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COMPARING PREDICTORS OF DIET QUALITY IN CANADA OVER TIME UNDER CONSIDERATION OF ALTERING FOOD GUIDES

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Abstract

Latest data on the diet of Canadians from the Canadian Community Health Survey reveals that the diet quality of Canadians needs improvement. Within this paper predictors of diet quality in Canada are identified based on two cross-sectional data sets from the Canadian Food Expenditure Survey. To measure diet quality, the Canadian Healthy Food Diversity (CanHFD)-Index is developed which is based on Food Guide recommendations. Moreover, this paper considers that the Food Guide between survey years has changed when analyzing diet quality. To track changes in demand for diet quality we use "Canada's Food Guide 1982" to calculate CanHFD-Index for 1984 and 1996. Changes in demand for diet quality according to "Canada's Food Guide to Healthy Eating 1992" are observed by calculating CanHFD-Index with data from 1984 and 1996. Theoretically, this model is related to Becker's household production theory and Lancaster's characteristics approach. Multiple regression results show significant changes in the Canadian demand for food diversity over time. Some of the differences can be traced back to the different versions of the Canada Food Guide. Increasing age, higher income, being female, and high education level are positive predictors of diet quality in 1984 and 1996 among others.

Keywords: diet quality, healthy food diversity, Canada, Food Guides

JEL Codes: D12, D13, I12, Q18

1. Introduction

The Canadian Community Health Survey (2004) reveals that the diet quality of Canadians needs improvement. For example, the majority of Canadians of all ages do not eat enough fruits and vegetables. In addition, more than 25% get more than 35% of their calories from fat. Moreover, snacks (defined as foods and drinks eaten in between meals) make up more calories than breakfast and almost as many calories as lunch (Garriguet, 2004).

For public health measures targeting an improvement in diet quality, insights into the predictors of diet quality are indispensable. There is little evidence on predictors of diet quality in Canada, however. While some studies have looked at diet quality for selected Canadian regions (Dubois et al., 2000 for Québec; Shatenstein et al., 2005 for Montreal), not much is known about predictors of diet quality in Canada overall. Far less is known whether the determinants of diet quality have changed over time, not only for Canada but worldwide.

While consumers' self-perceived diet quality for their diet is called subjective, diet quality is objective if it can be measured with nutritional norms (Brockmeier, 1993). Health Canada publishes nutritional norms that are intended to assure a high diet quality for the majority of the population. Health Canada uses a Food Guide that was last updated in 2007 ("Eating Well With Canada's Food Guide"). Since its first introduction, the Food Guide has been changed seven times, indicating that objective diet quality is not static. Generally, the Food Guides have changed in response to current health problems prevalent in the population (e.g. obesity), or the latest scientific findings (e.g. trans fatty acids). There are also rumours that guidelines change due to pressure from the food industry (Andresen, 2007).

Observing the evolution of diet quality in Canada over time requires the use of a diet quality indicator that is able to consider Food Guides. Thus, diet quality is measured according to the Healthy Food Diversity-Index (Drescher, Thiele and Mensink, 2007) as it is based on Food Guide recommendations. A number of nutritional studies associate food diversity with positive health outcomes. Eating diverse has been found to increase diet quality, e.g. the supply of essential nutrients is higher the more different foods are eaten (Ogle, Huang Hung and Tuyet, 2001). Since the association between food diversity and diet quality is consistently high among studies, food diversity itself is regarded as a predictor of diet quality (Ruel, 2003).

Based on these insights, this paper has three objectives. The first objective is to establish a measure of healthy food diversity for Canada. Second, we identify predictors of diet quality in Canada for two different survey years. Under the third methodological objective, we compare

resulting changes in Food Guides between those years when analyzing diet quality. To make diet quality comparable over the two survey years though, we calculate it according to two different versions of Canadian Food Guides.

The organization of this paper is as follows. Section 2 describes the association between food diversity and diet quality. In the subsequent section (section 3) how diet quality (i.e. food diversity) can be measured considering Food Guides is explained. Section 4 introduces a theoretical economic model to derive a demand function for diet quality. In section 5 the data and methodology used is explained before the results are presented in section 6. This paper ends with a conclusion.

2. The association between food diversity and diet quality

Traditionally, dietary quality has been measured at the nutrient level due to the fact that diet-related diseases have been mainly a problem of supply of single nutrients (such as sugar/caries or fat/cardio-vascular diseases). However, nutrient level indicators are criticised as they give only a selected view of consumers' diet and do not reflect total dietary behaviour (Dubois, Girard and Bergeron, 2000). Michels and Wolk (2002) note that studies solely considering nutrients might have confounder problems caused by other food items or nutrients consumed in combination which remain unaccounted for (see also Maunder, Matji and Hlathswayo-Molea, 2001). Moreover, it has been noted that consumer demand is not focused on single nutrients but rather on food items (Ogle, Huang Hung and Tuyet, 2001). Consequently, newer concepts point out the need for defining and analysing dietary quality at food level. They are regarded as "[…] more adequate for analyses concerned with population health, because they take into account the complexity of the diet (Dubois, Girard and Bergeron, 2000, p. 358; see also Kant, 1996). Food diversity indices are food-based dietary quality measures.

In the past 20 years, up to 50 studies have dealt with the relationship between diversity in the diet and health outcomes worldwide. Most of the diversity research has been conducted in the United States. Existing nutritional diversity studies can be categorized into five different research topics (Drescher, 2007). Among those topics, the greatest attention has been drawn

to the relationship between food diversity and dietary quality in terms of nutrient adequacy. We refer to this literature to justify the use of food diversity as an indicator of diet quality.[1]

In these diversity studies, whether a high diversity of foods in the diet increases or decreases the nutrient supply of single nutrient taking into account Recommended Daily Allowances differentiated by age, sex, physical activity etc. (e.g. Krebs-Smith et al., 1987; Cox et al., 1997; Hatloy, Torheim and Oshaug, 1998; Torheim et al., 2004) is analyzed.

Most of these studies show that food diversity is strongly correlated with dietary quality and nutrient adequacy. This finding is also consistent across developing as well as developed countries. Hence, many studies consider food diversity as a proxy for nutrient adequacy (Ruel, 2003). For example, Randall, Nichaman and Contant (1985) assess the nutritional consequence of the differences in food diversity for 3,645 Americans participating in the second National Health and Nutrition Examination Survey (NHANES II). It is observed that increasing food diversity, i.e. the increasing number of food items consumed, increases the total amount of all nutrients consumed. The seminal work of Krebs-Smith et al. (1987) links diversity measures with dietary quality as defined by the adequacy of intakes of energy, fat, sugar, cholesterol, and sodium using data of 3,701 U.S. Americans participating in the Nationwide Food Consumption Survey. Multiple regression findings illustrate that the variety among major food groups added the most (10%) to the explained variation of all regression models.

To analyse the relationship between variety and nutritional adequacy in a developing country, Hatloy, Torheim and Oshaug (1998) use data from 77 children from Mali, West Africa. Pearson's correlation coefficients between nutrient adequacy and variety indices are significant for the coefficient for vitamin C, vitamin A and energy percentage.

Ogle, Huang Hung and Tuyet (2001) observe a small sample size of 196 women in Vietnam. They focus on the association between food variety, nutrient intake and health status especially with respect to wild vegetables. Diets high in diversity have significantly higher intakes of energy and higher mean intake of all considered nutrients.

Overall, although dietary quality and diversity do not reflect the same constructs, diversity indicators are often preferred to nutrient adequacy dietary quality indicators because the data required for calculating food diversity is easier to collect (Torheim et al., 2004).

[1] Within the other categories, food diversity is associated with health outcomes such as dietary status (e.g. Body Mass Index), morbidity (cancer, cardiovascular diseases, obesity and body fat), mortality risks and the extent of food diversity in different population groups (cf. Drescher, 2007).

Thus, not only are food diversity indices regarded as better diet quality indicators than nutrient-based ones, they are also strongly correlated with nutrient-adequacy diet quality indicators. To sum up, food diversity is a good measure of diet quality.

3. Measuring diet quality under consideration of altering food guides

Food diversity has been analyzed from a technical and a social science perspective. In nutrition science, food diversity is mainly measured using count measures, such as the Diet Diversity Score (Kant et al., 1993) or the Food Variety Score (Hatloy, Torheim and Oshaug, 1998). Although these measures belong to the same mathematical class of diversity indices, they differ e.g. in the consideration of foods that count towards diversity. The problem with nutritional measures, as pointed out by Drescher, Thiele and Mensink (2007), is that they do not distinguish between healthy and unhealthy foods consumed. Many nutritional diversity studies therefore delete unhealthy foods from the analysis. Moreover, count measures fail to consider the distribution of foods. The distribution of foods is especially important for diet quality because it does make a difference if the consumer eats two food items in equal shares (50% each) compared to eating one food with 1% and the other one with 99%.

Economic diversity indices that consider both the number and distribution of food items when calculating diversity are so called distribution measures also known as concentration measures (Drescher, Thiele and Mensink, 2007). With these measures, diversity increases the more foods are eaten in equal shares. Next to the Entropie-Index, the Berry-Index is most often applied in economic diversity studies (Gollop and Monahan, 1991). The Berry-Index (BI), an extension of the well-known Herfindahl-Index, was proposed by Berry (1971). It takes the form:

$$(1)\quad BI = 1 - \sum_{i=1}^{n} s_i^2$$

where, n is the number of foods available, and s_i is the quantitative share of food i on the total amounts of foods. High values indicate high diversity. The Berry-Index lies in the range of 0 and 1/1-n. A value of zero would indicate no diversity; that is the diet is completely concentrated on a single food. If all foods in a consumption basket are eaten in equal shares, the Berry-Index reaches its maximum. For nutritional purposes the fact that the Berry-Index reaches highest values whenever foods are eaten in equal shares is undesired. International Food Guides recommend that “healthier” foods should be eaten in higher proportional shares than “unhealthy” foods. Against the background of the disadvantages of existing diversity studies, a new diversity index was proposed for Germany (Drescher, Thiele and Mensink,

2007). The idea behind the so called Healthy Food Diversity-Index is to extend the Berry-Index by a value that describes the healthiness of all foods eaten. The Healthy Food Diversity-Index takes the following form:

$$(2)\quad HFD = \left(1 - \sum_{i=1}^{n} s_i^2\right)\left(\sum_{i=1}^{n} hf_i * s_i\right).$$

The first term in (2) is the Berry-Index which measures diversity. The second term measures the healthiness of the food basket with hf_i as health factors that describe the nutritional value of single food categories. In the original version, these health factors were derived from German Food Guides (i.e. German Food Pyramid). The food categories that are recognized as healthier in the Food Guides get higher health factors (e.g. vegetables) than those foods that are considered as less healthy by the German Food Guides. These health factors are given for 15 food categories. To calculate how healthy the foods eaten are altogether, the quantitative share of each food is multiplied by the health factor, resulting in the health value. In the end, the Berry-Index and health value are multiplied to obtain the Healthy Food Diversity-Index. According to Drescher, Thiele and Mensink (2007), the HFD-Index becomes lower (higher), the less (more) unhealthy (healthy) foods are eaten. The authors also show that the HFD-Index better reflects a healthy diet than traditional diversity measures.

For the purpose of this paper, the original HFD-Index is adjusted using different versions of the Canadian Food Guide. Since this paper compares changes in demand for diet quality between 1984 and 1996, it is necessary to consider that the Canadian Food Guide changed between the survey years. Thus, the HFD-Index is adjusted twice according to the effective Food Guides in the survey years: “Canada’s Food Guide 1982” and “Canada’s Food Guide to Healthy Eating 1992” for survey year 1984 and 1996, respectively.

Figure 1 and Figure 2 show both, Canada’s Food Guide 1982” and “Canada’s Food Guide to Healthy Eating 1992” that are used to construct the Canadian Healthy Food Diversity-Index (CanHFD).

Insert Figure 1 and Figure 2 here

We use recommended servings based on amounts of foods eaten to construct the Canadian Healthy Food Diversity-Index. The idea behind it is that the recommended servings are highest for those foods Health Canada regards as healthier while recommended servings for foods considered as less healthy are lower. Thus, these servings represent a hierarchy in terms of their nutritional value (which reflects the original idea of the HFD-Index).

In the Canadian Food Guides, the recommended servings are given as upper and lower recommendations. Upper recommendations are given for people with especially high needs (e.g. sportsmen or pregnant women), while lower levels are given as guidelines for those groups that have a lower than average need for foods, for example, children. However, the Food Guides also state that most people can choose servings in between the upper and lower level (see Canada's Food Guide to Healthy Eating 1992). This is the reason for deriving the health factors from mean recommended servings. Technically speaking, the health factors are derived in the following manner. Starting from the recommended servings given by Health Canada's Food Guides, we calculate the mean servings and add them up to total servings. Afterwards, we calculate the percentage of each mean serving on the total servings. Finally, the percentages health factors are given in the range between 0 and 1. The derivation of the health factors based on Canada's Food Guide 1982 is given in Table 1.

Insert Table 1 here

With respect to Canada's Food Guide 1982 it has to be noted that there is no "other" food group. Thus, in the 1982 Food Guide all foods, including such as chocolate, have been assigned to the group of milk, meat, bread or fruits and vegetables. In this study, the "other" food group is differentiated for two reasons. First, assigning a food such as chocolate to the group of fruits of vegetables would be senseless in a study aiming at analyzing diet quality. Second, Canada's Food Guide for Healthy Eating 1992 considers the group of "other" foods. Therefore, the group "other" foods is distinguished in 1982 also in order to make indices comparable.

The health factors according to Canada's Food Guide for Healthy Eating 1992 are given in Table 2.

Insert Table 2 here

Canada's Food Guide for Healthy Eating 1992 distinguishes the group of "other" foods (see Figure 2), but it does not quantify recommended servings for the "other" food group to keep the consumption of these foods as low as possible. However, for our purposes, recommended servings are essential. We assume that if there is the possibility to eat a food out of the "other" food group (e.g. chocolate) than it seems justified to attach one "recommended" serving to the "other" food group. Looking at the mean recommended servings or Canadian health factors

reveals the biggest difference between the two Food Guide versions. In 1982 fruits and vegetables have the highest mean recommended servings. In 1992, fruits and vegetables are replaced by grain products on first place.

4. Theory

Among the few previous studies that analyze the demand for healthy eating or diet quality are Variyam et al. (1998) and Drescher et al. (2008). These studies refer to both the household production theory (according to Becker, 1965) and Lancaster's characteristics approach (Lancaster, 1971). In line with these predecessors, we assume that households maximize their utility to produce (in Lancaster's terminology) final "commodities". It is from these commodities, such as consumer's own health or the health of the family members, that the consumer gathers utility. The commodity "own health" is produced using different foods and medical care as inputs. To the consumer, these inputs have a value because of the characteristics they contain. For foods, the valued characteristics are taste or nutrients, for medical care, the valued characteristics are medical services.

The utility function of any representative consumer is (Variyam et al., 1998; Drescher et al., 2008)

(3) $U = U(Q, z, h)$

Q is the consumption bundle ($Q = q_1,q_2,\ldots,q_3$) and z represents the consumption of non-food items. H stands for consumers health status. The utility function satisfies the following conditions: given that the level of food items, non-food items or consumer's health status increases, consumer's level of utility increases also ($U' > 0$). This utility increases at a decreasing rate if either Q, z or h increase ($U'' < 0$).

The consumer's utility function (3) is maximized considering three restrictions. The first restriction is the budget restriction:

(4) $\sum_{i=1}^{n} p_i q_i + z \leq Y \qquad q_i \geq 0, \qquad i = 1,\ldots,n$

In the budget restriction, p_i is the price of food i. q_i describes the quantity of any food eaten. The price of the non-food item z is for simplification purposes normalised to 1. Finally, Y describes consumer's disposable income.

The second restriction is the health production restriction which is defined as (Drescher et al., 2008):

(5) $h = h(CanHFD, \mathbf{NF} | \mathbf{K}, E)$

In (5), *CanHFD* is the Canadian Healthy Food Diversity-Index that measures consumers diet quality. In equation (5), **NF** is a vector of non-food items the consumers uses to produce own health, too (for example medical services, physical exercise). Variayam et al. (1998) assume that consumers efficiency of producing *h* from *CanHFD* and **NF** depends on a vector of personal consumer characteristics. In equation 5, vector **K** represents a vector of consumer describing characteristics (e.g. education). *E* describes the exogenous health endowment out of consumer's control (e.g. genetic predisposition) (Drescher et al., 2008).

The third restriction the consumer needs to consider when maximizing his utility is that the input of *CanHFD* in the health production function (5) depends on the production function for healthy food diversity itself:

(6) $CanHFD = g(q_1,...,q_n, hf_1,....hf_n, \mathbf{K})$

Drescher et al. (2008) note that the production function in (6) is non-linear. An increasing quantity of foods does not result in a proportional increase in *CanHFD*. The authors refer to Chern (2003) who states that there are characteristics whose production depends on consumer's human capital and thus, there is not necessarily a proportional increase. On that account, Drescher et al. (2008) consider **K**, the vector of consumer describing characteristics for the *CanHFD* production function, too.

Considering the three restrictions when maximizing consumer's utility gives the demand function for *CanHFD* as (cf. Variyam et al., 1998; Drescher et al., 2008):

(7) $CanHFD = \mathrm{d}_0\ (p_1,...p_n, Y, \mathbf{K}, E)$

As a result, *CanHFD* is a function of food prices, consumer income, consumer-describing characteristics and the exogenous health endowment.

5. Data and methodology

We use the Canadian Healthy Food Diversity-Index to analyze the demand for diet quality in Canada. As mentioned in chapter 4, the Canadian Healthy Food Diversity-Index is a product of the Berry-Index and the health value of the consumption bundle. Because of the Berry-Index it is necessary to restrict the number of foods available in the data set. Since the Berry-Index lies in the boundaries of 0 and 1-1/*n* (with *n* = number of food items distinguished in the data set), it can only be compared over different data sets provided that the number of foods distinguished is the same in all data sets.

For the empirical implementation we use public-use micro-data files of the Canadian Food Expenditure Survey provided by Statistics Canada using the weekly quantities consumed in 1984 (n=5,360) and 1996 (n=10,459). In order to make the Berry-Index and therewith the

Canadian Healthy Food Diversity-Index comparable over all years, the number of foods counted in each year needs to be the same. Therefore, certain foods from each of the datasets were excluded. 9.2% have been deleted for the 1984 data set and 5.4% for 1996, respectively. However, it is shown that the share of each of the deleted foods on the total is small and thus negligible.[2] To track changes in demand for healthy food diversity we use "Canada's Food Guide 1982" to calculate CanHFD-Index for 1984 and 1996 ($CanHFD_{82}$). Accordingly, $CanHFD_{92}$ has been calculated for 1984 and 1996 based on "Canada's Food Guide to Healthy Eating 1992". Multiple regressions are conducted for each year using CanHFD-Index as dependent variable and various socioeconomics to explain differences in the demand for healthy food diversity. Table 3 gives the descriptive statistics of all variables used in the regression.

Insert Table 3 here

In detail, four regression models are completed. For Model 1 and Model 2, "Canada's Food Guide 1982" is used. In Model 1, the regression is based on data from 1984 and in Model 2 based on data from 1996. Model 3 and Model 4 refer to "Canada's Food Guide to Healthy Eating 1992". Model 3 uses data from 1984 and Model 4 uses the 1996 dataset. Model 2 and model 3 are kind of hypothetical models. It is at least questionable whether survey participants in 1996 remembered the 1982 Food Guide version (Model 2). And of course, survey participants in 1984 did not know the 1992 version of Canada's Food Guides (Model 3). However, model 2 and model 3 are used to differentiate the time impact (year effect) from the Food Guide effect on demand for diet quality.

The Canadian Healthy Food Diversity-Index is bounded between 0 and almost 1. In order to assure the assumptions of normality, the dependent variable is logit transformed which changes the boundaries of the dependent variable to minus and plus infinity. The logit transformation is achieved by (Greene, 1997):

(8) $TCanHFD = \ln\left(\left(CanHFD/\left(1-CanHFD\right)\right)\right)$

We additionally show cross table results on education and income with the Canadian Healthy Food Diversity Index.

6. Results

[2] Mean quantitative share of deleted foods from 1984, and 1996: 0.024, and 0.011, respectively.

The results of the four regression models of the Canadian Healthy Food Diversity-Index on sociodemographic variables are given in Table 4. Generally, the explanatory variables explain the CanHFD quite satisfactorily. The coefficient of determination is similar to other cross-sectional studies.

Insert Table 4 here

To compare the predictors of diet quality the results can be are divided into three categories:

a) predictors that are consistent across the survey years (no change in demand for diet quality) and that are consistent across Food Guide versions
b) predictors of Canadian demand for diet quality that changes over time (i.e. across survey years) but that are consistent across the Food Guide versions
c) predictors of Canadian demand for diet quality that can be traced back to Food Guide changes only.

First, we describe the results that are shown to be consistent across the two different versions of Canada's Food Guide (category a) and over the two years 1984 and 1996. These are the results that are independent of Food Guide changes and that are consistent across the two survey years. This applies for the variables age, gender, education, born South, born Other, household size and Prairies.

With regard to the characteristics of the survey participant, the demand for the Canadian Healthy Food Diversity-Index increases with increasing age. Thus, the older Canadians get, they eat diets of higher quality. Also, Drescher et al. (2008) show that the demand for Healthy Food Diversity increases with increasing numbers of foods eaten. They argue that health aspects of the diet become more important with increasing age. Similarly, Variyam et al. (1998) show that increasing age leads to higher Healthy Eating Index scores.

Furthermore, it is shown that male Canadians have a significantly lower demand for Healthy Food Diversity (CanHFD) than female Canadians (reference person). This result stands in sharp contrast to the analysis by Variyam et al. (1998), who observe no significant influence of gender on diet quality for US-consumers.

The impact of education is strong and consistent across the years. The effect of education occurs independent of the Canadian Food Guide version. Compared to Canadian households with the lowest education level (less than 9 years of education, education level of the reference person), households with higher education (secondary education, post secondary education, diploma, university) have higher CanHFD values. This reflects findings in

Drescher et al. (2008) and Variyam et al. (1998) where it is argued that more education results in better knowledge of the diet-health relationship and thus, higher diet quality.
The result that higher income is associated with better diet quality is confirmed with the following cross tables.

Insert table 5 and table 6 here

For both years, the percentages clarify that with increasing income is associated with higher diet quality values. This association is found to be significant at the 1% level according to the Chi^2-test for cross table relationship.
For households where the survey participant was born in the South and East Europe (Born South), the demand for diet quality is considerably higher compared to Canadian born households in both 1984 and 1996. The same result shows for households that are born in any other region (Asian and Oceanic).
With regard to the household characteristics, Table 5 shows that regardless of the Food Guide version or survey year, household size has no impact on the demand for diet quality in Canada which is a finding in line with Variyam et al. (1998).
With respect to the region it is shown that across both years and Food Guide versions, the diet quality of households located in the Prairies is highly significantly lower than of households in British Columbia.

Next, the results of category b) (changed predictors of diet quality consistent across Food Guide versions) are described. Those are born West, Ontario, single households, lone parent families and households consisting of relatives.
Among the variables reflecting the survey participants' place of birth, households born in United Kingdom, North America, or West Europe have significantly higher diet quality in 1984. However, the demand for diet quality changes: in 1996 there is no longer a significant difference in the demand for diet quality of Canadian born and Western born people. This might be due to the fact that the Western born households adapted the consumption structures of the Canadian born households in the course of time or that diets in those regions converged over the 1980s. These findings are of high relevance for Canada that is known to be a country with a high immigration rate.
For both CanHFD versions, in 1984 the demand for food diversity is significantly lower in Ontario than in British Columbia (reference household). However, there is no significant difference in the demand for diet quality between Ontario and British Columbia in 1996. This

gives reason to assume that households in Ontario improved their diet quality from 1984 to 1996.

From 1984 to 1996 the demand for diet quality changed for single households and lone parent families. While in 1984 the diet quality of single households appears to be highly significant lower than for households with a married couple, in 1996 there is no longer a significant difference between single and married households. The same results are observed for lone parent families. In 1984, the diet quality in households of lone parent families was highly significantly lower than in households with married couples while there is no difference in diet quality between those household types in 1996.

The results further show that households consisting of relatives (but not married couples), have no different demand for healthy food diversity than households with married couples in 1984. In 1996, households with relatives have a significantly higher demand for healthy food diversity than married households.

Below the differences in demand for diet quality are described that can be traced back to changes in Canadian Food Guides (category c). Differences occur for the household characteristic variable 'income' and the regions Atlantic and Québec. The fact that there are only three predictors of diet quality that belong to category c, i.e. that can be traced back to altering Food Guides, indicates that the changes made in the Food Guides are minor.

If diet quality is defined based on "Canada's Food Guide 1982", increasing income leads to a higher demand for diet quality in 1984 and 1996. Contrary, given that diet quality is defined based on "Canada's Food Guide to Healthy Eating 1992", income has no impact on the demand for healthy food diversity in 1984 but has a highly significant impact in 1996. For the 1992 Food Guide version, this indicates that over time income became more important to the demand for high quality diets.

The fact that higher income is associated with higher diet quality also shows in the following cross table results:

Insert table 7 and table 8 here

The association between income and diet quality shown in tables 7 and 8 is highly significant.

With the 1982 CanHFD version, there was no significant difference between the CanHFD for households living in the Atlantic region and those living in British Columbia in 1984. However, with the CanHFD 1992 version, Atlantic households have significantly lower CanHFD values in 1984 and 1996 compared to households in British Columbia. For Québec,

Table 4 shows varying results. If diet quality is defined using “Canada’s Food Guide 1982”, households living in Québec have no different demand for diet quality than households in British Columbia in 1984. In 1996, the demand for diet quality in Québec is higher compared to households in British Columbia. Contrary, if healthy food diversity is defined using “Canada’s Food Guide to Healthy Eating 1992”, Québécoise households demand significantly less diet quality in 1984 than households in British Columbia. However, in 1996 the demand for diet quality of Québécois households is significantly higher than for households from British Columbia.

7. Conclusion

Since other studies note that the diet of Canadians is far from being optimal, this study analyzes the demand for diet quality in overall Canada between the years 1984 and 1996. It is the first study that observes the demand for diet quality across all Canadian provinces. Diet quality is measured according to the recently developed Healthy Food Diversity-Index by Drescher, Thiele and Mensink (2007). For the purpose of this paper, a Canadian version of the HFD-Index is developed using the Canadian Food Guides that were prevalent at the time of the Canadian Food Expenditure Survey data collection in 1984 and 1996: “Canada’s Food Guide 1982” and “Canada’s Food Guide to Healthy Eating 1992”. Another novelty of this study is that it takes into account that officially recommended diet quality changed between the two survey years.

The theoretical basis of the study is based on a model of demand for healthy eating in the style of Becker’s household production theory and Lancaster’s characteristics approach which have already been applied in other empirical studies on demand for healthy eating or diet quality (Variyam et al., 1998; Drescher et al., 2008).

For the empirical implementation multiple regressions are conducted for each year using two versions of CanHFD as dependent variables and various socio-demographic variables to explain differences in the demand for healthy food diversity. We apply public-use micro-file data of the Canadian Food Expenditure Survey for 1984 (n=5,360) and 1996 (n=10,459) provided by Statistics Canada using the weekly quantities consumed for the same 176 food items.

There are three categories of results. Among the first category (a), predictors that are consistent across survey years and independent of Food Guides are variables such as age, education and gender. The second category (b) describes results that changed over time but these changes occur independent of altering Food Guides. Survey participants place of birth,

regional differences and marital status are among these results. Also, there are differences in the demand for diet quality which can be traced back to the different versions of Canada's Food Guides (category c). Given diet quality is defined according to "Canada's Food Guide 1982", increasing age, higher income, being female, and high education level are positive predictors of healthy food diversity in 1984 and 1996 among others. While households living in Atlantic Provinces (or Québec) have no different demand for diet quality in 1984 than households living in BC, their demand for diet quality was lower (higher) in 1996. If diet quality is defined based on "Canada's Food Guide to Healthy Eating 1992", similar but not identical results are observed. E.g., while income is not a significant predictor of diet quality in 1984, in 1996 it has a strong positive influence.

Future studies should observe changes in Canadian demand for diet quality over time using newer data sets.

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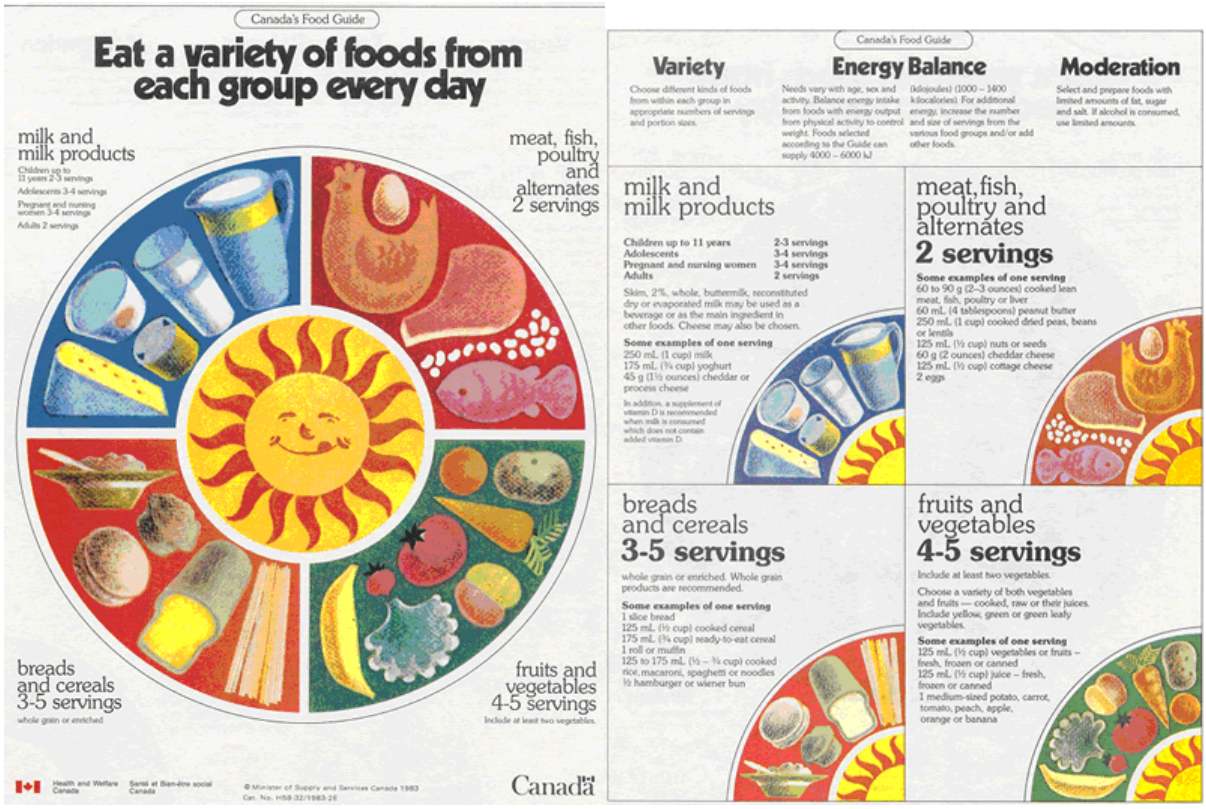
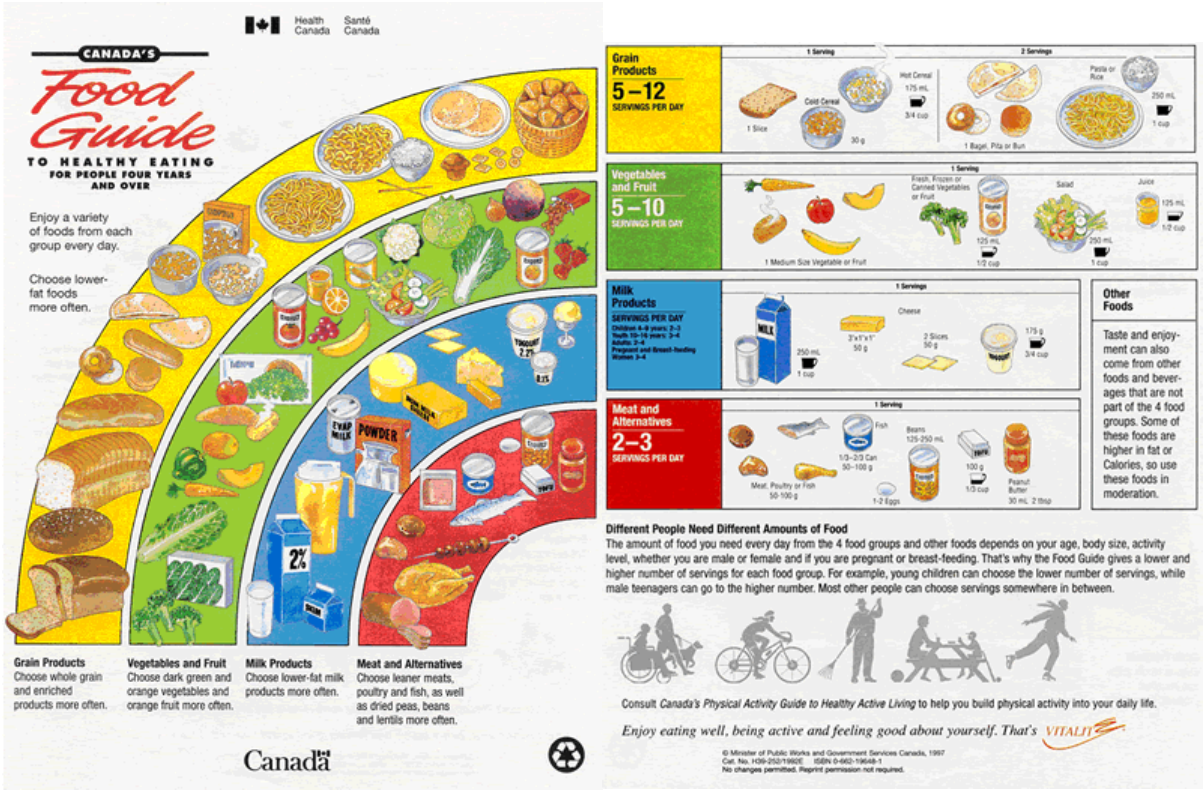
Figure 1: Canada's Food Guide 1982



Source: Health Canada, 2002, p. 19-20.

Figure 2: Canada's Food Guide to Healthy Eating 1992



Source: Health Canada, 2002, p. 22-23.

Table 1: Derivation of health factors based on Canada's Food Guide 1982

Food group	*Recommended servings (source)*	*Mean servings*	*% of total servings*	*Health factors*
Milk, milk products	2	2	14.81%	0.15
Meat, fish, poultry and alternates	2	2	14.81%	0.15
Bread and cereals	3-5	4	29.63%	0.30
Fruits and vegetables	4-5	4.5	33.33%	0.33
Other (not differentiated)	1	1	7.41%	0.07
Total servings		13.5	100%	1

Table 2: Derivation of health factors based on Canada's Food Guide for Healthy Eating 1992

Food group	*Recommended servings*	*Mean servings*	*% of total servings*	*Health factors*
Grain products	5-12	8.5	37.78	0.38
Vegetables and fruits	5-10	7.5	33.33	0.33
Milk products	2-4	3	13.33	0.13
Meat and alternatives	2-3	2.5	11.11	0.11
Other foods	1	1	4.44	0.04
Total servings		22.5	100%	1

Table 3: Descriptive statistics of variables used in OLS regression

Variable	Description	Mean (Std.dev)		*Min (Max)*	
		1984	1996	1984	1996
Dependent variables					
CanHFD Version 1982	Diet quality measure calculated from $HFD = \left(1 - \sum_{i=1}^{n} s_i^2\right)\left(\sum_{i=1}^{n} hf_i * s_i\right)$ where s_i is the share of food *i* on total quantities and hfi is the health factor for food i derived from Canada's Food Guide 1982	0.56 (0.12)	0.56 (0.13)	0.01 (0.85)	0.004 (0.87)
CanHFD Version 1992	Diet quality measure calculated from $HFD = \left(1 - \sum_{i=1}^{n} s_i^2\right)\left(\sum_{i=1}^{n} hf_i * s_i\right)$ where s_i is the share of food *i* on total quantities and hfi is the health factor for food i derived from Canada's Food Guide 1992	0.49 (0.11)	0.49 (0.12)	0.01 (0.75)	0.002 (0.78)
Characteristics of the survey participant					
Ln Age	Logarithm of the age of the survey participant	3.74 (0.38)	3.81 (0.34)	3.00 (4.33)	3.18 (4.38)
Male	Dummy variable is set at 1 if the survey participant is male and 0 otherwise	0.69 (0.46)	0.48 (0.50)	0 (1)	0 (1)
Female	Dummy variable is set at 1 if the survey participant is female and 0 otherwise	0.31 (0.46)	0.52 (0.50)	0 (1)	0 (1)
Low education	Low education - Dummy variable is set equal to 1 if the survey participant has completed less than 9 years of education and 0 otherwise	0.15 (0.36)	0.12 (0.33)	0 (1)	0 (1)
Secondary education	Secondary education – Dummy variable is set equal to 1 if the survey participant has completed some or completed secondary education and 0 otherwise	0.45 (0.50)	0.40 (0.49)	0 (1)	0 (1)
Post secondary education	Post secondary education – Dummy variable is set equal to 1 if the survey participant has some post-secondary education and is 0 otherwise	0.13 (0.33)	0.14 (0.34)	0 (1)	0 (1)
Diploma	Diploma – Dummy variable is set equal to 1 if the survey participant has a post-secondary non-university certificate or diploma and is 0 otherwise	0.13 (0.33)	0.19 (0.40)	0 (1)	0 (1)
University	University – Dummy variable is set equal to 1 if the survey participant has a	0.14 (0.35)	0.15 (0.35)	0 (1)	0 (1)

	university degree and is 0 otherwise				
Born West	Born West – Dummy variable is set equal to 1 if the survey participant in United Kingdom, North America, and West Europe and is 0 otherwise	0.10 (0.29)	0.07 (0.25)	0 (1)	0 (1)
Born South	Born South – Dummy variable is set equal to 1 if the survey participant is born in South and East Europe and is 0 otherwise	0.06 (0.23)	0.03 (0.17)	0 (1)	0 (1)
Born Other	Born Other – Dummy variable is set equal to 1 if the survey participant is born in Asia and Oceanic or elsewhere and is 0 otherwise	0.05 (0.23)	0.04 (0.19)	0 (1)	0 (1)
Born Canada	Born Canada – Dummy variable is set equal to 1 if the survey participant is born in Canada and is 0 otherwise	0.79 (0.41)	0.84 (0.37)	0 (1)	0 (1)
Household characteristics					
HHSize	Number of persons in the household	2.70 (1.43)	2.66 (1.35)	1 (10)	1 (6)
Ln Income	Logarithm of Income – personal income in the past 12 months, income of all family members	10.10 (0.73)	10.46 (0.78)	5.88 (12.00)	5.7 (13.65)
Atlantic	Dummy variable is set equal to 1 if the household is living Newfoundland and Labrador, Prince Edward Island, Nova Scotia, New Brunswick and is 0 otherwise	0.17 (0.37)	0.23 (0.42)	0 (1)	0 (1)
Québec	Dummy variable is set equal to 1 if the household is living in Quebec an is 0 otherwise	0.17 (0.37)	0.16 (0.36)	0 (1)	0 (1)
Ontario	Dummy variable is set equal to 1 if the household is living in Ontario and is 0 otherwise	0.23 (0.42)	0.26 (0.44)	0 (1)	0 (1)
Prairies	Dummy variable is set equal to 1 if the household is living in Manitoba, Saskatchewan, Alberta and 0 otherwise	0.31 (0.46)	0.23 (0.42)	0 (1)	0 (1)
BC	Dummy variable is set equal to 1 if the household is living in British Columbia and is 0 otherwise	0.12 (0.33)	0.13 (0.33)	0 (1)	0 (1)
Single	Single household – dummy variable is set equal to 1 if the household is a single household and 0 otherwise	0.23 (0.42)	0.22 (0.41)	0 (1)	0 (1)
Married HH	Married household – Dummy variable is set equal to 1 if the household is a married couple without children and without additional persons and is 0	0.22 (0.42)	0.25 (0.43)	0 (1)	0 (1)

	otherwise				
Marriedwchild	Married household with children – Dummy variable is set equal to 1 if the household is a married couple with unmarried children and without additional persons and is 0 otherwise	0.38 (0.49)	0.36 (0.48)	0 (1)	0 (1)
Marriedwrelat	Married household with relatives – Dummy variable is set equal to 1 if the household is a married couple with additional persons and is 0 otherwise	0.03 (0.17)	0.04 (0.19)	0 (1)	0 (1)
loneparent	Lone parent – Dummy variable is set equal to 1 if the household is a lone parent household and 0 otherwise	0.08 (0.26)	0.08 (0.27)	0 (1)	0 (1)
HHrelatives	Household with relatives – Dummy variable is set equal to 1 if all persons in the household are related and 0 otherwise	0.03 (0.16)	0.03 (0.19)	0 (1)	0 (1)
Nonmarried	Other non married household – Dummy variable is set equal to 1 if at least one person in the household is unrelated and is 0 otherwise	0.03 (0.18)	0.03 (0.17)	0 (1)	0 (1)

Table 4: Regression results of demand for diet quality over time

	CanHFD Version 1982		*CanHFD Version 1992*	
	Model 1	**Model 2**	**Model 3**	**Model 4**
	1984	**1996**	**1984**	**1996**
	Coeff.	**Coeff.**	**Coeff.**	**Coeff.**
Constant	-0.686	-1.378	-0.692	-1.481
	(-4.61)**	(-11.37)**	(-4.750)**	(-12.244)**
Characteristics of the survey participant				
Ln Age	0.185	0.287	0.155	0.267
	(8.759)**	(15.726)**	(7.518)**	(14.6449)**
Male	-0.103	-0.063	-0.087	-0.052
	(-5.582)**	(-5.517)**	(-4.386)**	(-4.606)**
Secondary	0.071	0.039	0.063	0.040
education	(3.197)*	(2.105)*	(2.866)*	(2.153)*
Post	0.122	0.122	0.102	0.119
secondary	(4.187)**	(5.431)**	(3.562)**	(5.303)**
education				
Diploma	0.109	0.105	0.086	0.095
	(3.731)**	(4.876)**	(3.009)*	(4.428)**
University	0.203	0.235	0.181	0.217
	(6.986)**	(10,036)**	(6.365)**	(9.296)**
Born West	0.078	0.018	0.055	0.026
	(3.116)*	(0.823)	(2.268)*	(1.196)
Born South	0.140	0.209	0.114	0.177
	(4.702)**	(8.032)**	(3.920)**	(6.826)**
Born Other	0.089	0.102	0.075	0.104
	(2.996)*	(3.902)**	(2.559)*	(3.976)**
Household characteristics				
HHSize	0.004	0.007	0.006	0.008
	(0.590)	(1.147)	(0.863)	(1.485)
Ln Income	0.035	0.046	0.015	0.033
	(2.796)*	(5.092)**	(1.216)	(3,681)**
Atlantic	-0.077	-0.063	-0.080	-0.067
	(-1.909)	(-2.556)*	(-2.029)*	(-2.731)*
Québec	-0.21	0.110	-0.047	0.090
	(-0.905)	(5.959)**	(-2.053)*	(4.872)**
Ontario	-0.128	-0.027	-0.123	-0.029
	(-5.649)**	(-1.542)	(-5.951)**	(-1.658)
Prairies	-0.145	-0.100	-0.133	-0.081
	(-5.864)**	(-4.977)**	(-5.487)**	(-4.043)**
Single	-0.150	-0.037	-0.140	-0.023
	(-6.001)**	(-1.950)	(-5.709)**	(-1.242)
loneparent	-0.160	-0.042	-0.155	-0.027
	(-5.015)**	(-1.833)	(-4.950)**	(-1.187)
HHrelatives	-0.042	0.108	-0.059	0.117
	(-0.942)	(3.680)**	(-1.325)	(3.983)**
Nonmarried	-0.204	-0.049	-0.210	-0.030
	(-4.690)**	(-1.579)	(-4.915)**	(-0.970)
Adj. R^2	0.064	0.065	0.05	0.051

Note: t-values are displayed in parentheses. All analyses were adjusted for sample weights. ** p<0.01, * p<0.05

Table 5: Cross table results 1984, CanHFD-Index and income categories by quintiles

	Income		
CanHFD	**Low**	**Medium**	**High**
Low	39.2%	32.5%	28.3%
Medium	30.3%	32.4%	37.1%
High	30.5%	35.1%	34.6%
Total	**100%**	**100%**	**100%**

Table 6: Cross table results 1996, CanHFD-Index and income categories by quintiles

	Income		
CanHFD	**Low**	**Medium**	**High**
Low	34.6%	33.8%	31.5%
Medium	30.6%	34.1%	35.5%
High	34.8%	32.1%	33.0%
Total	**100%**	**100%**	**100%**

Table 7: Cross table results, CanHFD-Index 1984 by quantiles and education categories

	Education				
CanHFD	**Low**	**Secondary**	**Post secondary**	**Diploma**	**University**
Low	28.4%	25.9%	24.5%	23.8%	18.2%
Medium	50.9%	49.7%	49.7%	47.0%	46.0%
High	20.7%	24.4%	25.7%	29.1%	35.7%
Total	**100%**	**100%**	**100%**	**100%**	**100%**

Table 8: Cross table results, CanHFD-Index 1996 by quantiles and education categories

	Education				
CanHFD	**Low**	**Secondary**	**Post secondary**	**Diploma**	**University**
Low	32.5%	37.3%	30.4%	33.4%	25.9%
Medium	34.0%	32.1%	35.8%	35.1%	31.5%
High	33.5%	30.6%	33.7%	31.5%	42.5%
Total	**100%**	**100%**	**100%**	**100%**	**100%**