meat and eggs purchased at higher education levels. Positive relationships were found for breakfast cereals and desserts/snacks, where higher quantities were purchased at higher levels of education.

When the education variables were omitted from the model of purchasing for the five major food groups, the effects of income on most food groups appeared slightly stronger (data not shown). The exception was the meat and alternatives group, where income effects appeared considerably weaker. As income and education are positively correlated, the income variable picks up some of the effects of education when educational covariates are omitted from the model. For most food groups, income and education worked in similar directions, so that when education was omitted from the model, the impact of income on food purchasing appeared stronger; however, because income and education had opposite effects on meat and alternatives purchasing, the impact of income on purchasing of this food group appeared weaker.

Effects of male and female education levels on food purchasing among households with a married couple

Of the 9969 households in the analytical sample, 6348 (64%) were households with a married couple. These households showed similar purchasing patterns according to the education level of the reference person as were seen in the full sample (data not shown). Compared with the higher education levels of the female spouse, post-secondary education or a higher level among male subjects tended to be significantly correlated with all outcomes, with the exception of meat and alternatives purchasing (Table 8).

Discussion

Our analyses revealed that household socio-demographic characteristics had a strong influence on food purchasing patterns. The ages of household members were important to food selections, reflecting the fact that particular life stages (i.e., childhood, older adulthood) have specific food needs and preferences, which are incorporated into household purchase decisions. Income and education were also strong determinants of food selection; however, they tended to operate somewhat differently, suggesting that these variables represent distinct dimensions of socio-economic position. By using non-parametric statistical techniques, this study was

Table 8 Effects of male versus female education level on food purchasing among households with a married couple, $n = 6328$[a]

Education level[c] *(% households)*	*Log (quantity purchased) Beta*[b] *(standard error),* P*-value*				
	Grain Products	*Vegetables and fruit*	*Milk products*	*Meat and alternatives*	*Other foods*
Male[d]					
< 9 years (ref) (11)	—	—	—	—	—
Secondary (40)	−0.061 (0.030)*	−0.026 (0.035)	0.024 (0.034)	−0.064 (0.028)*	−0.030 (0.041)
Some post-secondary (13)	0.002 (0.036)	0.047 (0.042)	0.048 (0.042)	−0.012 (0.034)	0.003 (0.049)
Post-sec non-university (19)	−0.004 (0.034)	0.072 (0.040)	0.080 (0.040)*	−0.056 (0.032)	−0.005 (0.047)
University degree (16)	0.018 (0.038)	0.119 (0.044)**	0.105 (0.043)*	−0.053 (0.035)	−0.124 (0.051)*
Female[d]					
<9 years (ref) (9)	—	—	—	—	—
Secondary (43)	0.019 (0.033)	−0.003 (0.038)	−0.003 (0.038)	−0.016 (0.030)	0.035 (0.044)
Some post-secondary (13)	0.003 (0.039)	−0.009 (0.045)	0 (0.045)	−0.067 (0.036)	0.036 (0.053)
Post-sec non-university (21)	0.006 (0.037)	0.006 (0.043)	0.039 (0.043)	−0.036 (0.034)	0.022 (0.050)
University degree (13)	−0.017 (0.042)	0.056 (0.049)	0.003 (0.048)	−0.121 (0.039)**	−0.075 (0.057)

[a]Households with expenditure shares greater than one ($n = 20$) were omitted from married sub-sample.
[b]Obtained from multiple regression models including all socio-demographic variables.
[c]Education levels of male and female included as separate variables in multiple regression model.
[d]Beta × 100 is the percent change in quantity purchased relative to the reference group, and controlling for spouse's education level, household size, composition and income.
**$P<0.01$, *$P<0.05$.

able to more accurately characterize the nature of the relationship between income and food selection, in effect distinguishing between a gradient effect for vegetables and fruit purchasing and threshold effects for the purchase of milk and 'other' foods. To our knowledge, no other study has characterized income/food selection relationships to this extent, and thus our results provide a novel contribution to the literature. In addition, this study importantly adds to our knowledge and understanding of Canadian food consumption patterns, which is very limited, because of the lack of nationally representative data on dietary intake.

Not surprisingly, household size was an important determinant of expenditures on food and quantities purchased, consistent with analyses of household food expenditures in many countries (Horton and Campbell, 1990; Deaton and Paxson, 1998). The economies of scale gained by larger households likely result from the benefits of buying larger quantities that often cost less per unit (Deaton and Paxson, 1998); however, lower food spending among larger households may also be explained by their tendency to substitute less-expensive foods, regardless of income level (Horton and Campbell, 1990), which may not be beneficial if these substitutions come at the expense of nutritional quality.

The composition of the household was also important in explaining variations in food purchasing. The emphasis on purchasing vegetables and fruit in households where older adults are present suggests health concerns may be a significant driver of food selections in these households. These purchasing patterns are in accord with individual consumption patterns in Canada, indicating older adults consume more vegetables and fruit than their younger counterparts (Perez, 2002). Older adults are more likely than younger adults to report health concerns as being very influential to their food choices, where they will impose restrictions on fat, salt and sugar intake and avoid certain foods (National Institute of Nutrition, 2002), attitudes that are consistent with an emphasis on vegetables and fruit and a de-emphasis on higher fat meat. At the other end of the age spectrum, where children are present in the household, the emphasis on higher fat milk suggests food selections in these households are influenced by the needs of children. These results correspond with those from analyses of US food expenditure data, indicating that households with proportionally more young children spend less on vegetables and fruit (Stewart *et al*., 2003), and spend more of their food budgets on dairy products (Huang and Lin, 2000).

Income- and education-related differences in food purchasing suggest higher education is associated with purchasing less of particular foods (i.e., meat and alternatives and 'other' foods), whereas lower income is associated with purchasing less of most foods, with some levelling off at per capita income levels upwards of $15 000. These patterns are consistent with those found in analyses of US expenditure data, where higher income was associated with increased spending on most foods (Huang and Lin, 2000; Curry Raper *et al*., 2002; Stewart *et al*., 2003), and higher education was associated with spending less of the food budget on some types of meat and more on vegetables (Huang and Lin, 2000). The similarly positive effects of income and education on the purchase of vegetables and fruit is consistent with those found for the consumption of vegetables and fruit among Canadian adults (Perez, 2002). However, the similar

effects of income and education on the purchase of lower fat milk runs contrary to those found in one US study of individuals' food consumption (Nayga *et al*., 1999). That study showed that only education, not income, was associated with the consumption of low-fat milk products. Discrepancies in study results may be attributed to the different dietary behaviours examined (i.e., individual-level consumption versus household-level purchasing), the use of various other explanatory variables in the model of US food consumption, and to different contextual factors (e.g., cultural, relative food prices).

Education-related differences in food purchasing seem to be more reflective of health concerns than those found for income. Individuals with higher education are reportedly more aware of diet–disease relationships than those with lower education, and are more likely to believe that their food choices can influence their health (National Institute of Nutrition, 2002). These attitudes would explain the greater purchasing of 'ABC-rich' vegetables and fruit and lower fat milk in more highly educated households, and reduced purchasing of higher fat milk, red meat, eggs, sugars and beverages, foods that have gained an unhealthy reputation. Although those with higher levels of education may simply be more responsive to health messaging, it is also possible that health messaging is more geared to this group than to those with less education.

Male education seemed to have a stronger impact on household food selections than female education, suggesting that while women may be the primary food shoppers, their selections are driven to a large extent by the preferences of their husband. Other studies have shown that women's diets are influenced less by social position than are men's (Roos *et al*., 1998; Groth *et al*., 2001), and that other factors, including spouse's SES and family status, are stronger determinants of women's food behaviour than men's (Roos *et al*., 1998; Groth *et al*., 2001; Martikainen *et al*., 2003).

In contrast to the negative association between higher education and the purchase of particular foods, food purchasing generally expanded with higher income, where an income gradient was apparent for the purchase of vegetables and fruit, and an income threshold was apparent for the purchase of milk products and 'other' foods. These patterns are consistent with the widely observed phenomenon that as incomes rise, households spend more on changing the type, quality, and variety of foods rather than increasing the quantity of calories consumed (Horton and Campbell, 1991). From a sociological perspective, these patterns may also reflect symbolic food selections, where particular foods are chosen in order to demonstrate one's affluence (Crotty, 1999); hence, a move away from more 'basic' foods like higher fat milk to more 'luxury' foods like vegetables and fruit with higher income. Those interpretations should not be taken to discount the role of health concerns; indeed, the desirability of some foods and their perceived higher quality (e.g., vegetables and fruit, lower fat milk, poultry and fish) may be related to their 'health-enhancing' properties.

It is important to recognize that, in this Canadian sample, the impact of income on food selection was nonlinear, with the strongest effects at lower income levels, suggesting severe constraints on food purchasing in the context of low income. These results are consistent with other Canadian studies of food purchasing and food intake (Leaman and Evers, 1997; Jacobs Starkey *et al*., 1999; Jacobs Starkey and Kuhnlein, 2000; Tarasuk, 2001; Kirkpatrick and Tarasuk, 2003), showing compromised food selection among low-income groups, with vegetables and fruit, and milk products identified as being particularly vulnerable to situations of low income. However, by using non-parametric statistical techniques, we have been able to discern an income threshold below which food purchasing appears to be severely constrained. The compromises in food purchasing we observed at per capita incomes below $15 000 are consistent with population surveys documenting dramatically increased odds of household food insecurity at incomes below this level (Che and Chen, 2001; Vozoris and Tarasuk, 2003; Ledrou and Gervais, 2005). These results have important implications for the design of income support programmes and other targeted interventions for low-income Canadians, insofar as they identify levels of income where food purchasing is severely limited and supplementation may be required.

One point of concern when using household expenditure data is the considerable error in estimating annual food purchasing patterns, based on those observed in only a 2-week time frame, because of inventory effects (i.e., food already available in the household will influence what food is purchased) and temporal effects (i.e., the season and weeks of the month in which purchases are recorded). During any 2-week period, some households will spend disproportionately large amounts on food, whereas others may spend disproportionately small amounts for various reasons (i.e., stocking up or alternatively depleting existing food stocks, or being away from home for an extended period during the 2-week recording time). Although households with expenditure shares greater than one were omitted, it is possible that there remained some households with disproportionately large and some with disproportionately small expenditure shares. Fortunately, this averages out over a large sample, resulting in an accurate depiction of average purchasing patterns.

Our analyses were restricted to foods purchased in stores, which represented the most substantial portion of total food spending. Foods purchased in restaurants and other eating establishments could not be included in our analyses, as there was no detailed information available on the types and quantities of these foods. However, as food spending in restaurants declined with decreases in income, it is unlikely that lower levels of purchasing among lower income households would be compensated for by greater consumption of foods outside the home. Regarding education-related

differences in purchasing, it is possible that lower levels of purchasing of some foods (i.e., meat, 'other' foods) among highly educated households could be compensated for by greater consumption outside the home, as food spending in restaurants was higher among more educated households. But, this is highly unlikely, given the small amount of food purchased in restaurants relative to that purchased in stores. (Among the highest educated households, on average 33% of total spending was allocated to food in restaurants, but this represents a much smaller proportion when considering food quantity, as a large portion of expenditures in restaurants is attributed to the cost of service.) In addition, if health concerns have a strong influence on food selections, it is likely that this is the case both at home and elsewhere.

Unfortunately, as the consumption of food outside the home and the distribution of food among household members were not measured directly, it is not possible to fully evaluate the nutritional adequacy of individual food intakes. Therefore, conclusions about whether Canadians are meeting dietary recommendations are somewhat limited. However, this was not our aim; rather the intent of this study was to document relative differences in purchasing according to socio-demographic characteristics in order to further our understanding of food selection determinants. Nevertheless, comparisons to other studies, which have examined socio-economic differentials in diet quality, are limited. In addition, because of the nature of food coding in this data set, it was not possible to ascertain socio-demographic differences in the purchase of some specific classes of foods considered important to health (e.g., whole grain or lower fat products), limiting comparisons to other studies in this regard.

In conclusion, household socio-demographic characteristics have a strong influence on food purchasing. Of particular concern are the constraints lower income places on the purchase of foods generally recommended for health (i.e., vegetables and fruit and milk), highlighting the need for targeted interventions among particularly disadvantaged groups. Further exploration of the income gradient for vegetables and fruit purchasing is warranted, in order to understand what underlies this gradient. One possible explanation is that vegetables and fruit are higher in price relative to other types of foods, and price has less of an influence on purchase decisions at higher incomes (Drewnowski and Barratt-Fornell, 2004; Drewnowski *et al*., 2004; Drewnowski and Specter, 2004). More research is needed in this area, particularly given the proposed application of taxes and subsidies on some foods as a means to address problems of overweight and obesity. Regarding current public education programmes aimed at improving dietary behaviours, it appears that these are more relevant to those individuals with the greatest amount of resources at their disposal (i.e., knowledge, prestige, social connections). However, in order to achieve dietary improvements where they are most needed, alternative approaches, which address the specific needs and situations of those with the least resources, need to be embraced. These will likely fall outside the scope of food and nutrition policy, and traverse areas of social and economic policy.

Food policy in Canada, as elsewhere, is increasingly focused on marketplace interventions designed to influence food choice, in the competition for consumer dollars (Lang and Heasman, 2004). In Canada, new food labelling regulations were recently implemented (Health Canada, 2003), and significant changes to the regulations governing the addition of vitamins and minerals to foods are now being introduced (Health Canada, 2005). These policies are designed to alter dietary practices through changes in the marketplace, providing consumers with a greater array of foods from which to choose and helping them to make more informed choices. However, given the profound influence of income and education on food selections, as documented in our study, it is an open question how much of these effects can be overridden by improved product labelling and the availability of more product options. It will be critical to monitor the impact on different population subgroups of such market-based interventions in order to guide decision-making around the effective use of public resources.

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References

Billson H, Pryer J, Nichols R (1999). Variation in fruit and vegetable consumption among adults in Britain. An analysis from the dietary and nutritional survey of British adults. *Eur J Clin Nutr* **53**, 946–952.

Che J, Chen J (2001). Food insecurity in Canadian households. *Health Rep* **12**, 11–22.

Crotty P (1999). Food and class. In: Germov J and Williams L (eds). *A Sociology of Food and Nutrition: The Social Appetite*. Oxford University Press: New York, pp 135–148.

Curry Raper K, Namakhoye Wanzala M, Nayga Jr R (2002). Food expenditures and household demographic composition in the US: a demand systems approach. *Appl Econ* **34**, 981–992.

Deaton A (1997). *The Analysis of Household Surveys: A Microeconomic Approach to Development Policy*. Johns Hopkins University Press: Baltimore.

Deaton A, Paxson C (1998). Economics of scale, household size, and the demand for food. *J Political Econ* **106**, 897–930.

Drewnowski A, Barratt-Fornell A (2004). Do healthier diets cost more? *Nutr Today* **39**, 161–168.

Drewnowski A, Darmon N, Briend A (2004). Replacing fats and sweets with vegetables and fruits – a question of cost. *Am J Pub Health* **94**, 1555–1559.

Drewnowski A, Specter SE (2004). Poverty and obesity: the role of energy density and energy costs. *Am J Clin Nutr* **79**, 6–16.

Dubois L, Girard M (2001). Social position and nutrition: a gradient relationship in Canada and the USA. *Eur J Clin Nutr* **55**, 366–373.

Engel E (1895). Die Lebenskosten Belgischer Arbeiter-Familien Früher and Jetzt. *Int Stat Bull* **9**, 1–124.

Giskes K, Turrell G, Patterson C, Newman B (2002). Socioeconomic differences among Australian adults in consumption of fruit and vegetables and intakes of vitamins A, C and folate. *J Hum Nutr Dietet* **15**, 375–385.
Groth M, Fagt S, Brondsted L (2001). Social determinants of dietary habits in Denmark. *Eur J Clin Nutr* **55**, 959–966.
Health Canada (1992). *Food Guide Facts Background for Educators and Communicators*. Minister of Supply and Services Canada: Ottawa.
Health Canada (2003). *Nutrition Labelling* http://www.hc-sc.gc.ca/hpfb-dgpsa/onpp-bppn/labelling-etiquetage/index_e.html.Health Canada.
Health Canada (2005). *Addition of Vitamins and Minerals to Foods*. Health Canada: Ottawa.
Horton S, Campbell C (1990). Do the poor pay more for food? *Food Market Commentary* **11**, 33–39.
Horton S, Campbell C (1991). Wife's employment, food expenditures, and apparent nutrient intake: evidence from Canada. *Am J Agric Econ* **73**, 784–794.
Huang K, Lin B (2000). *Estimation of food demand and nutrient elasticities from household survey data*. Economic Research Service, USDA: Washington, DC. Technical Bulletin no.1887.
Irala-Estevez J, Groth M, Johansson L, Oltersdorf U, Prattala R, Martinez-Gonzalez M (2000). A Systematic review of socio-economic differences in food habits in Europe. *Eur J Clin Nutr* **54**, 706–714.
Jacobs Starkey L, Gray-Donald K, Kuhnlein HV (1999). Nutrient intake of food bank users is related to frequency of food bank use, household size, smoking, education and country of birth. *J Nutr* **129**, 883–889.
Jacobs Starkey L, Kuhnlein HV (2000). Montreal food bank users' intakes. *Can J Diet Pract Res* **61**, 73–75.
James W, Nelson M, Ralph A, Leather S (1997). The contribution of nutrition to inequalities in health. *BMJ* **314**, 1545–1549.
Kirkpatrick S, Tarasuk V (2003). The relationship between low income and household food expenditure patterns in Canada. *Pub Health Nutr* **6**, 589–597.
Lang T, Heasman M (2004). *Food Wars: The Global Battle for Mouths, Minds and Markets*. Earthscan: London.
Leaman M, Evers S (1997). Dietary intake by food groups of preschool children in low-income communities in Ontario. *J Can Diet Assoc* **58**, 184–191.
Ledrou I, Gervais J (2005). Food insecurity. *Health Rep* **16**, 47–50.
Mancino L, Biing-Hwan L, Ballenger N (2004). *The role of economics in eating choices and weight outcomes*. Economic Research Service, USDA: Washington, DC. Agriculture Information Bulletin no.791.
Martikainen P, Brunner E, Marmot M (2003). Socioeconomic differences in dietary patterns among middle-aged men and women. *Soc Sci Med* **56**, 1397–1410.
Milans F (1991). *Mismanagement of Nationwide Food Consumption Survey GAO/T-RCED-92-7*. United States General Accounting Office, Department of Agriculture: Washington, DC.
National Institute of Nutrition (2002). *Tracking Nutrition Trends IV: An Update on Canadians' Nutrition-Related Attitudes, Knowledge and Actions*. National Institute of Nutrition: Ottawa, ON.
Nayga R, Tepper B, Rosenzweig L (1999). Assessing the importance of health and nutrition related factors on food demand: a variable preference investigation. *Appl Econ* **31**, 1541–1549.
Paulin G (1998). The changing food-at-home budget. *Monthly Labor Rev* **121**, 3–32.
Perez C (2002). *Fruit and Vegetable Consumption*. Statistics Canada: Ottawa, ON. Health Reports 13 (3).
Roos E, Lahelma E, Virtanen M, Prattala R, Pietinen P (1998). Gender, socioeconomic status and family status as determinants of food behaviour. *Soc Sci Med* **46**, 1519–1529.
Smith A, Baghurst K (1992). Public health implications of dietary differences between social status and occupational category groups. *J Epidemiol Commun Health* **46**, 409–416.
Statistics Canada (1997). *1996 Census Nation Tables* www.statcan.ca/english/census96/nation.htm Statistics Canada: Ottawa, ON.
Statistics Canada (1999). *1996 Food Expenditure Survey Public-use Microdata Files, Version 1*. Statistics Canada: Ottawa.
Stewart H, Blisard N, Jolliffe D (2003). Do income constraints inhibit spending on fruits and vegetables among low-income households. *J Agric Resource Econ* **28**, 465–480.
Tarasuk V (2001). Household food insecurity with hunger is associated with women's food intakes, health, and household circumstances. *J Nutr* **131**, 2670–2676.
Trichopoulou A, Naska A, Costacou T (2002). Disparities in food habits across Europe. *Proc Nutr Soc* **61**, 553–558.
Vozoris N, Tarasuk V (2003). Household food insufficiency is associated with poorer health. *J Nutr* **133**, 120–126.
Yatchew A (2003). *Semiparametric Regression for the Applied Econometrician, 213 pages, Themes in Modern Econometrics*. Cambridge University Press: Cambridge.

Appendix A

Statistical analysis of household survey data is often conducted using equations of the particular form (see Deaton 1990, p. 231, Equation 4.14):

$$y = \beta_0 + \beta_1 \log hhsize + \beta_2 \log pcinc + \sum_{j=1}^{q} \gamma_j prop_j + z\delta + \varepsilon \quad \text{(A.1)}$$

where *hhsize* is the household size; *pcinc* is the per capita income, that is, household income divided by household size; $prop_j$ is the proportion of the household consisting of members of type '*j*', for example the proportion of individuals that are children up to age 15 years, or the proportion of individuals who are over the age of 65 years; and, *z* is a vector of additional variables, such as education which may help to explain household expenditures.

Alternative dependent variables may be selected for the specification in (A.1). If *y* is the share of household income spent on a commodity or class of commodities, then the equations are called Engel curves after a 19th century economist who first studied the statistical relationship between income and expenditure on food and other goods (Engel, 1895; Deaton, 1997).

In these models, it is common to log-transform certain variables. This affords a direct interpretation to corresponding coefficients. For example, suppose initially household spending on fruits and vegetables is 1.7% of household income. If the estimate of β_1 is -0.54 then increasing household size by say 50% while holding per capita income constant decreases the share of income spent to approximately $1.43\% = (1.7 - 0.54 \times 0.5)\%$. If the estimate of β_2 is -1.9, then increasing per capita household income by 10% decreases the share of income spent on the given commodity to approximately 1.51% $(= 1.7 - 1.9 \times 0.1)\%$. Finally,

coefficients of dummy variables may also be used directly to calculate impacts. For example, suppose that z_5 is a dummy variable which equals 1 if the head of household has a university degree with coefficient estimate $\hat{\delta}_5 = 0.823$. Then the expected impact of a university degree, relative to households with the lowest level of schooling (less than 9 years, see Table 5) will be to increase the share of income spent on fruits and vegetables by 0.823%.

By setting the dependent variable y to be the (log of the) quantity purchased, specification (A.1) may also be used to estimate the relationship between quantities and household characteristics. Once again coefficients of log-transformed variables admit a direct interpretation. If the estimate of β_1 is 0.78 in the 'fruits and vegetables' equation, then increasing household size by say 50% while holding per capita income constant increases the quantity of fruits and vegetables purchased by $39\% = (0.78 \times 0.5) \times 100\%$. If the estimate of β_2 is 0.16, then increasing per capita household income by 10% increases the quantity of fruits and vegetables purchased by 1.6% $(= 0.16 \times 0.1) \times 100\%$. Finally, suppose that z_5 is a dummy variable which equals 1 if the head of household has a university degree with coefficient estimate $\hat{\delta}_5 = 0.14$. Then the expected impact of a university degree, relative to households with the lowest level of schooling is to increase the quantity of fruits and vegetables by 14%.

One of the disadvantages of the specification in Equation (A.1) is that the impact of log (per capita income) on the dependent variable is linear. For commodities such as foods, this may not be appropriate. For example, consider equations where the dependent variable is the quantity of grain products consumed. One would expect that at low-income levels, quantities increase as income increases. However, at some point quantities purchased are likely to level off. To model nonlinearity of the income effect it is convenient to modify (A.1) as follows:

$$y = f(\log\ pcinc) + \beta \log\ hhsize + \sum_{j=1}^{q} \gamma_j prop_j + z\delta + \varepsilon \quad \text{(A.2)}$$

where $f(\log\ pcinc)$ is a smooth non-parametric function of its argument and all other variables appear in the same format as they did before. Equation (A.2) is called a 'partial linear model' and techniques for its estimation are well-known (Yatchew, 2003). By graphing the non-parametric estimate of f, one can better appreciate nonlinearities and saturation effects.