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Caribou consumption in northern Canadian communities

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ABSTRACT

Chronic wasting disease (CWD) is a transmissible spongiform encephalopathy (TSE) found in both farmed and wild deer, elk, and moose in the United States and Canada. Surveillance efforts in North America identified the geographical distribution of the disease and mechanisms underlying distribution, although the possibility of transmission to other cervids, including caribou, and noncervids, including humans, is not well understood. Because of the documented importance of caribou (*Rangifer tarandus*) to human populations in the northern regions of Canada, a risk-management strategy for CWD requires an understanding of the extent of potential dietary exposure to CWD. Secondary 24-h dietary recalls conducted among Inuvialuit and Inuit in 4 communities in the Northwest Territories and Nunavut were employed in this study. Econometric demand systems were estimated to model the impacts of individual- and community-level socioeconomic characteristics on expenditures on caribou and other foods, in order to examine the households' ability to consume other foods in response to changing levels of caribou consumption. Thirty-five percent of respondents reported consuming caribou in the survey period, and caribou comprised, on average, 26% of daily dietary intake by weight, or approximately 65 g/d, across individuals in the 4 communities. Consuming caribou was also shown to exert positive impacts on dietary quality, as measured by calorie intake and dietary diversity. Communities with less access to employment, income and food stores are predicted to be constrained in their ability to obtain an adequate diet in the event of scarcity of caribou meat.

Four subspecies of caribou (*Rangifer tarandus*), a member of the Cervidae family, are found in Canada, including barren-ground caribou (*R. t. groenlandicus*), woodland caribou (*R. t. caribou*), pearyi caribou (*R. t. pearyi*), and Grant's caribou (*R. t. granti*) (Banfield, 1961; COSEWIC [Committee on the Status of Endangered Wildlife in Canada], 2011). In Canada, caribou are found in greatest density in the Arctic and sub-Arctic regions[1] (COSEWIC, 2011). Most barren-ground caribou herds typically undertake long migrations from the boreal forest or tundra in the winter, to calving areas on the tundra (COSEWIC, 2011). From archaeological and paleontological evidence, Burch (1972) identified that caribou has been a source of food, shelter, and clothing for humans for tens of thousands of years. Involvement in hunting, preparing, sharing, and eating caribou and other country foods fosters kinship and ties to the community, promotes physical activity, and provides a sense of cultural identity (Condon et al., 1995; Kuhnlein et al., 1996; Samson and Pretty, 2006). Across Dene/Métis, Yukon First Nations, and Inuit communities, Lambden et al. (2007, p. 315) found that 85% of respondents expressed agreement with cultural attributes of harvesting and eating country food such as the following: "keeps people 'in tune with' nature," "teaches patience," "builds one's pride and confidence." Lambden et al. (2006) reported on some of the economic factors affecting access to country foods (between "14.7% of Yukon First Nation and 42.1% of Inuit found hunting to be too expensive" and "27.4% of the entire studied population did not have access to enough hunting equipment," p. 339). Rosol (2009) noted that 79% of a sample of participants in the

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[1]The Arctic biome covers the three Canadian territories (Northwest Territories, Yukon, and Nunavut) and the northern parts of Manitoba, Ontario, and Quebec. The sub-Arctic biome covers the Northwest Territories and the Yukon as well as the northern parts of seven provinces (British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, Quebec, and Newfoundland and Labrador) (Bone 2009; Environment Canada & Canadian Wildlife Federation 2013). Communities in Canada's four Inuit regions are located in the Arctic and sub-arctic biomes.

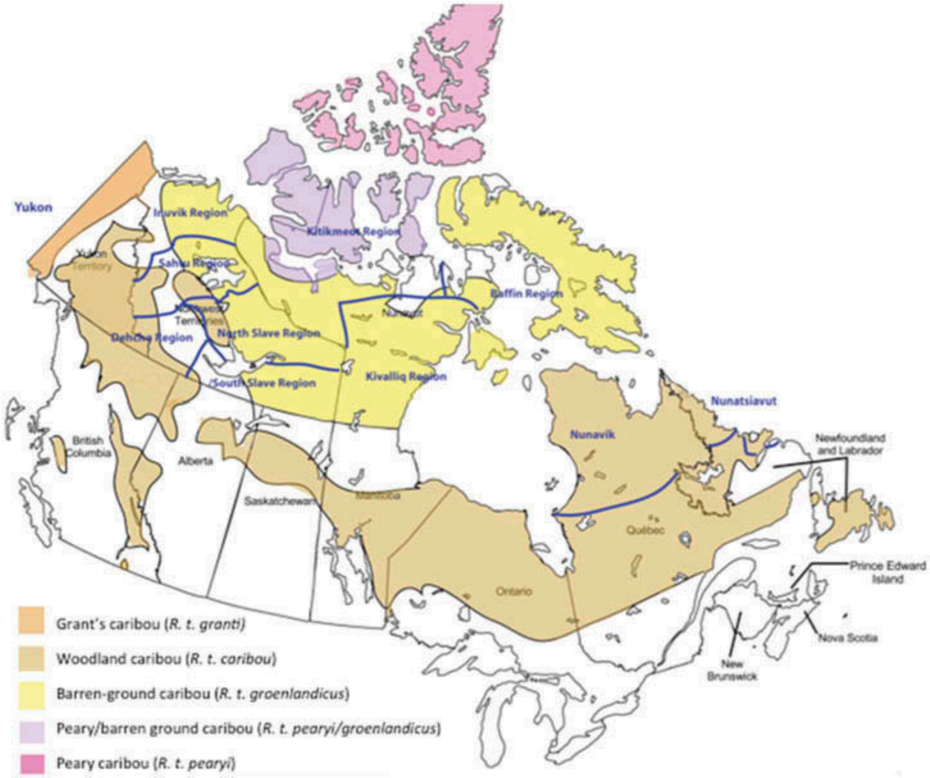

Figure 1. Map of caribou subspecies ranges, territorial administrative regions of the Northwest Territories and Nunavut, and Inuit region boundaries of Nunatsiavut and Nunavik. Administrative regions of the Northwest Territories include the Inuvik, Sahtu, Dehcho, North Slave, and South Slave regions, and administrative regions of Nunavut include the Baffin, Kitikmeot, and Kivalliq regions. References: Statistics Canada (2000), GNWT (2005), Fick (2007), Statistics Canada (2008), Library and Archives Canada (2009). 2001 Census of Canada Base Map (Statistics Canada, 2000, used under the Open Licence Agreement—http://www.statcan.gc.ca/eng/reference/licence-eng).

Inuit Health Survey reported that they would prefer to eat more country food than it was possible to obtain. See maps in Figures Figure 1 and Figure 2.

The availability and adequacy of caribou as a food source are currently threatened by a multitude of factors. Population declines have been noted for 34 out of 43 monitored herds in worldwide circumpolar regions over an average of approximately 10 years (Vors and Boyce, 2009). Populations of woodland caribou are considered endangered, threatened, or of special concern (Environment Canada, 2008). Empirical studies demonstrated that the health and reproductive success of caribou populations are adversely affected by climate change, which may lead to decreased accessibility and availability of forage and increases in the likelihood of predation due to range shifts in other prey species and predators (Vors and Boyce, 2009). Potential enhanced availability of forage in warmer months may be accompanied by increased harassment by insects, which was found to exert adverse effects on physiological conditions (Gunn et al., 2009; Toupin et al., 1996; Witter et al., 2012). Development of industrial sites for mining, logging, and hydro-electric generation was shown to affect usage of traditional forage sites (Beverly and Qamanirjuaq Caribou Management Board, 2004; Cameron et al., 2005; Nellemann and Cameron, 1998). At the same time, thinner ice poses a risk for overland travel, and hunters may have to travel farther and in more dangerous conditions to access caribou (Nickels et al., 2005; Wesche and Chan, 2010). Infectious disease also poses a threat to caribou health and human consumers of caribou. Nematode parasites, toxoplasmosis, and brucellosis were identified in caribou meat; toxoplasmosis was found to be transmissible to humans (Kutz et al., 2001; Levesque et al., 2007; McDonald et al., 1990; Pitt and Jordan, 1994; Tessaro and Forbes, 2004).

Chronic wasting disease (CWD), a degenerative brain disease, was detected in deer and elk in Canada and the United States, and poses a potential disease threat to caribou (Happ et al., 2007; Sigurdson, 2008). The risk of CWD in caribou and

Figure 2. Map of Inuit regions of Canada (Statistics Canada, 2008, reproduced under the Open License Agreement—http://www.statcan.gc.ca/eng/reference/licence-eng).

other cervids—deer, elk, and moose—may impact the capacity of northern households to sustain a traditional diet and achieve food security, the state where "all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (Food and Agriculture Organization [FAO], 1998).

Households in isolated northern communities face multiple constraints in acquiring both store-bought foods and harvested foods such as caribou. The high price of store foods has been widely cited as a barrier to purchasing nutritious foods, while quality and variety of store foods are often poor, since many communities lack year-round road access (Beaumier and Ford, 2010; Chabot, 2008; Chan et al., 2006; Ford and Beaumier, 2011; Ladouceur and Hill, 2002; Lawn and Harvey, 2001; Todd, 2010). Individuals need to allocate time between employment and on the land harvesting. Although employment may restrict time available for harvesting, income from employment also facilitates the purchase of costly harvesting equipment like snowmobiles, firearms, ammunition, and fuel (Condon et al., 1995; Todd, 2010). Any threat to the supply of caribou for human consumption may negatively impact a household's ability to acquire nutritious country food and potentially increase household vulnerability to food insecurity.

Twenty-four-hour dietary recall data collected by Sharma et al. (2009, 2010)[2] in two Inuvialuit communities in the Northwest Territories and two Inuit communities in the territory of Nunavut were used in econometric analysis of individual food intake. The intakes of caribou, other country foods, and store-bought foods are identified from dietary recall data, and economic values are imputed for foods in a microeconomic framework.

Economic modeling of food choice behavior is employed in this study to determine how households may respond to a reduction of caribou in the diet. Various investigators considered the impact of

[2]Dietary data were provided through research agreement with Dr. Sangita Sharma, PI of Healthy Foods North and Aboriginal & Global Health Research Group, University of Alberta (gita.sharma@ualberta.ca).

demographic factors on frequency of use and consumed quantities of both store and country foods, as well as the influence of price changes on quantities of certain types of foods consumed (Duhaime et al., 2002; Hoppinget al. 2010b; Erber et al. 2010a; Lawn and Harvey 2001). Pakseresht et al. (2014) reported differences in food expenditure and proportion of food expenditure for food groups based on individual demographic categories with data from six Inuit and Inuvialuit communities in 2009. In the present study, both individual- and community-level characteristics were modeled as a set of factors affecting individual food expenditure shares with economic demand models. From the estimated parameters, elasticities were computed in order to determine whether consumption of a food might increase or reduce given changes in prices or total expenditure. Elasticity measures are important should the need to develop substitutes for caribou arise, since they would demonstrate which foods would currently be acceptable as substitutes by individuals. While Wilkie and Godoy (2001) and Wilkie et al. (2005) estimated demand equations to determine the impacts of income and price alterations on consumption of store-bought and country foods in Central African and Latin American hunting households, no other apparent studies to date involve estimation of price elasticities of demand for Canadian Arctic households.

Caribou was shown to be a high contributor of energy (calories), protein, and nutrients such as iron (Sharma et al., 2009, 2010; Van Oostdam et al., 2005). A modification in consumption of caribou or other country foods may influence overall diet quality and hence household food security status. Specifically, a reduction in consumption of nutrient-dense country foods may lead to an increased risk of consuming a nutritionally inadequate diet, if households do not consume other nutrient-dense foods as replacements. Pakseresht et al. (2012) calculated nutrient and energy/calorie costs to determine the influence of shifting expenditures from non-nutrient-dense to country foods. In this study, the effect of caribou consumption on diet quality indicators—dietary diversity and caloric intake—was modeled with econometric equations while controlling for overall expenditure level.

Econometric model estimates may be used to assess how diets might change and to elucidate the potential impacts on the ability of individuals to consume nutritionally adequate diets, should CWD become prevalent and residents become concerned regarding the safety of caribou consumption. In the past, community members reported being wary of taking meat from animals that appear unhealthy as evidenced by having swollen joints or parasite infestations (Nickels et al., 2005; WMAC North Slope, 2009).

Literature Review of Harvest and Dietary Studies on Caribou Consumption

Harvest studies carried out under Aboriginal land claim agreements, including those in the Inuvialuit, Nunavut, and Gwich'in regions, provide an indication of the relative potential use of different species (McDonald, 2009; Priest and Usher, 2004; The Joint Secretariat, 2003). For each species, numbers of animals harvested as shown in data reports may be converted to amounts of edible weight, as values derived from Usher (2000) and Ashley (2002), to illustrate availability of harvested country meat and fish available at the community and per-capita levels. As calculated with 2006 population values from federal census data, edible weight of country food harvested ranged from 24 to 369 g in the Inuvialuit Settlement Region, from 24 to 1553 g in Gwich'in Settlement Area, and from 22 to 469 g in Nunavut. On average, the harvest (in edible weight) comprised of caribou was higher than that for other categories of country animals—fish, sea mammals, birds, small mammals, and furbearers in the Kitikmeot and Kivalliq regions of Nunavut. It was found that the proportion of the harvest comprised of caribou was higher than that of other country animals in 5 out of 6 communities in the Inuvialuit Settlement Region, 2 out of 13 communities in the Baffin region (Nunavut), 5 out of 7 communities in the Kitikmeot region (Nunavut), 5 out of 7 communities in the Kivalliq region (Nunavut), and 2 out of 4 communities in the Gwich'in Settlement Area. In communities where caribou was not the animal harvested at the highest edible weight, the country animals that were predominantly consumed were fish, sea mammals, or muskox. For the Sahtu Settlement Area, McMillan (2012) showed from edible-weight calculations that barren-ground caribou comprised the highest proportion of total edible weight harvested compared with woodland caribou, moose, small mammals, birds, and fish in two communities, and barren-ground caribou and moose were each, in different years, the predominant harvested animal in two other communities.

From dietary studies, a range of values was noted for consumption of caribou and moose meat across the North. The median daily consumption of different types of caribou meat and fat ranged from around 56–337 g/d in a few Northwest Territories communities and 36–338 g/d in some Yukon communities, while mean daily consumption of different caribou parts was reported to be 7–67 g/d in the Inuvialuit Settlement Region (Batal et al., 2005; Egeland, 2010a). For different types of cooked moose, the range for median daily consumption was 49–245 g/d across Yukon and Northwest Territories communities (Batal et al., 2005). In the eastern Arctic, average consumption of caribou was 5–55 g/d in Nunavik communities, 31–208 g/d in Nunavut communities, and approximately 67 g/d in Nunavatsiavut (Duhaime et al., 2002; Egeland, 2010b, 2010c; Innis et al., 1988; Lawn and Harvey, 2001, 2003, 2004).

Caribou and moose meat were consistently found to be among the top country food species consumed, after calculating percent of respondents consuming and ranking the percentages across studies in northern communities since the 1980s. In the Northwest Territories and Yukon, caribou meat was demonstrated to be among the top 5 (out of lists of 10–28 country foods) or among the top 10 (out of a list of 101 country foods), with percent of participants consumption ranging between 4 and 100% across communities or regions and study periods (Batal et al., 2005; Egeland, 2010a; Kuhnlein et al., 1994; Nakano et al., 2005; Tracy and Kramer, 2000). The studies by Kuhnlein et al. (1994), Batal et al. (2005), and Nakano et al. (2005) showed that moose is among the top 5 (out of lists of 15 or 28 country foods) or top 20 foods (out of a list of 101 country foods) consumed in Dene/Metis communities in the Northwest Territories and Yukon First Nations communities. In the eastern Arctic, caribou was the country food most commonly consumed in Nunavik, the most commonly consumed country food in Nunatsiavut, and either the first or second most commonly consumed country food, on average, across Nunavut communities, with consumption ranging between 6.9 and 98% (Duhaime et al., 2002; Egeland, 2010b, 2010c; Gagné et al., 2012; Johnson-Down and Egeland, 2010; Kuhnlein and Soueida, 1992).

Caribou was found to be consumed between 1.3 and 3.2 times per week, and moose between 1.6 and 2.7 times per week across the North (Kuhnlein, personal communication, 2002, as cited in Van Oostdam et al., 2005). Zotor et al. (2012) noted that baked, boiled, or roasted caribou was consumed on average 0.18 times per day in a sample of three Inuvialuit communities in 2007 and 2008. Lawn and Harvey (2003, 2004) demonstrated from studies in two Nunavut communities that caribou was consumed between 5.25 and 10.5 times in a month. Blanchet and Rochette (2008) found that 87.4% of respondents reported consuming caribou more than 11 times a year and 11.5% of participants indicated consuming caribou 1–10 times per year in Nunavik in 2004. While meat is often the most consumed part, the ingestion of caribou and moose bone marrow, brain, fat, head, heart, liver, stomach, intestine, and ribs was also noted (Kuhnlein and Soueida, 1992; Kuhnlein et al., 1994; 2002; Wein et al., 1991).

Food that an individual or household consumes or has access to may not be appropriate to meet nutritional needs. Dietary quality may be assessed with objective indicators that involve measuring nutritional adequacy—comparing levels of a single nutrient or a set of nutrients consumed to nutritional requirements defined by nutritional scientists, or applying a validated food-pattern or index measurement that reflects diversity or variety of foods and levels of nutrients consumed (Babu and Sanyal, 2009; Drescher, 2007; Drewnowski et al., 1997; Ruel, 2003; Thomson and Metz, 1998). These indicators may illustrate how different foods consumed, such as caribou, contribute to the physical status of an individual.

It was found that caribou and other "large game" are the highest contributors among country foods to energy intake and the highest overall contributors to protein intake and iron intake among Inuit and Inuvialuit (Erber et al., 2010b; Hoppinget al., 2010a). Caribou liver was reported to be the source from which respondents in the Kitikmeot and Inuvialuit regions derived the highest quantities of vitamin A, while caribou meat was noted to be among the top three contributors of omega-3 fatty acids, vitamin E, zinc, and iron in other Inuit regions (Van Oostdam et al., 2005). The consumption of country food in aggregate was linked with increased intake of iron, zinc, potassium, protein, vitamin A, vitamin D, vitamin E, riboflavin, vitamin B-6, copper, magnesium, manganese, phosphorus, and selenium, and diminished intake of sodium, fat, carbohydrates and sugar (Receveur et al., 1997; Kuhnlein et al., 2004; Egeland et al., 2011).

Aside from assessing intake of individual nutrients, objective dietary quality indicators may involve collecting information on a number of factors and potentially combining them into summary or index measures such as weight or servings of different foods consumed, quantities of nutrients consumed, dietary diversity (the total number of items consumed) or dietary variety (the total number of unique items consumed) within or among food groups, the relative occurrence of different foods, or ratios between actual and recommended consumption of food items or nutrients (Arimond and Ruel, 2004; Basiotis et al., 1995; Drescher, 2007; Ferguson et al., 1993; Haines et al, 1999; Haveman-Nies et al., 2001; Huijbregts et al., 1997; Kant, 1996; Kennedy et al., 1995; Krebs-Smith et al., 1987; Onyango et al., 1998; Patterson et al., 1994). With data from 33 Inuit communities in 2007–2008, the Healthy Eating Index (HEI) score, which involves measurement of 9 components—the intakes of 4 food groups, total fat, saturated fat, total cholesterol intake, total sodium intake, and dietary variety—and has a maximum value of 100, was found to range from 51 to 80, with means of between 55.2 and 55.3 across all “food secure” and “food insecure” groups (Huet et al., 2012). The HEI scores for these respondents were lower than the national average score of 58.8 (Garriguet, 2009). While Huet et al. (2012) did not discuss the relationship between caribou consumption and HEI score, no other known food-pattern or index indicators are known to have been analyzed for northern Canadian populations.

The impacts of socioeconomic characteristics on household or community vulnerability to CWD are not entirely understood from existing dietary and harvest data, which indicate high relative levels of caribou consumption. One approach to examining the influence of socioeconomic characteristics on food demands and substitutability is a common approach in economics that involves estimating a system of simultaneously determined demand equations derived from assumptions of individuals maximizing their utility of consuming various foods subject to their individual budget (income) constraints. Demand for each individual food (as part of the system) would be estimated as a function of prices of all foods, food expenditure (budget), and socioeconomic characteristics of individuals and the communities in which they live (e.g., number of grocery outlets). Through this mechanism the substitution possibilities (e.g., caribou vs. other foods) for households in different communities can be identified. These measures can be useful in identifying the communities and households that would be most seriously affected by lack of caribou to eat in terms of dietary quality and calorie intake. This approach requires significant attention to determining economic costs (in some cases market prices) of the different foods consumed by households, and those data requirements are found in the following methods section.

Data and Methods

Data Description

Economic models were estimated with dietary recall data collected in two communities in the Inuvialuit Settlement Region and two in the Kitikmeot administrative region in Nunavut, Canada. As described by Sharma et al. (2009, 2010), 24-h dietary recalls were conducted among Inuvialuit and Inuit aged 19 years and over to determine the foods and nutrients to be targeted in a nutritional intervention program. Local interviewers recorded information on time of consumption, types of food or drinks (meat type or brand name, source, and any additions to the food) over the preceding 24-h period, and quantities of foods based on prespecified quantity models. Data collection was carried out in communities in spring or winter 2006. Data on individual- and community-level explanatory variables are available from the survey data and also retrieved from federal census data. The study communities varied in population size and economic characteristics (Table 1).

For 188 respondents in the sample, 3185 food entries were reported in dietary data aggregated for the 4communities. Records of alcoholic beverage or water consumption were excluded from analysis, and it was assumed that water consumed is from municipal sources. For mixed dishes such as sandwiches, sauces, stews, stir-fry, and soups, quantities consumed of component parts are identified in data for some recall items. For mixed dishes where ingredients are listed in the recall entry without associated quantities, the amount of the ingredient used in the dish was presumed to be equal to the total weight of the dish multiplied by the proportion the ingredient comprises, where proportions are derived from published recipes. A few single-item-ingredient food items that are usually prepared with addition of water, such as coffee, powdered beverages, and pasta, were converted to raw ingredient weights with published preparation instructions.

The dietary intakes of food items by individual households were analyzed as cross-sectional data and food prices assigned to individual foods in order to calculate total individual food expenditure and food expenditure shares for different groups of foods. Recall items were first classified into 25 food groups defined in the Canadian Nutrient File (CNF), and then classified into one of 4 groups as defined by Canada's Food Guide—(i) vegetables and fruit, (ii) grain products, (iii) milk and alternatives, (iv) meat and alternatives (Health Canada, 2010a). Since consumption of caribou is of interest in this investigation, the meat group is further disaggregated—store meat is classified into groups for beef, chicken, pork, processed meat, and seafood, while country meat is classified into groups for caribou and other country foods. While nuts and seeds are categorized under "meat and alternatives" in the food guide, they are categorized in the demand analysis groups under the dairy group. Foods that could not be categorized into the four Food Guide groups,

Table 1. Socioeconomic characteristics by community.

Variable abbreviation	Variable description	Sample community			
		1	2	3	4
Community-level characteristics					
	Population (2006)	1477	809	3651	907
	Percentage change in population (2001/2006)	10%	10%	10%	−10%
	Population (2001)	1309	720	3395	999
	Percentage Aboriginal identity	80%	90%	60%	90%
NSTORES	Number of private or cooperative food retailers	2	2	7	1
	Road access	None	None	All year	Winter only
	Food mail receiving community	Yes	Yes	No	Yes
ERATE	Employment rate	63.7	40.4	70.8	38.9
Individual characteristics from recall data					
AGE	Mean age (years)	42.6	52.2	47.8	46.6
GENDERD	Percent of respondents male	47%	50%	42%	50%
EMP	Percent of respondents employed (includes part time and seasonal employment)	51%	10%	44%	30%
	Interview period	Spring (March–April)	Spring (March–April)	Winter (November–December)	Winter (November–December)
	Sample size	$n = 47$	$n = 40$	$n = 45$	$n = 56$

Note. References: Community-level demographic variables are from Statistics Canada (2006), Community Profiles and websites for Government of the Northwest Territories, Government of Nunavut, Arctic Co-operatives Limited (http://www.arcticco-op.com/co-op_location.htm), Northwest Company Limited (http://www.northernstores.ca/store_locator.htm), Inuvialuit Development Corporation (http://www.idc.inuvialuit.com), 411.ca (http://411.ca), and ProFile Canada (http://www.profilecanada.com).

but were defined in the CNF as fats and oils, sugars, snacks, nonalcoholic beverages, and food-away-from-home, were included in the demand analysis as a group labeled "other foods." The energy intakes (number of kilocalories) from food items in the dietary recall are also calculated with values from the Canadian Nutrient File (version 2010) (Health Canada, 2010b).

Expenditures were calculated for each participant for 10 individual food groups: (1) beef, (2) chicken, (3) pork, (4) processed meat and store seafood ('processed meat and seafood'), (5) caribou, (6) other country meat and fish, (7) fruits and vegetables, (8) grain, (9) dairy, eggs, and alternatives, and (10) "other foods." The price for each food group faced by a given respondent was calculated by taking the sum of expenditures on all items in that food group for the individual and dividing by the sum of quantities consumed on all items in that food group. For "other country meat and fish," price was calculated by taking the mean of prices (total expenditure divided by total quantity) calculated for four subgroups: land mammals other than caribou, fish, sea mammals, and birds. Less than 1% of respondents reported consuming moose; moose is categorized in the "other country food" category. For consumers with zero consumption of items in a given food group, the price is the mean of the calculated prices for that food group faced by all nonzero consumption consumers from the same community. Using prices averaged at the community level for individuals as approximations for missing prices for subjects involves assumption that prices, which may be dependent on transportation infrastructure and types of products available for purchase, are heterogeneous among communities but homogeneous at the community level.

Store and Country Food Prices

Prices are typically not collected for 24-h recall data and were not reported in the present data. Since no published price data are available for food items for the study period and region, unit prices for individual food items provided in the survey were collected at an Edmonton retail store and from a fast food restaurant in one of the study communities in September 2010. Other studies employed regional or national prices for food expenditure calculation when community-level price data were not available (Cade et al., 1999; Darmon et al., 2004; Guo et al., 2000). It is assumed that foods consumed are prepared by the household, unless the dietary entry specifies that an item is consumed away from home. Food prices were first adjusted from 2010 to 2006 prices with Alberta index values for individual food categories (Statistics Canada, 2012b). Food prices were then modified to community-level prices with values from the Revised Northern Food Basket, a price survey conducted by the federal government to measure the weekly cost of food for a family of four in northern communities and associated southern supply centers (Aboriginal Affairs and Northern Development Canada [AANDC], 2008).

While traditional demand analysis may only account for only "goods" or "commodities" purchased in the market, the household production model shows that households may combine time and store-bought goods in order to generate final commodities for consumption while facing resource constraints for available income and time for production of these commodities (Becker, 1965; Gronau, 1977, 1986). The price of harvested country food may be estimated and used in the calculation of food expenditures if it is assumed that the household production function, or the household's ability to convert store-bought goods and time to the home-produced item (i.e., country food), exhibits specific properties such as constant returns to scale and nonjoint production (or the use of each input for the production of only one commodity) (Pollak and Wachter, 1975). Since data on goods and time inputs used for harvesting country food are not available from the dietary recall to model the rate at which the household can trade time off for goods in the production of country food, simplifying assumptions were made such that the price of harvesting country food, which may be called π_i, is modeled as a function of only one type of good—goods or time.

It may be assumed that a household's land or capital is fixed in the short term, or that household time is the only input used in the production process with no substitution of goods for time (Gronau, 1977; Singh et al., 1986). The "opportunity cost" price of a unit of harvested country food may be written π_{OC} and is influenced by two factors—a community-level estimated wage rate, and time required to harvest one unit of country food, which is dependent on local availability and accessibility of country animals. It is presumed that the nonemployed household enters the labor market without costs, and both employed and nonemployed individuals are expected to respond to increases in π_{OC} negatively and decrease demand for the country food in question. In reality, individual characteristics such as education or previous training, if available, may be used to estimate a labor function to determine wages at the individual level. In addition, detailed data on individual time use may enable more accurate estimation of opportunity costs that accounts for heterogeneity among individuals. For instance, opportunity cost may not be valued at the wage rate by employed harvesters, as they may be employed in rotational or seasonal employment or in flexible employment that enables harvest time outside of work (Hobart, 1982; Kruse et al., 1983; Todd, 2010). On the other hand, employed harvesters may not be able to easily allocate time between wage work and harvesting: Hunters in Inuvialuit communities have expressed desires to get out on the land, but felt constrained by work schedules, which only permit hunting on weekends and holidays (Condon et al., 1995; Todd, 2010).

An alternate assumption for the household's utility function is that households derive leisure from all time spent in harvesting. The only cost faced by the household in harvesting is for equipment and market inputs—the "out-of-pocket" cost of harvested country food, called π_{OP}. Individuals are also expected to respond to an increase in π_{OP} with reduced consumption. While it is assumed in the present model that consumed meat is obtained from country food harvested by households with their own resources, households may participate in and obtain meat from community hunts, borrow harvest equipment or obtain subsidies for equipment purchase under harvest support programs, lend equipment to other households in exchange for food, or receive food directly from other households (Chan et al., 2006; Condon et al., 1995; McMillan, 2012; Wenzel, 1995). Intra- and interhousehold factors are not modeled, since data on family structure (e.g. number of household members) and community social networks (which may affect access to country food harvested by other households, or the rate of sharing harvested food with other households) were not available.

Without detailed survey data on individual hunting effort and harvest success, data from recent harvest studies in the respective communities are used to approximate harvest effort in terms of the number of animals that may be harvested in a day. Number of animals and number of harvesters per month for select species are reported for 6 communities in the Inuvialuit Harvest Study (IHS) and for 27 communities in the Nunavut Wildlife Harvest Study (NWHS) (Priest and Usher, 2004; The Joint Secretariat, 2003). To determine the price per unit of country food consumed in terms of opportunity cost or out-of-pocket equipment cost, a measure of harvest effort (time required to harvest) is first calculated, as follows:

$$k_{ij} = \frac{\sum_j (\textit{number of hunter months}) * \frac{\textit{number of days}}{\textit{number of hunter months}}}{\sum_j \textit{number of animals} * \frac{\textit{edible weight}}{\textit{animal}}}$$

where $i \in$ *caribou, land mammals other than caribou, fish, sea mammals, birds,* $j \in$ *community* 1, 2, 3, 4, and number of hunter months refers to the number of hunters in a month summed across all months surveyed.

For the calculation of k_{ij}, it is assumed that different levels of harvest effort are expended for different species that are noted in the harvest studies, as it was found that the harvest of large land and sea mammals is most likely to be carried out by full-time hunters and hence may require more time (Chabot, 2003; Condon et al., 1995; Kruse, 1991). It is assumed that full-time hunters devote an average of 20 d/mo (the amount of time that may alternatively be devoted to full-time employment) to harvesting.

The opportunity cost of harvesting a unit of animal may be written

$o_{ij} = k_{ij} * h_j * \mathrm{r}$[3]

where o_{ij} is the opportunity cost of harvesting an animal, h_j is the average hourly wage of trades and construction occupations in the community,

[3]Opportunity cost units: $\frac{days}{kg} * \frac{\$}{hours} * \frac{8hours}{day}$.

and r is the number of hours spent harvesting per day.

The average hourly wage is multiplied by 8 to represent the total daily wages that may be earned by an individual, since most full-time employees are typically paid for 8 h of employment. This value is assumed to be an average time cost and represents the exogenous time cost for harvesting an animal in the community. Hourly wage figures were not available for all types of occupations, so available published figures were used (Human Resources and Skills Development Canada, 2012a, 2012b).

The basic out-of-pocket cost calculation ($/kg) may be stated as

$$\pi_{ij} = \alpha_{ij}k_{ij} + \beta_{ij}k_{ij} + c_{ij}\mathrm{d}^{4}$$

where $i \in$ *caribou*, land mammals other than caribou, fish, sea mammals, birds, j ∈ community 1, 2, 3, 4, α_{ij} is the cost of equipment per day spent harvesting, β_{ij} the cost for fuel per day assuming one trip per day, $k_{ij}$the days required per kilogram harvested, $c_{ij}$the cost per kilogram harvested,and d the kilograms harvested.

The α_{ij} and β_{ij} terms are

$$\alpha_{ij} = k_{ij} * (\textit{fuel costs per day})$$
$$\beta_{ij} = k_{ij} * (\textit{equipment ownership and depreciation cost})$$

It is assumed that the cost of fuel per day spent on the land is the cost of one trip to the harvesting site, where harvest distances are assumed to be the average of the closest and farthest distances from the community to caribou ranges as shown in herd distribution maps. The term c_{ij} is comprised of ammunition costs, where it is assumed that four bullets per animal are required for seals and whales, two shots are required for caribou, and one shot is required per goose (Smith and Wright, 1989).

The mean annual cost for harvesting country food was reported in previous studies. Costs may be classified by season or type of hunt (whether on land, ice, or sea), but are not classified by species names (Ames et al., 1989; Smith, 1991; Smith and Wright, 1989). The inventory reported by Smith and Wright (1989) was adopted for calculation of the daily cost of using harvest equipment. Prices for snowmobiles, ATVs, boat hulls and motors, firearms, and ammunition were found from online catalogues, while prices for other equipment were taken from Smith and Wright's (1989) listed prices and adjusted to 2006 prices with the CPI for Yellowknife, NT, Canada (Statistics Canada, 2012a).

Demand Equations for Caribou and Other Foods

Systems of demand equations were estimated to investigate how households may make food consumption decisions (based on prices for all food groups) and also food substitution decisions. The traditional demand relationship, where quantity demanded is a function of total expenditure and prices, is expressed algebraically as an expenditure share equation. Expenditure shares as the dependent variable is used because algebraic restrictions imposed to satisfy the axioms of consumer theory are easy to introduce. A traditional Engel relationship, showing that the proportion of income spent on food falls as income rises, is estimated using the Working–Leser (W-L) model, where expenditure share on a food is modeled as a function of total expenditure (Chern et al., 2002; Deaton and Muellbauer, 1980; Deaton and Paxson, 1998). Individual- and community-level socioeconomic characteristics are included in the model by demographic translation (Pollak and Wales, 1992):

$$w_i = \alpha_0{}^* + \alpha_i * \log TOTAL_m + \sum_k \gamma_{ik} * D_k + \varepsilon_i$$

where w_i is the expenditure share of a food i; $TOTAL_m$ has $m = 1$ when total food expenditures of country food are calculated with opportunity costs and $m = 2$ when total food expenditures of country food are calculated with out-of-pocket costs; D_k are individual- and community-level demographic variables; ε_i is a random disturbance term; and $\alpha_0{}^*$ is $\alpha_0 - \sum_k \gamma_{ik} * D_k$. The adding-up restriction, which implies that the sum of expenditures is equal to the total budget available, may be imposed in this system. The W-L functional form, while easily estimable since price data is not required, does not allow for implementation of the theoretical properties of demand functions such as homogeneity and symmetry.

[4]Out-of-pocket cost π_{ij}units: (Fuel cost) + (Equipment ownership and depreciation costs) + (Cost of ammunition) = $\left(\frac{\$}{day} * \frac{days}{kg}\right) + \left(\frac{\$}{day} * \frac{days}{kg}\right) + \left(\frac{\$}{kg} * kg\right)$.

A second empirical model, the Almost Ideal Demand System (AIDS), is estimated to illustrate the effects of own- and cross-prices on demand for a given food type (Deaton and Muellbauer, 1980). Restrictions such as homogeneity and symmetry may be imposed algebraically within the system. A version of the model where the price index is linearized, called the LA/AIDS model, was estimated as follows (Green and Alston, 1990):

$$w_i = \alpha_0{}^* + \beta_i * \ln\left(\frac{TOTAL_m}{P}\right) + \sum_j \gamma_{ij} \ln(p_j) + \sum_k \gamma_{ik} * D_k + \varepsilon_i$$

where w_i is the expenditure share of a food i; $TOTAL_m$ has $m = 1$ when total food expenditures of country food are calculated with opportunity costs and $m = 2$ when total food expenditures of country food are calculated with out-of-pocket costs; $p_j$is price of the jth food group; P is the linearized price index, which is specified $\sum_i w_i p_i$; $D_k$are the individual- and community-level demographic variables; ε_i is a random disturbance term; and $\alpha_0{}^*$ is $\alpha_0 - \sum_k \gamma_{ik} * D_k$.

The two-step estimation method of Heien and Wessells (1990) is used for both the W-L and LA/AIDS models to account for zero consumption values. In the first stage, the participation equation, where the dependent variable is a binary variable for whether or not a food type is consumed, is estimated by the probit method to retrieve the parameters of the inverse Mills ratio (IMR). In the second stage, all observations are used in the demand system estimation, with the inverse Mills ratio from the first stage used as an instrument in the second stage. The two-step estimator of Heien and Wessells (1990) is consistent (though not fully efficient) for a system of equations.

The probability of consuming a food item (for food i, the hth individual, in time period t) is stated:

$$\Pr[y_{iht} = 1] = \Pr\left[X'_{iht}\beta + a_{iht} + \varepsilon_{iht} > 0\right] = \phi\left(X'_{iht}\beta\right)$$

The probability of not consuming a food item is stated:

$$\Pr[y_{iht} = 0] = \Pr\left[X'_{iht}\beta + a_{ih} + \varepsilon_{ih} = 0\right] = 1 - \phi\left(X'_{iht}\beta\right)$$

In the Working–Leser specification, $X'_{iht}\beta$ is expressed:

$$X'_{iht}\beta = \beta_0 + \beta_1 * AGE + \beta_2 * GENDERD + \beta_3 * EMPLOY + \beta_4 * ERATE + \beta_5 * NSTORES + \beta_6 * IMR + \varepsilon_i$$

In the AIDS specification, $X'_{iht}\beta$ is expressed:

$$X'_{iht}\beta = \beta_0 + \beta_1 * AGE + \beta_2 * GENDERD + \beta_3 * EMPLOY + \beta_4 * ERATE + \beta_5 * NSTORES + \beta_6 * IMR + \beta_7 \ln(\frac{x}{P}) + \sum_k \gamma_{ij} \ln(p_j) + \varepsilon_i$$

The demand system estimates were obtained with the LSQ command in Time Series Processor (TSP) version 5.1 (Hall and Cummins, 2009). Since the respective expenditure shares for different types of goods should theoretically add up to 1, the “other foods” equation was excluded from the Working–Leser and LA/AIDS estimations to avoid singularity of the estimated variance–covariance matrix. Parameter estimates for “other foods” were retrieved by calculations.

Demand for Calorie Intake and Dietary Diversity

Single-nutrient and food-pattern measures were considered as indicators for food security and overall diet quality. Investigators used different benchmark measures of calorie intake as an indicator for overall food security (Chung et al., 1997; Haddad et al., 1994; Hoddinott, 1999; Rose and Charlton, 2002). Murphy et al. (1992) found positive correlations between calorie intake and select micronutrients from dietary-recall data from the U.S. Nationwide Food Consumption survey. In contrast, intakes of nutrient-poor and energy-dense foods were also shown to be positively associated with energy intake and inversely related with nutrient density and intake of important micronutrients (Andrieu et al., 2005; Kant and Schatzkin, 1994). Since caribou was noted to be a significant contributor to intake of energy or calories in northern communities, the relationship between caribou intake and energy intake was analyzed with a demand relationship.

The number of calories consumed serves as an overall indicator of food security, but may not accurately reflect intake of macro- or micronutrients. Individuals may be at risk for overconsumption of calories. Further studies may employ measurement of the proportion of individuals in a community who have excessive calorie intake and who are at risk of obesity, versus the proportion of individuals who underconsume calories. The food group score developed by Kant et al. (1993) (DDS score) and Drewnowski et al. (1997) (DD score), which involves counting different number of food groups in which food items are consumed, was implemented as a measure for dietary diversity. Because serving or portion sizes for foods reported in the dietary data are not provided, and since calculating serving sizes from weights of foods consumed is a complex task for which conversion factors are not readily available from government-published sources, quantity thresholds that the consumed amounts have to fall within in order for a food group to be counted were not implemented. While Kant et al. (1993) and Drewnowski et al. (1996) specify five food groups to be estimated (milk and milk products, meat, grain, fruit, and vegetable), the score for this study was calculated based on four groups from Canada's Food Guide. There is evidence that high DD/DDS scores are positively related to measures of nutrient adequacy, such as energy and fiber intake, and negatively related to mortality; this measure is therefore suitable as a proxy for food security, despite its shortcoming of not accounting for potential consumption of unhealthy foods (Drewnowski et al., 1996; Kant et al., 1993). In addition, the food group score does not account for diversity among different country foods and animal parts, from which a variety of nutrients may be drawn from by individuals.

To examine the potential effect of caribou consumption on overall energy intake, a binary indicator for individual caribou consumption of this product was included as an exogenous variable in the demand equations for calories and dietary diversity. Assuming that prices are constant in a cross-sectional data set, the consumption equation for the calories for the hth individual is specified (Basiotis et al., 1983; Devaney and Fraker, 1989; Nayga, 1994; Nayga and Capps, 1994):

$$N_h = \beta_0 + \beta_1 * AGE + \beta_2 * GENDERD + \beta_3 * EMP + \beta_4 NSTORES + \beta_5 ERATE + \beta_6 CARIBOUD + \beta_7 x_{hm} + \varepsilon_i$$

where N_h is the number of calories consumed by individual h in a 24-h period and $CARIBOUD$ is the caribou consumption dummy (= 1 if consumed caribou, 0 otherwise).

It is predicted from the Jackson (1984) theory of hierarchical demand that dietary diversity increases with expenditure. The estimated equation for dietary diversity for the$h$th individual is specified:

$$M_h = \beta_0 + \beta_1 * AGE + \beta_2 * GENDERD + \beta_3 * EMP + \beta_4 NSTORES + \beta_5 ERATE + \beta_6 CARIBOUD + \beta_7 x_{hm} + \varepsilon_i$$

where M_h is the dietary diversity score and $CARIBOUD$ the caribou consumption dummy (= 1 if consumed caribou, 0 otherwise).

The range of the dietary diversity score is 0–4, where "0" = 0 food groups consumed, "1" = 1 food groups consumed, "2" = 2 food groups consumed, "3" = 3 food groups consumed, and "4" = 4 food groups consumed. An ordered probit model based on random utility theory was estimated. The dependent variable is ordinal and hypothesized to be a function of a set of measurable factors and certain unobservable factors (Greene, 2003). Assuming a normal distribution of error terms, the latent probability of receiving a given score is shown in the parameter estimates, while marginal impacts of changes in the explanatory variables on the respective probabilities are found in the marginal effects computations. The model was estimated in LIMDEP with the heteroskedastic ordered probit model (Greene, 2007). The model was tested for multiplicative heteroskedasticity, where it is assumed that the error variance may be related to any or all of the continuous variables (Verbeek, 2008).

Results

Descriptive Analysis

Across the study sample, caribou is consumed in greater quantity than all types of store meat—beef, chicken, pork, processed meat, and seafood. Caribou is consumed by a higher proportion of respondents (around 35%) than any other type of store meat or country meat. Six percent, 31%, and 2% of participants reported consumption of other land mammals, sea mammals and fish, and birds, respectively. The relative quantities of different country and meat types consumed reflect the quantities harvested in published harvest studies. The mean value of caribou consumed also falls within the range from the values noted in dietary studies for the Northwest Territories and Nunavut. Mean estimated prices faced by respondents for each food type are illustrated, with the highest prices (>$20/kg) recorded for store meats. Individuals face estimated prices of between $7.16/kg and $9.11/kg for fruits and vegetables, grains, or dairy products, and a higher average price for "other foods." A higher average level of expenditure was also recorded for caribou than for any of the store meats with the opportunity cost computation method, though a higher level was found for other country foods ($1.28) than on caribou ($0.91) (Figure 3 and 4).

In both opportunity cost and out-of-pocket cost specifications for country food pricing, it was found that consumers spent the highest proportion of their total food expenditure on "other foods," including sugars and sweets, fats and oils, soups, sauces, and gravies, and food-away-from-home. With the opportunity cost specification, consumers spent the second highest total daily proportion on store meat and seafood combined, followed by caribou and other country meat and fish combined, fruits and vegetables, grains, and dairy products. Pakseresht et al. (2014) noted the same relative expenditure pattern—a higher percentage of expenditure was allocated to store meat than to country meat and fish. With the out-of-pocket cost specification, the proportion of expenditure on country meat and fish combined was lower than that computed for grains and fruits and vegetables (Figure 5 and 6).

The most popular caribou preparation method was cooking—roasting, frying, boiling, or baking. Caribou meat and fat are the only reported caribou types consumed—there is no indication of other parts being consumed. Out of the land animals consumed, muskox was consumed the highest number of times. Char was the most highly consumed fish item in terms of number of meals, while whale fat (muktuk) was the most highly consumed sea mammal. Two species of birds—ptarmigan and goose—were consumed (Figure 7).

Demand System Analysis

The probit equations are estimated twice, with both opportunity cost (OC) and out-of-pocket cost (OP) country food pricing, and served as the first-stage model for both the Working–Leser and LA/AIDS estimations. The overall significance of each of the equations was assessed by a likelihood ratio test, with the null hypothesis that the slope estimates are all equal to zero. For both OC and OP specifications (see Table 2 and Table 3), the probit equations for pork, processed meat and seafood, other country foods, grains, and dairy were significant at the 10% level. The probit equation for fruits and vegetables was also significant at the 10% level in the OP specification. Percent of correct predictions for consumption generated by the probit equations ranged from 60 to 90%.

From the probability estimates and corresponding marginal effects for the OC model, increased age led to higher probabilities of consuming caribou and other country foods, with the coefficient for age being significant at the 10% level. For the OP model, increased age leads to a higher probability of consuming country foods other than caribou, but not caribou. Socioeconomic factors influenced likelihood of consuming different types of store food: In estimates from both price specifications, participation in employment and community employment rate exerted positive impacts on pork consumption, age had a positive effect on grain consumption, and being a male elevated the likelihood of consuming dairy products. Increased total food expenditure led to higher likelihood of consuming processed meat and seafood, grains, and dairy with OC calculations, and higher likelihood of consuming pork, processed meat, and seafood, fruits and vegetables, grains, and dairy and lower likelihood of consuming caribou and country foods other than caribou with OP calculations.

In the Working–Leser model estimates (presented in Table 4 and Table 5), increased age was

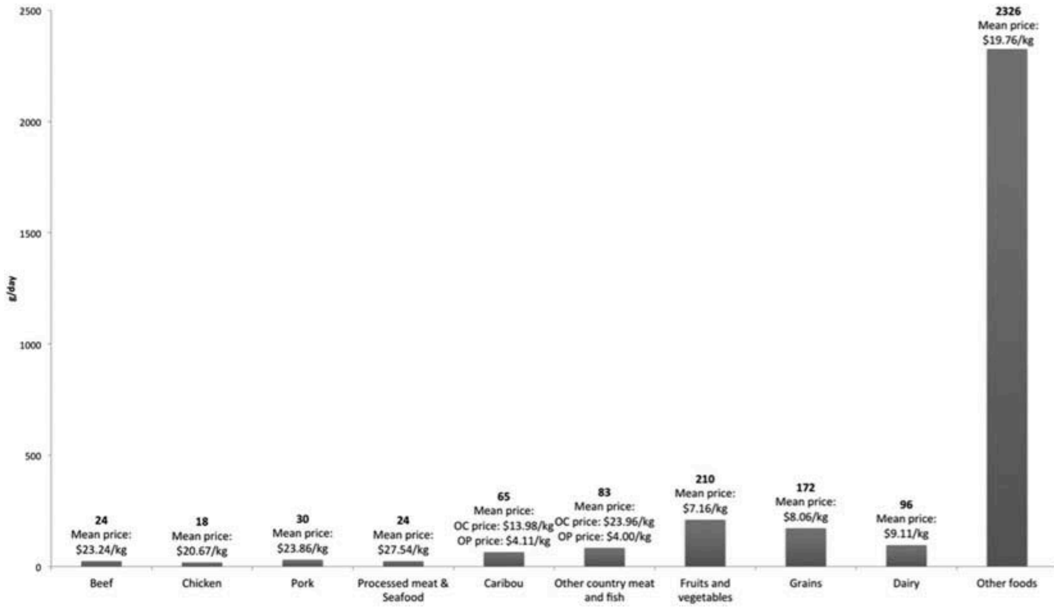

Figure 3. Mean daily consumption for different food items (g/d), mean price ($/kg) of store-bought foods, and mean opportunity (OC) and out-of-pocket (OP) prices ($/kg) of country foods ($n$ = 188).

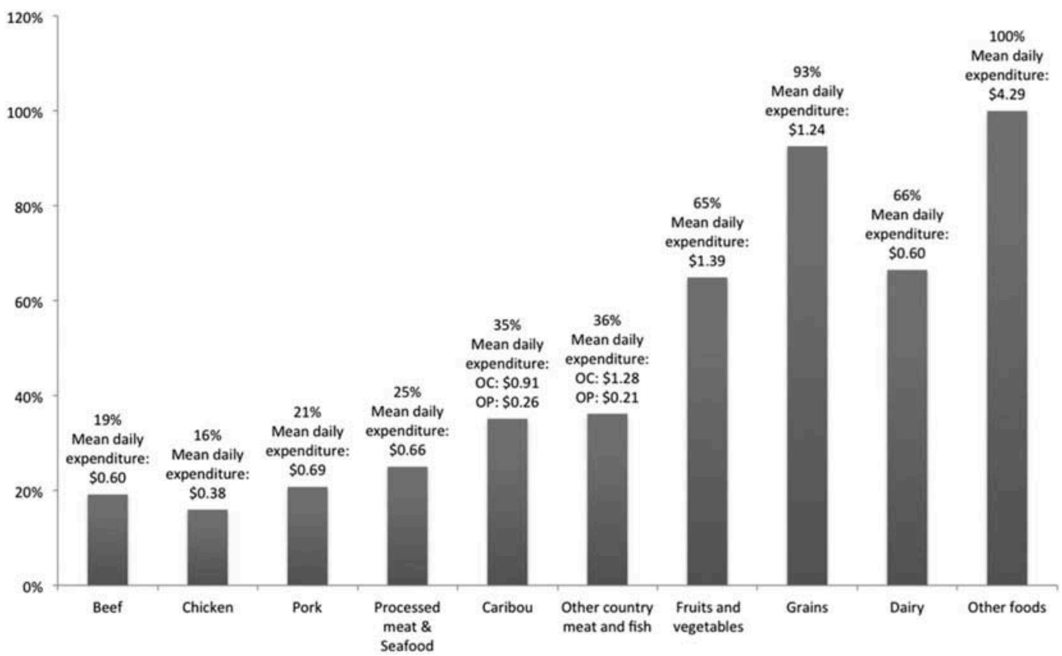

Figure 4. Percentage of respondents (%) consuming different food items, mean daily expenditure ($) of store-bought foods, and mean opportunity (OC) and out-of-pocket (OP) expenditures ($) of country foods.

associated with higher expenditure share level for country food other than caribou in both of the OC and OP specifications at the 10% significance level. A higher community employment rate was found to be negatively related to the caribou expenditure share in the OC specification, but showed no marked influence in the OP equation. Increased total food expenditure was found to be negatively

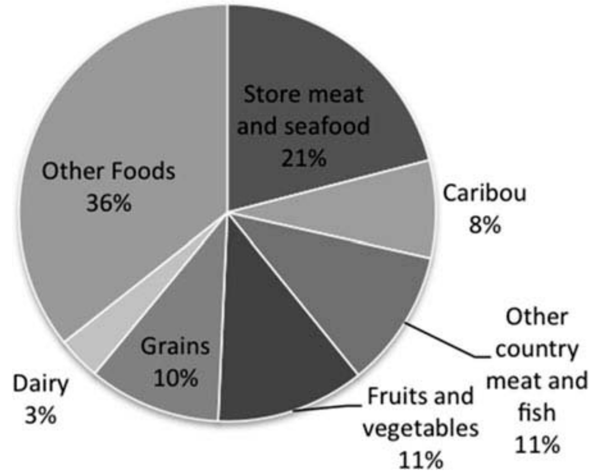

Figure 5. Percentage of total daily expenditures (%) (aggregated across entire sample, n = 188) for food groups with opportunity cost country food price calculations.

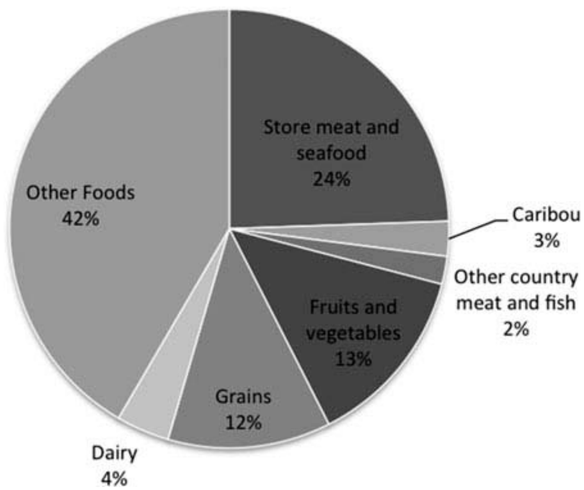

Figure 6. Percentage of total daily expenditures (%) (aggregated across entire sample, n = 188) for food groups with opportunity cost country food price calculations.

related to the expenditure share for caribou in both the OC and OP cost specifications and also negatively related to the expenditure share of other country foods, but only in the OP specification.

Socioeconomic factors included in the estimation exerted varied impacts on expenditure shares of store food: Higher age produced a negative influence on consumption of “other” foods (OC and OP estimates), being male led to decreased expenditure share levels for chicken (OP estimate), individual participation in employment had a positive impact on beef consumption (OP estimate) and a negative effect on pork consumption (OC and OP estimates), a greater number of food stores in the community exerted a positive impact on beef consumption and negative effects on consumption of pork and fruits and vegetables (OC and OP estimates), and an increased community-level employment rate produced positive impacts on the consumption of pork and fruits and vegetables and a diminished influence on chicken consumption (OP and OC estimates). Increased total expenditure led to higher expenditure share levels for processed meat and seafood (OC and OP estimates), pork (OP estimate), and fruits and

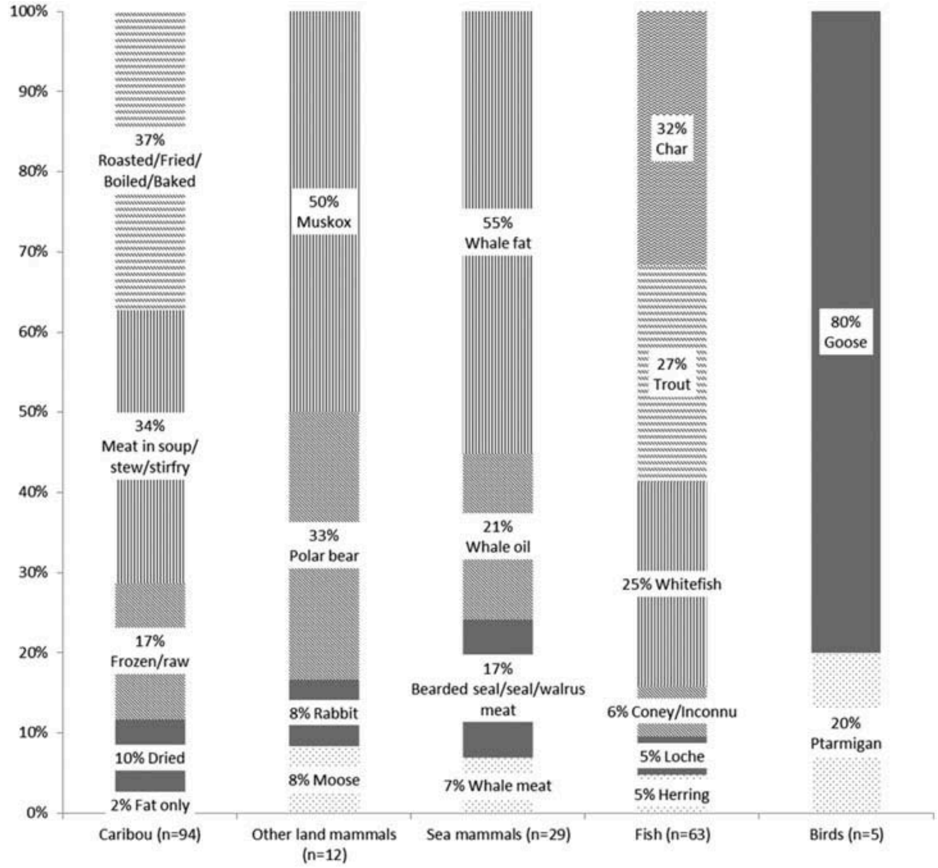

Figure 7. Types of country food consumed by proportion (of total number of meals) (%), classified by five country food groups: caribou, other land mammals, sea mammals, fish, and birds.

vegetables (OP estimate), and lower expenditure share levels of chicken (OC estimate) and grains (OP estimate).

From the LA/AIDS estimates (Table 6 and Table 7), age was found to exert a positive impact on expenditure share level of other country foods in both the opportunity cost and out-of-pocket cost models. An increased number of stores was found to produce a negative influence on caribou expenditure share level in the OC model, while elevated total expenditure was noted to exert a negative effect on caribou expenditure share level in the OP model.

In terms of expenditure share levels for store foods, being male was found to have a positive impact on beef consumption (OC estimate), and diminished effects on chicken consumption (OP estimate) and fruits and vegetables (OC and OP estimates) at the 10% significance level. Individual participation in employment was noted to exert a positive effect on the expenditure share level of beef in the OC estimate. An enhanced number of food stores in a community led to decreased consumption of beef (OC estimate). An increased community-level employment rate led to elevated consumption of beef and pork and reduced consumption of chicken (OC and OP estimates). Higher levels of total expenditure exerted positive impacts on consumption of processed meat and seafood, fruits and vegetables, and dairy products (both OC and OP estimates) and lower levels of consumption of beef (OC estimate), chicken (OC estimate), and "other foods" (OP estimate).

The Lagrange multiplier test statistic, which is used to test for heteroskedasticity, was found to be significant at the 10% level across all W-L equations except for the dairy equation in the OC specification and grain and dairy equations in the OP specification but was significant at the 10% level for all LA/AIDS equations. The models were estimated with Robust–White heteroskedastic-consistent standard errors. The likelihood ratio test (LRT) was used to find the best fitting model and performed by

Table 2. First-stage Probit estimates with marginal effects for opportunity cost country food specification.

Variables	Beef	Chicken	Pork	Processed meat and seafood	Caribou	Other country meat & fish	Fruits and vegetables	Grains	Dairy
C	−2.029***	−0.191	−3.763**	−0.741	−0.607	−0.892	0.130	0.165	−1.320**
	(0.702)	(0.680)	(0.763)	(0.606)	(0.575)	(0.589)	(0.571)	(0.822)	(0.654)
	[0.177]	[0.211]	[0.171]	[0.185]	[0.211]	[0.217]	[0.211]	[0.084]	[0.226]
TOTAL	−0.010	0.005	0.018	0.036***	0.006	0.016	0.019	0.074**	0.082***
	(0.016)	(0.017)	(0.015)	(0.014)	(0.013)	(0.014)	(0.014)	(0.033)	(0.021)
	[−0.003]	[0.002]	[0.005]	[0.011]	[0.002]	[0.006]	[0.007]	[0.008]**	[0.028]***
AGE	0.002	0.001	0.006	−0.007	0.010*	0.020***	−0.007	0.017*	0.005
	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.009)	(0.006)
	[0.001]	[0.005]	[0.001]	[−0.002]	[0.004]*	[0.007]***	[−0.003]	[0.002]*	[0.002]
GENDERD	0.297	−0.303	0.060	0.112	0.180	−0.028	−0.003	0.068	0.386*
	(0.225)	(0.236)	(0.233)	(0.213)	(0.197)	(0.200)	(0.199)	(0.316)	(0.209)
	[0.079]	[0.066]	[0.015]	[0.035]	[0.066]	[−0.011]	[−0.001]	[0.007]	[0.131]*
EMP	0.006	−0.234	−0.420*	0.119	−0.009	−0.080	0.085	−0.229	−0.023
	(0.241)	(0.263)	(0.259)	(0.228)	(0.216)	(0.220)	(0.218)	(0.318)	(0.232)
	[0.002]	[−0.003]	[−0.099]*	[0.037]	[−0.003]	[−0.030]	[0.031]	[−0.025]	[−0.008]
NSTORES	0.023	0.047	−0.077	0.041	−0.048	−0.023	0.072	0.077	0.036
	(0.070)	(0.083)	(0.068)	(0.070)	(0.067)	(0.068)	(0.068)	(0.103)	(0.072)
	[0.006]	[−0.018]	[−0.019]	[0.013]	[−0.018]	[−0.009]	[0.027]	[0.008]	[0.012]
ERATE	0.018	−0.016	0.050**	−0.006	−0.005]	−0.009	0.003	−0.007	0.006
	(0.013)	(0.014)]	(0.013)	(0.012)	(0.011)	(0.012)	(0.011)	(0.016)	(0.012)
	[0.005]	[−0.002]	[0.013]***	[−0.002]	[−0.002]	[−0.003]	[0.001]	[−0.001]	[0.002]
Regression statistics									
Schwarz B.I.C.	105.790	98.2509	100.694	117.58	136.422	133.472	135.568	61.9352	121.595
LR (zero slopes)	8.704	5.204	27.235 ***	12.934**	7.497	15.764**	10.4112	12.442*	33.254***
Scaled R^2	0.046	0.028	0.145	0.069	040	0.083	0.055	0.068	0.173
Correct predictions	80.85%	84.04%	79.26%	73.94%	65.96%	67.55%	65.43%	92.55%	71.28%
Number of positive observations	36	30	39	47	66	68	121	174	125

Note. Significant differences: ***, **, and * indicate significance at 1, 5, and 10% level, respectively. Values in parentheses are standard errors; values in square brackets are marginal effects.

Table 3. First-stage Probit estimates with marginal effects for out-of-pocket cost country food specification.

Variables	Beef	Chicken	Pork	Processed meat and seafood	Caribou	Other country meat and fish	Fruits and vegetables	Grains	Dairy
C	−2.208***	−0.283	−3.947***	−0.937	−0.402	−0.543	−0.076	0.217	−1.224*
	(0.708)	(0.683)	(0.782)	(0.623)	(0.580)	(0.595)	(0.587)	(0.814)	(0.641)
	[−0.579]***	[−0.066]	[−0.982]***	[−0.285]	[−0.148]	[−0.201]	[−0.028]	[0.023]**	[−0.424]*
TOTAL	0.011	0.017	0.036**	0.059***	−0.026*	−0.029*	0.048***	0.068**	0.082***
	(0.017)	(0.017)	(0.017)	(0.015)	(0.015)	(0.016)	(0.017)	(0.033)	(0.022)
	[0.003]	[0.004]	[0.009]**	[0.018]**	[−0.010]*	[−0.011]*	[0.018]***	[0.007]**	[0.028]***
AGE	0.004	0.002	0.008	−0.003	0.007	0.015**	−0.004	0.019**	0.007
	(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)	(0.006)	(0.009)	(0.006)
	[0.001]	[0.001]	[0.002]	[−0.001]	[0.002]	[0.005]**	[−0.001]	[0.002]	[0.003]
GENDERD	0.237	−0.340	0.028	0.066	0.275	0.117	−0.075	0.070	0.391*
	(0.224)	(0.236)	(0.234)	(0.215)	(0.197)	(0.201)	(0.201)	(0.315)	(0.209)
	[0.063]	[−0.079]	[0.007]	[0.020]	[0.101]	[0.043]	[−0.028]	[0.008]	[0.134]*
EMP	−0.025	−0.238	−0.458*	0.117	0.018	−0.057	0.068	−0.236	−0.034
	(0.242)	(0.264)	(0.262)	(0.233)	(0.217)	(0.220)	(0.221)	(0.314)	(0.230)
	[−0.007]	[−0.054]	[−0.106]*	[0.036]	[0.006]	[−0.021]	[0.025]	[−0.027]	[−0.012]
NSTORES	0.036	0.052	−0.070	0.053	−0.065	−0.043	0.084	0.078	0.043
	(0.071)	(0.084)	(0.069)	(0.072)	(0.067)	(0.068)	(0.068)	(0.102)	(0.072)
	[0.010]	[0.012]	[−0.017]	[0.016]	[−0.024]	[−0.016]	[0.031]	[0.008]	[0.015]
ERATE	0.014	−0.018	0.048***	−0.009	0.000	−0.003	−0.001	−0.007	0.005
	(0.013)	(0.014)	(0.013)	(0.013)	(0.011)	(0.012)	(0.012)	(0.016)	(0.012)
	[0.004]	[−0.004]	[0.012]***	[−0.003]	[1.268E−04]	[−0.001]	[−0.001]	[−0.001]	[0.002]
Regression statistics									
Schwarz B.I.C.	105.768	97.8384	99.2181	113.556	134.987	132.533	131.979	62.552	122.325
LR (zero slopes)	8.749	6.029	30.187***	20.982***	10.368	17.641***	17.590***	11.208*	31.794***
Scaled R^2	0.046	0.032	0.1602	0.111	0.055	0.093	0.093	0.061	0.166
Correct predictions	80.85%	84.04%	79.26%	77.66%	64.36%	65.96%	72.34%	92.55%	70.21%
Number of positive observations	36	30	39	47	66	68	121	174	125

Note. Significant differences: ***, **, and * indicate significance at 1, 5, and 10% level, respectively. Values in parentheses are standard errors; values in square brackets are marginal effects.

Table 4. Working-Leser demand system estimates for opportunity cost specification.

Variables	Beef	Chicken	Pork	Processed meat and seafood	Caribou	Other country meat and fish	Fruits and vegetables	Grains	Dairy	Other foods
C	0.025	0.186***	−0.141***	0.013	0.235***	−0.034	−0.004	0.186***	0.028	0.505***
	[0.587]	[5.995]	[−3.356]	[0.399]	[4.475]	[−0.536]	[−0.074]	[3.422]	[0.998]	[4.625]
TOTAL	4.144E−04	−0.020**	0.007	0.021***	−0.030**	0.004	0.013	−0.004	0.001	0.009
	[0.038]	[−2.559]	[0.644]	[2.603]	[−2.263]	[0.255]	[0.880]	[−0.315]	[1.256]	[0.313]
AGE	2.900 E−04	−4.022 E−04	−3.531 E−05	9.853 E−05	1.103 E−04	0.004***	−4.774 E−05	−1.864 E−04	−2.620E−05	−0.004***
	[0.752]	[−1.442]	[−0.094]	[0.341]	[0.234]	[6.834]	[−0.094]	[−0.383]	[−0.091]	[−3.615]
GENDERD	0.005	−0.011	0.003	−0.002	0.004	−0.007	−0.016	0.007	0.008	0.010
	[0.352]	[−1.151]	[0.256]	[−0.238]	[0.236]	[−0.377]	[−0.958]	[0.442]	[0.781]	[0.324]
EMP	0.029**	−8.804E−05	−0.024*	0.009	0.012	−0.004	−0.013	−0.023	−0.006	0.020
	[2.027]	[−0.009]	[−1.744]	[0.823]	[0.716]	[−0.194]	[−0.683]	[−1.267]	[−0.601]	[0.533]
NSTORES	0.011***	0.001	−0.013***	0.002	0.003	−0.003	−0.011**	0.004	5.126E−05	0.006
	[2.662]	[0.261]	[−3.107]	[0.718]	[0.578]	[−0.552]	[−1.983]	[0.697]	[0.016]	[0.552]
ERATE	−0.001	−0.001***	0.004***	−0.001	−0.002*	−0.001	0.002**	−0.001	1.313E−04	−4.556E−04
	[−0.913]	[−2.691]	[5.777]	[−1.005]	[−1.959]	[−0.528]	[2.445]	[−1.303]	[0.235]	[−0.252]
IMR	0.150***	0.141***	0.139***	0.111***	0.158***	0.170***	0.101***	0.053***	−1.024***	−1.024
	[16.555]	[20.998]	[15.601]	[17.259]	[16.394]	[14.590]	[10.022]	[3.491]	[−28.461]	[−28.461]
Regression statistics										
Std. error	0.086	0.062	0.084	0.064	0.105	0.125	0.113	0.108	0.064	
R^2	0.590	0.703	0.597	0.609	0.595	0.588	0.343	0.100	0.015	
LM het. test	81.004 ***	52.956***	74.742***	24.222***	56.464***	45.383***	36.568***	2.745*	0.062	
D-W stat.	2.050	2.211	2.188	2.267	1.933	2.102	2.116	2.099	2.005	

Note. Significant differences: ***, **, and * indicate significance at 1, 5, and 10% level, respectively. Values in square brackets are *t*-statistics.

Table 5. Working–Leser demand systemestimates for out-of-pocket cost specification.

Variables	Beef	Chicken	Pork	Processed meat and seafood	Caribou	Other country meat and fish	Fruits and vegetables	Grains	Dairy	Other foods
C	−0.005	0.163***	−0.167***	−0.002	0.145***	0.041*	−0.024	0.202***	0.039	0.608***
	[−0.108]	[5.397]	[−4.187]	[−0.051]	[5.024]	[1.691	[−0.405]	[3.509]	[1.198]	[6.610]
TOTAL	0.013	−0.005	0.020**	0.032***	−0.041***	−0.024***	0.026*	−0.006***	0.001	−0.016
	[1.245]	[−0.698]	[2.066]	[3.831]	[−5.899]	[−4.156]	[1.816]	[−0.427]	[1.320]	[−0.713]
AGE	0.001	−2.479E−04	2.490E−04	3.816E−04	−3.008E−04	0.001***	4.940E−04	4.266E−04	1.913E−04	−0.003***
	[1.214]	[−0.863]	[0.657]	[1.158]	[−1.099]	[4.004]	[0.880]	[0.781]	[0.568]	[−2.885]
GENDERD	−0.003	−0.018*	−2.186E−04	−0.002	0.010	0.004	−0.017	0.004	0.008	0.014
	[−0.195]	[−1.884]	[−0.018]	[−0.170]	[1.079]	[0.484]	[−0.896]	[0.247]	[0.701]	[0.444]
EMP	0.024	−0.002	−0.024*	0.009	−3.002E−04	0.001	0.001	−0.025	−0.007	0.022
	[1.618]	[−0.177]	[−1.741]	[0.802]	[−0.031]	[0.078]	[0.037]	[−1.287]	[−0.542]	[0.644]
NSTORES	0.011**	0.001	−0.012***	0.003	−0.001	−5.581E−05	−0.011*	0.004	0.001	0.005
	[2.330]	[0.435]	[−2.915]	[0.857]	[−0.339]	[−0.022]	[−1.849]	[0.649]	[0.206]	[0.441]
ERATE	−0.001	−0.002***	0.004***	−0.001	−9.292E−05	−4.100E−05	0.002*	−0.002	−1.756E−04	−0.001
	[−0.788]	[−3.183]	[5.567]	[−1.366]	[−0.179]	[−0.093]	[1.872]	[−1.516]	[−0.273]	[−0.535]
IMR	0.155***	0.152***	0.150***	0.118***	0.071***	0.051***	0.114***	0.065	−0.876***	
	[15.960]	[22.275]	[17.114]	[16.120]	[12.729]	[10.576]	[10.240]	[3.869]	[−26.378]	
Regression statistics										
Std. error	0.092	0.063	0.082	0.072	0.060	0.051	0.122	0.119	0.073	
R^2	0.583	0.724	0.637	0.592	0.503	0.461	0.359	0.128	0.014	
LM het. test	78.015 ***	49.590 ***	71.256***	18.524***	47.629***	24.402***	36.809***	2.045	0.089	
D-W stat.	2.053	2.173	2.192	2.261	1.761	2.010	2.136	2.160	2.027	

Note. Significant differences: ***, **, and * indicate significance at 1, 5, and 10% level, respectively. Values in square brackets are *t*-statistics.

Table 6. LA/AIDS demand system estimates for opportunity cost specification.

Variables	Beef	Chicken	Pork	Processed meat and seafood	Caribou	Other country meat and fish	Fruits and vegetables	Grains	Dairy	Other foods
C	0.157**	0.235***	−0.186**	−0.066	−0.111	0.324*	−0.133	−0.131	−0.118**	1.029*
	[2.250]	[3.796]	[−2.014]	[−0.989]	[−0.687]	[1.856]	[−1.300]	[−0.292]	[−2.206	[1.869]
TOTAL	−0.035***	−0.015*	1.758E−04	0.015*	−0.007	−0.019	0.053***	0.054	0.028***	−0.074
	[−3.547]	[−1.711]	[0.015]	[1.717]	[−0.503]	[−1.102]	[3.706]	[0.820]	[3.671	[−0.997]
AGE	−2.053E−04	−2.574E−04	−9.922E−05	5.453E−05	3.649E−04	0.004***	6.131E−05	3.063E−04	1.485E−04	−0.004
	[−0.627]	[−0.898]	[−0.247]	[0.185]	[0.746]	[6.439]	[0.131]	[0.139]	[0.590	[−1.502]
GENDERD	0.018*	−0.014	0.004	−4.175E−04	−0.002	0.001	−0.035**	−0.010	0.001	0.035
	[1.660]	[−1.437]	[0.335]	[−0.042]	[−0.115]	[0.074]	[−2.184]	[−0.129]	[0.153	[0.485]
EMP	0.024**	−0.001	−0.019	0.015	0.003	0.010	−0.024	−0.013	−0.004	0.008
	[2.020]	[−0.055]	[−1.313]	[1.449]	[0.197]	[0.469]	[−1.381]	[−0.164]	[−0.416	[0.100]
IMR	0.146***	0.133***	0.121***	0.106***	0.136***	0.140***	0.080***	−0.895***	0.034***	
	[19.183]	[20.654]	[12.907]	[16.274]	[14.155]	[12.341]	[8.242]	[−38.669]	[7.229	
NSTORES	−0.017**	0.001	−0.003	0.009	−0.052***	0.040*	0.002	0.008	−0.002	0.013
	[−2.535]	[0.119]	[−0.258]	[1.055]	[−2.623]	[1.853]	[0.344]	[0.340]	[−0.410	[0.484]
ERATE	0.003***	−0.001*	0.003**	−0.001	−0.002	0.002	7.653E−05	−0.002	−8.309E−05	−2.575E−04
	[3.364]	[−1.815]	[2.359]	[−1.557]	[−1.071]	[0.913]	[0.077]	[−0.541]	[−0.150	[−0.057]
P_{BEEF}	0.120***									−0.003
	[7.890]									[−0.232]
$P_{CHICKEN}$	−0.039***	0.031]								−0.041***
	[−2.745]	[1.022]								[−3.186]
P_{PORK}	−0.056**	0.022	0.221**							−0.023
	[−2.348]	[0.615]	[2.140]							[−1.034]
$P_{PROCESSED}$	−0.048***	−0.003	−0.066	0.157***						−0.049**
	[−2.925]	[−0.115]	[−1.168]	[3.506]						[−2.226]
$P_{CARIBOU}$	0.024	0.034	−0.107	−0.013	−0.893**					−0.044
	[0.846]	[0.686]	[−0.875]	[−0.165]	[−2.119]					[−1.575]
$P_{OTHER\text{-}COUNTRY}$	0.037	−0.002	0.039	0.028	1.008**	−1.066***				−0.006
	[1.233]	[−0.043]	[0.318]	[0.369]	[2.453]	[−2.601]				[−0.178]
$P_{FRUIT\&VEG.}$	−0.011	−0.007	−0.021	−0.008	0.002	−0.043**	0.081***			0.019
	[−1.170]	[−0.731]	[−1.608]	[−0.846]	[0.130]	[−2.352]	[4.921]			[0.775]
P_{GRAINS}	−0.005	−0.001	−0.002	0.002	−0.021**	−0.007	−0.013	0.023		0.020
	[−0.699]	[−0.248]	[−0.253]	[0.262]	[−2.152]	[−0.622]	[−1.318]	[0.513]		[0.628]
P_{DAIRY}	−0.020***	0.006	−0.007	−1.878E−04	0.010	0.012	1.686E−04	0.005	0.004	−0.010]
	[−2.934]	[0.892]	[−0.705]	[−0.026]	[0.790]	[0.875]	[0.023]	[0.981]	0.621	[−0.943]
P_{OTHER}										0.134**
										[2.023]
Std. error	0.072	1.940	0.086	0.063	0.104	0.122	0.103	0.490	2.017	
R^2	0.721	0.713	0.584	0.624	0.609	0.618	0.459	0.059	0.264	
LM het. test	84.566***	46.938***	71.999***	29.761***	68.390***	27.808***	58.906***	186.452 **	23.150***	
D-W stat.	1.940	2.285	2.143	2.256	1.859	2.095	1.988	2.017	1.980	

Note. Significant differences: ***, **, and * indicate significance at 1, 5, and 10% level, respectively. Values in square brackets are *t*-statistics.

Table 7. LA/AIDS demand system estimates for out-of-pocket cost specification.

Variables	Beef	Chicken	Pork	Processed meat and seafood	Caribou	Other country meat and fish	Fruits and vegetables	Grains	Dairy	Other foods
C	0.131	0.228***	0.175	−0.013	−0.264	0.061	−0.298***	−0.243	−0.077	1.300***
	[1.638]	[2.735]	[0.566]	[−0.119]	[−0.760]	[0.506]	[−2.769]	[−0.614]	[−1.295]	[2.653]
TOTAL	−0.028	−0.008	0.009	0.020**	−0.017*	−0.015**	0.074***	0.071	0.029***	−0.134**
	[−2.635]	[−0.994]	[0.815]	[2.047]	[−1.961]	[−2.184]	[4.863]	[1.230]	[3.398]	[−2.013]
AGE	−9.414E−05	−1.357E−04	1.197E−04	1.707E−04	1.699E−05	0.001***	0.001	0.001	3.316E−04	−0.003
	[−0.259]	[−0.467]	[0.304]	[0.507]	[0.057]	[4.608]	[1.173]	[0.567]	[1.160]	[−1.370]
GENDERD	0.013	−0.019*	0.002	0.002	0.003	0.002	−0.037**	−0.019	0.001	0.051
	[1.043]	[−1.934]	[0.159]	[0.179]	[0.290]	[0.318]	[−2.145]	[−0.284]	[0.148]	[0.824]
EMP	0.023	−3.214E−04	−0.019	0.016	−0.001	0.005	−0.011	−0.014	−0.004	0.005
	[1.772]	[−0.031]	[−1.356]	[1.341]	[−0.132]	[0.631]	[−0.590]	[−0.199]	[−0.373]	[0.075]
IMR	0.149***	0.142***	0.131***	0.109***	0.065***	0.045***	0.086***	−0.768***	0.040***	
	[17.779]	[21.784]	[14.246]	[14.775]	[10.920]	[9.365]	[8.066]	[−37.471]	[7.179]	
NSTORES	−0.008	0.005	−0.024	0.005	0.007	0.007	−0.003	0.004	4.816E−04	0.008
	[−1.497]	[0.757]	[−1.542]	[0.484]	[0.464]	[0.686]	[−0.565]	[0.181]	[0.134]	[0.359]
ERATE	0.002***	−0.002***	0.005***	−0.001	−0.001	−4.088E−04	2.096E−05	−0.002	−0.001	0.001
	[2.629]	[−3.011]	[4.065]	[−1.319]	[−0.885]	[−0.493]	[0.020]	[−0.652]	[−0.973]	[0.130]
P_{BEEF}	0.113***									0.014
	[7.139]									[1.051]
$P_{CHICKEN}$	−0.034***	0.035								−0.029**
	[−2.595]	[1.195]								[−2.283]
P_{PORK}	−0.025	0.022	−0.095							−0.019
	[−1.147]	[0.611]	[−0.515]							[−0.954]
$P_{PROCESSED}$	−0.044**	−0.010	−0.088	0.155***						−0.052**
	[−2.534]	[−0.354]	[−1.536]	[2.990]						[−2.133]
$P_{CARIBOU}$	−0.002	0.015	0.275	0.005	−0.298					−0.043**
	[−0.087]	[0.456]	[1.483]	[0.091]	[−1.282]					[−2.462]
$P_{OTHER\text{-}COUNTRY}$	0.013	−0.002	−0.036	0.035	0.060	−0.054				−0.004
	[0.893]	[−0.092]	[−0.538]	[0.966]	[0.843]	[−1.030]				[−0.287]
$P_{FRUIT\&VEG.}$	−0.014	−0.006	−0.025*	[−0.008	−0.007	−0.013*	0.081***			0.004
	[−1.343]	[−0.630]	[−1.909]	−0.768]	[−0.668]	[−1.668]	[4.549]			[0.163]
P_{GRAINS}	−0.002	3.902E−04	−0.001	0.005	−0.014**	−0.005	−0.013	0.034		−0.007
	[−0.315]	[0.066]	[−0.119]	[0.790]	[−2.427]	[−1.096]	[−1.288]	[0.861]		[−0.252]
P_{DAIRY}	−0.020***	0.008	−0.007	0.001	0.009	0.008	0.002	0.003	0.005	−0.008
	[−2.755]	[1.202]	[−0.751]	[0.129]	[1.168]	[1.214]	[0.260]	[0.559]	[0.638]	[−0.726]
P_{OTHER}										0.158***
										[2.920]
Std. error	2.91973	1.92052	0.083599	0.072033	0.061863	0.050386	0.112531	0.437693	0.062455	
R^2	0.696054	0.733145	0.632796	0.592872	0.466445	0.470421	0.468206	0.054612	0.288124	
LM het. test	84.046***	47.426***	66.924***	22.462***	45.842***	25.728***	62.876***	185.603***	23.929***	
D-W stat.	1.92052	2.2492	2.13322	2.237	1.83763	2.17456	1.98791	2.03242	2.0394	

Note. Significant differences: ***, **, and * indicate significance at 1, 5, and 10% level, respectively. Values in square brackets are *t*-statistics.

estimating versions of the basic model with each explanatory variable restricted to be zero. The goodness of fit was compared between unrestricted and restricted models for both the W-L and LA/AIDS models. For each of the respective models, the null hypotheses that the explanatory variables each did not improve the fit of the model are rejected at the 10% level. All original variables should be retained in the estimations of each of the models. It was found that the inverse Mills ratios for all W-L and LA/AIDS models estimated were significant at the 10% level, suggesting that using the inverse Mills ratio as an instrumental variable helps account for censored latent variables in the second-stage estimation.

Price and Income Elasticities

Elasticities are measures of the responsiveness of quantity demanded of a good to a change in price of that good, another good, or total expenditure.[5] From expenditure elasticities for the W-L model[6] (Table 8), it was found that caribou is a normal good in the OC specification and grains are a normal good in both OC and OP specifications at the 10% significance level. With a 1% increase in total expenditure, the quantity demanded of these goods rises less than 1%. . Expenditure elasticities from the LA/AIDS[7] model estimations (Table 9 and Table 10) suggest that there is a one-to-one relationship between total food expenditure and expenditure on caribou—approximately a 1% increase in total food expenditure is associated with a 1% elevation in caribou consumption in both OC and OP models. Expenditure elasticities for country food other than caribou showed the same pattern. OC expenditure elasticities range from 0.461 to 7.638, and OP expenditure elasticities range from 0.069 to 6.902.

From the LA/AIDS estimation, the own-price elasticities of both caribou and other country foods from both opportunity and out-of-pocket cost estimations were significant at the 10% level and less than −1, indicating that with a 1% rise in price, quantity demanded decreases by more than 1%. Complementary relationships were found for caribou and other country foods, respectively, with some nonmeat food types. Cross-price elasticity estimates were significant at the 10% level and negative for caribou and grains (OC and OP estimates), other country foods and fruits and vegetables (OC and OP estimates), caribou and other foods (OP estimate), fruits and vegetables and other country foods (OC and OP estimates), and grains and caribou (OC and OP estimates). The elasticity estimates suggest that store-bought foods such as grains, fruits and vegetables, and other foods are complements with caribou and other country foods.

Opportunity cost model cross-price elasticities were significant at the 10% level and positive for the following pairs of goods: beef and caribou, beef and other country foods, caribou and other country foods, other country foods and beef, and other

Table 8. Expenditure elasticities for Working–Leser model.

	Opportunity cost expenditures		Out-of-pocket cost expenditures	
	Estimate	*t*-Statistic	Estimate	*t*-Statistic
Beef	1.008***	5.640	1.255***	7.265
Chicken	0.503	1.499	0.884***	3.963
Pork	1.133***	6.646	1.355***	8.862
Processed meat and seafood	1.468***	7.148	1.646***	8.105
Caribou	0.665***	4.289	0.017	0.076
Other country meat and fish	1.037***	6.452	0.274*	1.845
Fruits and vegetables	1.121***	8.176	1.217***	10.148
Grains	0.960***	7.919	0.955***	8.951
Dairy	1.018***	82.917	1.021***	74.332
Other	1.024***	13.117	0.963***	18.561

Note. Significant differences: ***, **, and * indicate significance at 1, 5, and 10% level, respectively.

[5]Marshallian price elasticities calculations are shown here. Calculations for elasticity of substitution, which is the ratio of percentage change in the relative demand for two goods to the percentage change in relative price and shows how substitutable goods are, are shown in Chiu (2013).

[6]Formula for own-price elasticity (Chern et al 2002):$e_{iy} = 1 + \frac{\beta_i}{w_i}$.

7ormulas for own-price, cross-price, and expenditure elasticities (Green and Alston, 1990): $e_{ij} = \frac{\gamma_{ij} - \beta_j w_j}{w_i}$;$e_{ii} = \frac{\gamma_{ii}}{w_i} - \beta_i - 1$; $e_{iy} = 1 + \frac{\beta_i}{w_i}$.

Table 9. Own- and cross-price and expenditure LA/AIDS elasticities for opportunity cost specification.

	Beef	Chicken	Pork	Processed meat and seafood	Caribou	Other country meat and fish	Fruits and vegetables	Grains	Dairy	Other foods	Expenditure elasticity
Beef	1.491*** [2.950]	−0.763*** [−3.208]	−1.102** [−2.240]	−0.950*** [−3.277]	0.561* [1.741]	0.833** [2.165]	−0.153 [−0.843]	−0.018 [−0.145]	−0.368** [−2.135]	0.187 [0.628]	0.707*** [9.273]
Chicken	−0.932*** [−3.199]	−0.230 [−0.178]	0.562 [0.907]	−0.054 [−0.091]	0.857 [0.985]	−0.013 [−0.013]	−0.124 [−0.668]	0.003 [0.021]	0.165 [1.328]	−0.879** [−2.514]	0.529 [0.463]
Pork	−1.075** [−2.315]	0.429 [0.876]	3.266* [1.654]	−1.273 [−1.063]	−2.071 [−1.352]	0.756 [0.438]	−0.411* [−1.679]	−0.040 [−0.318]	−0.135 [−1.048]	−0.449 [−0.979]	1.001*** [21.721]
Processed meat and seafood	−1.069*** [−3.434]	−0.076 [−0.145]	−1.460 [−1.077]	2.414* [1.813]	−0.305 [−0.313]	0.582 [0.483]	−0.215 [−1.244]	−0.002 [−0.015]	−0.019 [−0.123]	−1.180** [−2.375]	1.097*** [22.366]
Caribou	0.273 [1.554]	0.376 [0.963]	−1.183 [−1.342]	−0.136 [−0.275]	−10.863** [−2.107]	11.156** [2.130]	0.032 [0.205]	−0.226** [−2.025]	0.111 [0.925]	−0.459 [−1.472]	1.008*** [59.305]
Other country meat and fish	0.341** [1.974]	−0.012 [−0.034]	0.362 [0.449]	0.263 [0.527]	9.102** [2.130]	−10.593** [−2.432]	−0.371** [−2.456]	−0.046 [−0.395]	0.115 [1.234]	0.008 [0.024]	1.018*** [49.751]
Fruits and vegetables	−0.131 [−1.522]	−0.083 [−1.106]	−0.228* [−1.946]	−0.101 [−1.349]	−0.025 [−0.186]	−0.465*** [−2.904]	−0.281 [−1.322]	−0.173** [−2.031]	−0.021 [−0.313]	0.006 [0.024]	1.652*** [6.583]
Grains	−0.068 [−0.971]	−0.034 [−0.616]	−0.045 [−0.649]	−0.008 [−0.147]	−0.241** [−2.061]	−0.121 [−0.880]	−0.168 [−1.548]	−0.843*** [−2.816]	0.024 [0.408]	0.007 [0.018]	3.354 [0.671]
Dairy	−0.462** [−2.437]	0.109 [1.004]	−0.185 [−1.274]	−0.032 [−0.207]	0.158 [0.663]	0.194 [0.850]	−0.061 [−0.376]	0.045 [0.376]	−0.935*** [−7.115]	−0.444* [−1.722]	7.638 [0.813]
Other foods	0.001 [0.030]	−0.108*** [−2.951]	−0.055 [−0.863]	−0.128** [−2.071]	−0.106 [−1.336]	0.007 [0.076]	0.077 [1.089]	0.079 [0.886]	−0.020 [−0.636]	−0.535*** [−2.680]	0.461 [0.756]

Note. Significant differences: ***, **, and * indicate significance at 1, 5, and 10% level, respectively. Values in square brackets are *t*-statistics.

Table 10. Own- and cross-price and expenditure LA/AIDS elasticities for out-of-pocket cost specification.

	Beef	Chicken	Pork	Processed meat and seafood	Caribou	Other country meat and fish	Fruits and vegetables	Grains	Dairy	Other foods	Expenditure elasticity
Beef	1.216** [2.556]	−0.629*** [−3.323]	−0.445 [−1.176]	−0.817*** [−3.239]	−0.008 [−0.039]	0.266 [1.552]	−0.205 [−1.096]	0.025 [0.198]	−0.363** [−2.061]	0.503* [1.831]	0.752*** [10.133]
Chicken	−0.768*** [−3.376]	−0.187 [−0.157]	0.519 [0.902]	−0.211 [−0.379]	0.350 [0.659]	−0.045 [−0.080]	−0.109 [−0.613]	0.034 [0.233]	0.200* [1.720]	−0.594* [−1.681]	0.763 [1.192]
Pork	−0.452 [−1.273]	0.391 [0.871]	−2.722 [−0.999]	−1.593 [−1.504]	4.940* [1.816]	−0.662 [−0.653]	−0.469** [−2.072]	−0.039 [−0.336]	−0.142 [−1.164]	−0.419 [−1.067]	0.903*** [4.932]
Processed meat and seafood	−0.909*** [−3.401]	−0.212 [−0.435]	−1.809 [−1.517]	2.129 [1.467]	0.081 [0.097]	0.697 [1.257]	−0.220 [−1.227]	0.056 [0.460]	6.929E−05 [4.618E−04]	−1.219** [−2.393]	1.129*** [16.910]
Caribou	−0.017 [−0.065]	0.378 [0.680]	6.661* [1.824]	0.137 [0.138]	−8.183* [−1.805]	1.457 [1.121]	−0.112 [−0.572]	−0.292** [−1.977]	0.236 [1.327]	−0.859** [−2.143]	1.056*** [21.872]
Other country meat and fish	0.404 [1.523]	−0.047 [−0.065]	−1.058 [−0.632]	1.063 [1.308]	1.794 [1.121]	−2.590* [−1.859]	−0.347* [−1.786]	−0.097 [−0.574]	0.248** [2.047]	0.077 [0.183]	1.279*** [5.231]
Fruits and vegetables	−0.150* [−1.781]	−0.075 [−1.110]	−0.244** [−2.388]	−0.102 [−1.356]	−0.081 [−1.162]	−0.134** [−2.404]	−0.397** [−2.056]	−0.193** [−2.297]	−0.016 [−0.253]	−0.229 [−1.103]	1.915*** [6.223]
Grains	−0.046 [−0.787]	−0.021 [−0.463]	−0.037 [−0.691]	0.014 [0.283]	−0.132** [−2.508]	−0.058 [−1.293]	−0.166* [−1.770]	−0.808*** [−3.446]	−0.004 [−0.080]	−0.284 [−0.958]	3.065 [1.069]
Dairy	−0.407** [−2.352]	0.131 [1.441]	−0.167 [−1.331]	−0.006 [−0.045]	0.144 [1.046]	0.122 [1.589]	−0.025 [−0.174]	−0.009 [−0.083]	−0.938*** [−7.767]	−0.377 [−1.660]	6.902 [0.880]
Other foods	0.050 [1.565]	−0.056* [−1.829]	−0.028 [−0.587]	−0.107* [−1.860]	−0.088** [−2.142]	0.002 [0.057]	0.047 [0.830]	0.024 [0.360]	−0.002 [−0.091]	−0.524*** [−3.747]	0.069 [0.115]

Note. Significant differences: ***, **, and * indicate significance at 1, 5, and 10% level, respectively. Values in square brackets are *t*-statistics.

country foods and caribou. Out-of-pocket model cross-price elasticities were significant at the 10% level and positive for the following pairs of goods: pork and caribou, caribou and pork, and other country foods and dairy. Hence, caribou and other country foods, respectively, were found to be gross substitutes for beef, and caribou was reported to be a gross substitute for pork. Other country foods and pork were noted to be gross substitutes for caribou, and beef, caribou, and dairy were found to be gross substitutes for other country foods.

Calorie Intake and Dietary Diversity Analysis

As shown in Figure 8, about half of the individuals (46%) in the sample reported consuming all four food groups defined as groups for calculating the dietary diversity score adopted for this study. All individuals in the sample reported positive consumption for at least one food group. Meat and alternatives and grains were the most commonly consumed food groups in terms of proportion of respondents consuming. From a 2004 survey of Nunavik Inuit, it was demonstrated that most participants met the recommended serving levels for meat and alternatives consumed, but fell below recommended levels for other food groups (Blanchet and Rochette, 2008).

Guidelines for recommended energy intake requirements are defined by Health Canada (2011). It was found that about half of individuals (54%) did not meet estimated energy requirements for their age and gender category at the sedentary activity level (Table 11). It was noted that males consumed more calories than females on average, and had a higher food group score. In terms of energy requirements, more males than females reached the recommended energy intake levels for sedentary activity. Employed individuals consumed more calories than nonemployed ones and displayed higher scores of diversity. A lower proportion of nonemployed than employed individuals were found to meet the recommended daily intake of energy (calories). The calorie calculations were compared to those reported in other studies: Calculated mean calories for males and females from the present sample fall into the range calculated from the 2004 Canadian Community Health Survey 2.2 (Garriguet, 2004).

Caloric intake and dietary diversity scores showed positive correlations (0.12 and 0.08, respectively) with the amount (in grams) of caribou consumed, although the correlations are not statistically significant. Dietary diversity demonstrated a positive correlation with caribou consumption, while number of calories consumed showed a negative correlation (−0.017) with caribou consumption. However, these

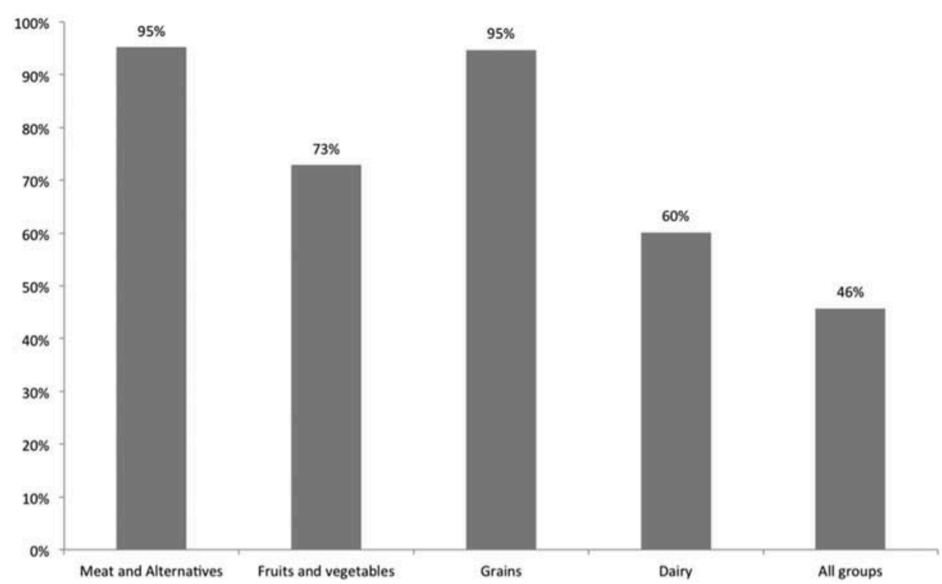

Figure 8. Percentage of respondents (%) consuming different food groups: meat and alternatives, fruits and vegetables, grains, dairy, and all groups—any of the four food groups (n = 188).

Table 11. Summary statistics: Calories and diversity by gender and employment status.

	Calories[a]		Proportion meeting estimated energy requirement			Food group score (diversity)	
	Mean	SD	Sedentary	Low active	Active	Mean	SD
By gender							
Male	2394.63	1338.95	49%	36%	27%	3.28	0.90
Female	1691.09	825.02	42%	30%	21%	3.15	0.83
By employment status							
Employed	2213.61	1183.32	52%	34%	29%	3.32	0.96
Not employed	1924.06	1126.38	33%	21%	21%	3.08	0.93
Total sample							
Total	2024.15	1151.52	46%	33%	24%	3.23	0.83

[a]Sharma et al. (2009, 2010) also analyzed calories for the same 24-h recall data used in this study, and reported median levels as calculated for each of the two regions.

correlations are not significant at the 10% level. The relationships between caribou consumption and, respectively, calorie intake and dietary diversity are examined in the econometric models.

From the ordinary least squares (OLS) model estimates for calorie demand (Table 12), it was found that increased age exerted a negative effect, and being male has a positive effect, on calories consumed in both OC and OP equations at the 10% significance level. Employment status was not found to produce an effect on calories consumed. An elevated number of stores in the community and increased total expenditure were both found to exert positive effects on calorie intake in both specifications at the 10% significance level. The binary variable for caribou intake was not significant in the OC model, but was significant in the OP model.

From the goodness-of-fit results for OLS model estimates, the *R*-squared value indicates that 58% of variation in calorie intake may be attributed to the explanatory variables for the OC expenditure estimates, while 55% of the variation in calorie intake may be due to explanatory variables for the OP expenditure estimates. The Lagrange multiplier test statistic was significant in both equations, indicating the presence of heteroskedasticity. Models were reestimated with heteroskedastic-consistent robust standard errors, and increased age was shown to exert a negative effect, male gender a positive effect, and total expenditure a positive influence on calories consumed, as in the previous estimation. Number of stores did not significantly affect calorie consumption in both specifications, and consuming caribou did not exert a marked effect in the OP model. Although the results are sensitive in terms of the types of standard errors employed, the original version of the estimation is shown.

From the ordered probit regression for dietary diversity (Table 13), it was found that an increased total expenditure level exerted positive effects on dietary diversity in the OC model at the 10% significance level. From the marginal effects (Table 14), data showed that total expenditure produced a reduced influence on likelihood of having a food group score of 1, 2, or 3, but a positive effect on having a food group score of 4. In the OP model, caribou consumption and total expenditure were noted to produce positive effects on diversity at the 10% significance level. From the marginal effects computations, it was found that caribou consumption and increased total expenditure each exerted negative effects on the likelihood of having a food group score of 1, 2, or 3, but a positive influence on having a food group score of 4. Based on the Wald test, data demonstrated that both dietary diversity demand equations display overall significance—the variables are jointly significant. The coefficients for the opportunity cost total expenditure and out-of-pocket cost total expenditure in the variance function were found to be significant in the respective equations and were retained in the heteroskedastic model estimates.

Discussion

Econometric analyses showed that demographic and socioeconomic factors influence intake of individual food types and diet quality indicators. Increased age was found to exert positive effects on incidence of a household reporting caribou consumption in the out-of-pocket (OP) cost

Table 12. Calorie intake model OLS regression estimates for opportunity cost and out-of-pocket specifications.

	Opportunity cost total expenditure				Out-of-pocket cost total expenditure			
Variable	Estimated coefficient	Standard error	*t*-Statistic	*p* Value	Estimated coefficient	Standard error	*t*-Statistic	*p* Value
CONSTANT	1115.290***	337.461	3.305	.001	1000.690***	352.535	2.839	.005
AGE	−13.075***	3.446	−3.794	.000	−10.722***	3.637	−2.948	.004
GENDERD	426.633***	115.567	3.692	.000	440.817***	119.974	3.674	.000
EMP	−191.601	125.184	−1.531	.128	−171.281	129.830	−1.319	.189
NSTORES	73.505*	38.449	1.912	.057	71.146*	39.909	1.783	.076
ERATE	0.592	6.656	0.089	.929	1.295	6.910	0.187	.851
CARIBOUD	19.060	118.576	0.161	.872	231.128*	123.995	1.864	.064
TOTAL	94.587***	7.945	11.906	.000	99.185***	9.102	10.897	.000
R-squared = 0.580194					*R*-squared = 0.547873			
LM het. test = 10.9927 [0.001]					LM het. Test = 19.7178 [.000]			
Durbin–Watson = 1.98295 [<.687]					Durbin–Watson = 1.92718 [<.542]			
n = 188								

Note. Significant differences: ***, **, and * indicate significance at 1, 5, and 10% level, respectively.

Table 13. Dietary diversity heteroskedastic ordered probit coefficient estimates for opportunity cost and out-of-pocket specifications.

	Opportunity cost total expenditure				Out-of-pocket cost total expenditure			
Variable	Estimated coefficient	Standard error	*z*-Statistic	*p* Value	Estimate	Standard error	*z*-Statistic	*p* Value
CONSTANT	0.882	0.786	1.122	.262	0.686	0.826	0.831	.406
AGE	0.006	0.008	0.750	.454	0.012	0.008	1.487	.137
GENDERD	-0.098	0.264	−0.369	.712	−0.092	0.266	−0.346	.729
EMP	0.102	0.282	0.361	.718	0.213	0.292	0.728	.467
NSTORE	0.148	0.102	1.456	.145	0.156	0.102	1.538	.124
ERATE	-0.012	0.016	−0.735	.463	-0.016	0.017	-0.956	.339
CARIBOUD	0.364	0.308	1.183	.237	0.588*	0.295	1.992	.046
TOTAL	0.202***	0.062	3.256	.001	0.252***	0.066	3.827	.000
Variance function								
TOTAL	0.040**	0.019	2.146	.032	0.048***	0.017	2.844	.005
Wald chi-squared (df = 8) = 42.293					Wald chi-squared (df = 8) = 54.700			
Prob > chi^2 = 0.119E-05					Prob > chi^2 = 0.000			
McFadden pseudo *R*-squared = 0.010					McFadden pseudo *R*-squared = 0.129			
Log pseudo-likelihood = −190.630					Log pseudo-likelihood = −184.426			
n = 188								

Note. Significant differences: ***, **, and * indicate significance at 1, 5, and 10% level, respectively.

Table 14. Dietary diversity heteroskedastic ordered probit marginal effects estimates for opportunity cost and out-of-pocket specifications.

	Opportunity cost total expenditure				Out-of-pocket cost total expenditure			
	Marginal effects							
Parameter	y = 0 (score = 1)	y = 1 (score = 2)	y = 2 (score = 3)	y = 3 (score = 4)	y = 0 (score = 1)	y = 1 (score = 2)	y = 2 (score = 3)	y = 3 (score = 4)
CONSTANT	−0.021	−0.100	−0.098	0.218	−0.014	−0.073	−0.079	0.166
AGE	−0.001E−01	−0.001	−0.001	0.001	−0.003E−01	−0.013E−01	−0.014E−01	0.003
GENDERD	0.002	0.011	0.011	−0.024	0.002	0.010	0.011	−0.022
EMP	−0.002	−0.012	−0.011	0.025	−0.004	−0.023	−0.025	0.051
ERATE	−0.004	−0.017	−0.016	0.037	−0.003	−0.017	−0.018	0.038
NSTORES	0.003E−01	0.001	0.001	−0.003	0.0003	0.002	0.002	−0.004
CARIBOUD	−0.009	−0.041	−0.040	0.090	−0.012	−0.062	−0.068	0.142
TOTAL	−0.005	−0.023	−0.022	0.050	−0.005	−0.027	−0.029	0.061

specification and on incidence and expenditure share of consumption of other country meat and fish. Previous studies also demonstrated that higher age produced a positive influence on country food consumption in terms of quantity or frequency consumed (Hopping et al., 2010b; Kuhnlein et al., 2004; Receveur et al., 1997). Among community characteristics modeled, an increased community employment rate and elevated number of stores available in the community led to a decreased expenditure share for caribou. The negative impact of employment on caribou consumption level corroborates previous findings where it was suggested that increased time spent in employment leads to decreased time spent in harvesting (Smith and Wright, 1989; Todd, 2010). A higher community employment rate may restrict the supply of caribou meat available to a given household in the community (who might have no ability to hunt due to age or other characteristics), since only nonemployed individuals may harvest meat to be shared with community members. Participation in full-time employment was reported to lead to lowered willingness to share harvesting equipment with nonemployed persons (Wenzel, 1995).

Increased food expenditure was found to be associated with a lower caribou expenditure share. However, it was shown from expenditure elasticity estimates that higher total food expenditure, which is a proxy for total income, leads to a proportionate increase in the quantity of caribou consumed. Several investigators reported that higher incomes have positive effects on harvesting activity or the consumption of country food (Berman, 1998; Condon et al., 1995; Erber et al., 2010a; Hopping et al., 2010b). The results suggest that while increased access to overall income at the individual level may lead to a higher consumption level of caribou, decreased harvesting time across the community, as indicated by the employment rate variable, may have a negative effect on access to caribou meat for some households.

In communities with access to employment, employers need to examine the possibility of flexible schedules or permitted leaves for harvesting to increase the access to caribou meat for households unable to hunt. While the Nunavut hunter support program was suspended in 2014 for review, both increased funding and also better targeted funding may facilitate higher levels of harvest participation (Action Canada, 2014; Chan et al., 2006; Nunavut Tunngavik, Incorporated, 2014). On-the-land programs need to continue to be implemented to promote participation in harvesting, especially among youth who might have limited training in dealing with extreme weather conditions. Action Canada (2014) suggested that these programs may be offered through Arctic colleges or Inuit organizations.

From the own-price elasticity demand estimates for caribou, individuals were found to respond negatively (decrease consumption) in the face of increasing overall monetary costs of harvesting (hunting). There is also evidence that individuals may substitute other protein sources other protein sources including other country foods and store foods such as pork for caribou .Other studies have provided some evidence of substitution among country foods as circumstances change. For example, Ford et al. (2006) noted that individuals were found to switch locations and species harvested, given reduced accessibility to hunting areas due to climate change. There has been a rise in the incidence of abnormalities found among marine and terrestrial species, and changes in weather patterns and permafrost conditions led to alterations in migration and distribution patterns of different species (Berkes and Jolly, 2001; Nickels et al., 2005). The economic costs of harvesting other country food species may also rise significantly if it becomes more difficult to obtain country food. In the Inuvialuit Settlement Region warmer temperatures have led to fish rotting more quickly and the necessity for more frequent fish harvests, while in ISR and Nunavut communities, seals have decreased fat as a result of lowered amounts of sea ice and shorter nursing periods, producing for harvesters a need to travel more quickly to reach them before they sink (Nickels et al., 2005).

In the case of reduced access to caribou, if consumption is shifted from caribou to a store-bought food such as pork, a potential substitute as predicted by model estimates, individual food expenditure level would need to increase significantly given the higher average prices of store meat types. Given that the median census family income was $49,270 in Nunavut and $86,132 in

Northwest Territories (NWT) in 2006, it was calculated from the present empirical analysis that the increase in food expenditure may potentially be equal to 2 to 4% of annual family income in Nunavut, and between 1 and 2% of annual family income in Northwest Territories (Chiu, 2013; Statistics Canada 2007a, 2007b). From the published data for the three territorial capitals in the Canadian Food Expenditure Survey, it was found that food expenditures in Nunavut were, on average, significantly higher than in the rest of Canada and in the other territories (NWT and Yukon) (Chiu, 2013). The proportion of total expenditures on food items (out of total household expenditure) in the territories was greater than the national average, with Nunavut residents exhibiting the highest proportion of food expenditure, between 15 and 28% of total household expenditures. More recent findings from the Inuit Health Survey showed that the Inuit household of 4 individuals spends the equivalent of $19,760 CAD on groceries per year, while about half of adults earned less than $20,000 CAD in the same period, and approximately 40% of households reported receiving income support (Rosol et al., 2011). Thus, income supplementation programs for employed individuals or income replacement programs such as employment insurance or social assistance need to be bolstered to ensure food security (Battle and Torjman, 2013). Diminished access to caribou meat as a food source could even increase the food costs of many households in the North.

Increased age and male gender were found to be associated with higher calorie intake in other studies (Garriguet, 2004; Wright and Wang, 2010). Elevated total expenditures were shown to exert positive impacts on calorie intake and dietary diversity indicators, in agreement with theoretical predictions. Lawn and Harvey (2001) found that improved socioeconomic status produced a positive influence on calorie intake in one northern community, while Huet et al (2012) noted that lower HEI scores in Arctic communities were associated with food insecurity, which was subsequently found to be associated with socioeconomic disadvantages such as being on income support or living in public housing. While controlling for food expenditure levels, there is some evidence from the present empirical analysis that consuming caribou leads to improved dietary quality as measured by two indicators: energy intake and dietary diversity. Therefore, with increased costs for harvesting and lowered consumption of caribou, substitution with other foods may result in an overall decline in dietary quality. The demand elasticity calculations show that individuals are sensitive to changes in prices of caribou and other country foods, as well as prices for store foods such as fruits and vegetables, grains, dairy, and other products. Initiatives to promote knowledge regarding preparation of nutritious and culturally appropriate foods at the same time involving local store managers in product selection, such as the Healthy Foods North program, needs to be implemented alongside price controls (Gittelsohn et al., 2010). When consuming store meat, individuals may not be familiar with the fact that muscle meat is the primary type of meat available in stores (Government of Nunavut, 2014).

Conclusions

Although CWD is not a current risk factor for consumption of northern caribou, its potentially enormous impacts on the livelihoods of northern peoples—both economically and culturally—merit the development of a risk-management strategy. Caribou health and populations need to be continually monitored for changing body condition, susceptibility to contaminants, and climate change risks to habitat and food sources. The mechanism of disease spread in other cervid populations also need to be monitored in order for local governments and wildlife agencies to be able to manage any potential risks. There are strong preferences for caribou—it is used by more households than any type of store-bought meat or other country land mammals, country fish and sea mammals, and birds. More caribou meal items are consumed than any other type of country meat and fish meal item. Unlike previous studies where only aggregate costs of harvest equipment or opportunity costs of days spent on the land are accounted for, this study involved using two theoretical frameworks to compute costs of individual species of country food by edible weight. Calculated opportunity cost and out-of-pocket costs for caribou were lower than respective prices of any type of store meat. While the opportunity cost price of caribou was higher than respective prices of other store food types including fruits and vegetables, grains, and dairy, the out-of-pocket price of caribou was lower. In the event of shortage of caribou meat, which may result in higher caribou "prices," there is evidence that individuals may substitute other country meat and fish and pork for caribou.

Community-level characteristics, in general, appear to play a more prominent role on the level of caribou consumption than do the few individual level demographic characteristics available in this study (further study is warranted). In the face of risks to caribou health, this study suggests that communities with older populations, lower employment rates, and fewer stores may be the most adversely affected through reduced access to country foods and caribou in particular. These communities need to be the first targets in a CWD risk communication and risk management strategy should the disease spread to caribou.

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