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Development and use of FFQ among adults in diverse settings across the globe

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In nutritional epidemiology, development of valid dietary assessment instruments specific to populations in diverse settings is of paramount importance. Such instruments are essential when trying to characterise dietary patterns and intake, investigate diet–disease associations, inform and evaluate nutrition interventions, assess nutrient–gene interactions, conduct cross-country comparison studies and monitor nutrition transitions. The FFQ is a relatively inexpensive tool for measuring long-term dietary intake for large populations and for allowing researchers to track dietary changes over time. However, FFQ must be population specific to capture the local diet and available foods. Collecting 24-h dietary recalls and utilising community feedback to build the FFQ ensures that a culturally appropriate instrument is developed. This article presents several examples describing FFQ development and utilisation in different settings globally. In the Canadian Arctic, FFQ were developed and utilised to inform and evaluate a community-based intervention programme, characterise the diet and track dietary changes occurring among Inuit and Inuvialuit, populations experiencing rising rates of chronic disease and likely to be extremely vulnerable to the potential effects of climate change. Another example is an FFQ developed to assess sodium intake and evaluate a sodium reduction trial in a high-risk population in Barbados. An example is provided from Brazil, where an FFQ was developed to assess associations between diet, heterocyclic aromatic amines and colorectal adenoma among Japanese Brazilians and to conduct cross-country comparisons. These and other case studies highlight the diversity in dietary intake between populations and the need for FFQ to be developed to capture this diversity.

FFQ: Nutritional epidemiology: Interventions: Multi-ethnic populations

Dietary assessment methodologies

In nutritional epidemiology, a variety of different approaches can be used to measure food and nutrient intakes in individuals and populations. These range from relatively simple techniques such as 24-h dietary recalls, estimated or weighed food records, narrative diet histories and FFQ, to the more complex biochemical approach of measuring static or functional markers of nutrient intake in blood, urine or other biological samples. The selection of a dietary assessment methodology depends on the population under investigation and typically involves a compromise between the desired level of accuracy and organisational or financial constraints[1]. Biochemical markers of nutrient intake, while arguably more objective than other methods, are used infrequently outside of small validation or pilot studies due to their high cost and logistical requirements[2]. Food records and 24-h dietary recalls are expensive and

Abbreviations: BNCS, Barbados National Cancer Study; CRC, colorectal cancer; HAA, heterocyclic aromatic amine; NWT, Northwest Territories; QFFQ, quantitative FFQ; USDA, United States Department of Agriculture.

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tend to underestimate actual intake due to participants' incomplete record keeping and fallible memories[3]. Although the accuracy of food records can be improved by using weighed-food records, this requires the participants to be literate and to have numerical skills. Moreover, it is time consuming and burdensome for participants. These negative characteristics may lead to modification of usual dietary habits[1]. Interviewer-administered 24-h dietary recalls require much less time from participants, and, as a retrospective measure, cannot inadvertently influence participants to alter their food intake[1]. However, dietary recalls cannot be used to rank participants' intakes reliably; single 24-h dietary recalls cannot measure the day-to-day variation of dietary intake, while multiple recalls are expensive[4]. Narrative diet history, another dietary assessment tool that lends itself well to the clinical setting[5], is particularly useful with populations that respond poorly to highly structured techniques and may be better able than other methods to capture infrequently consumed items. However, this approach tends to introduce greater heterogeneity in the results and has the same weaknesses of interview bias and imperfect memories[6,7], which may limit their usability outside of clinical settings.

The drawbacks of these dietary assessment methodologies have spurred the development of new techniques intended to both increase objectivity and decrease participant burden. Much of the effort has focused on portable electronic systems for recording food intake, including mobile phones[8,9], personal digital assistants[10], and purpose-built devices[11]. These technologies have the potential to significantly alter the way dietary assessments are performed; nevertheless, they are only in the initial stages of development and are yet to be validated against more traditional methodologies[12].

FFQ

Compared with other dietary assessment methodologies, FFQ are the most feasible and cost-effective means of assessing diet in large-scale nutritional epidemiology studies. In contrast to other methods, FFQ assess long-term usual dietary intake[1]. Their low cost and ease of administration also make them viable for the repeated assessment of a population's diet over time to establish trends. Moreover, FFQ are one of the least invasive methods and incur low participant burden[13]. Although unable to assess absolute dietary intakes, FFQ are mainly used to categorise and rank individuals either by their usual frequency of consumption or nutrient intake, and, as a standardised dietary assessment methodology, allow for comparison of food and nutrient intake across cultures, populations and countries[13–17]. FFQ can be self- or interviewer administered, though interviewer administered is preferred to ensure adequate completion, and may take place over the telephone, via mail, on computers and through personal interviews, depending on the needs and funding of the study[1,18]. However, FFQ are subject to recall bias, and because of the large variety of foods often available, they are limited in their ability to capture the total diet for most populations. FFQ, like many other assessments, are limited by self-reported information. Other challenges include the need for validation and the possibility of participants over- or under-reporting consumption[7]. Because of time and funding constraints, researchers often use or adapt previously developed FFQ, such as the Harvard and National Cancer Institute questionnaires, for their study population[18–20]. However, due to the fact that food availability, accessibility and preferences can vary greatly between settings, research with ethnic/racial minority, multi-ethnic or culturally distinct populations and countries requires that questionnaires be developed specifically for that population in order to produce valid and reliable data[21,22].

The objective of this article is to provide a guide to the development of population-specific, culturally appropriate FFQ for adults and to exemplify several uses for them once developed. To illustrate the process, examples will be taken from several research projects the author has carried out with multi-ethnic populations in a variety of developing or low-income settings in different parts of the world. These include the Apache and Navajo American Indian populations in the US[23–25], low-income African-American adults in an inner city in the US[26], African-Barbadians in Barbados[27–29], African-origin Caribbean migrants to the UK[17,30–33], urban and rural Cameroonians[17,34], African-origin Jamaicans[17], First Nations Aboriginal populations in northwest Ontario, Canada[35], Inuit and Inuvialuit aboriginal populations in the Canadian Arctic[36,37], and Japanese Brazilians in São Paulo, Brazil[16,38] (Table 1).

A comparison of the FFQ developed for each population illustrates diet diversity (Table 2). For example, the Cameroonian study population consumed snail soup and foo foo (cassava), compared with the consumption of polar bear and caribou by Inuit and Inuvialuit in Arctic Canada, coxinha and nishime by Japanese Brazilians, and tamales and menudo stew by Apache and Navajo in southwestern US. Dramatic differences between populations clearly demonstrate the necessity for researchers to develop their own population-specific FFQ.

To develop a culturally relevant, locally appropriate and population-specific FFQ, four main steps are required if there are little or no data available on total food consumption: compilation of a complete and accurate food list, determination of culturally appropriate portion sizes, categorisation of frequencies of consumption and development of a food composition table[1,18] (Fig. 1). The food list is the most critical part of the development process because the omission of important items may lead to underestimation of nutrient intake, while the inclusion of irrelevant items unduly increases participant burden. For completeness, the food list must contain items that are consumed by a substantial proportion of the population, are frequently consumed, include a variety of foods consumed within the population, contain significant amounts of the nutrients or food constituents of interest and cumulatively provide at least 85% of the dietary intake[1,18,19]. If the FFQ is developed for an intervention evaluation study, the foods promoted and de-promoted by the intervention should be added (even if not frequently consumed initially). Effective methods used to compile the food list

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Table 1. Development of culturally competent, population-specific quantitative FFQ (QFFQ) through 24-h dietary recalls, food records and national databases by study

Project (year)	Study population	*n*	Purpose of the QFFQ
Barbados National Cancer Study (2004)[28]	African-origin Barbadian adults in Barbados, West Indies	1600 from national survey conducted in the year 2000. Fifty (twenty-two men, twenty-eight women)	(i) Assess usual food, nutrient, and food group intake (ii) Examine associations of diet with breast and prostate cancer, as well as to test emerging hypotheses on nutrient–gene interactions
Case-control study of adenoma in São Paulo Japanese (2005)[16]	Japanese Brazilian adults in São Paulo, Brazil	Sixty (twenty-nine men, thirty-one women)	(i) Assess food, nutrient, food group and heterocyclic aromatic amine intake (ii) Compare results with those of parallel case–control studies of colorectal adenoma being conducted among Japanese in Hawaii and Tokyo
Sustaining and scaling up a successful food-store-based programme to improve diet and reduce risk for obesity and other chronic disease in American Indians (2006–2007)[25]	Navajo adults on Navajo Nation in south-western US	Seventy-eight (forty men, thirty-eight women)	(i) Characterise the dietary intake of Navajo adults (ii) Highlight specific foods to target in the nutrition intervention programme (iii) Evaluate the effectiveness of the programme
An integrated community-based programme to modify diabetes risk factors in First Nations reserves (2003–2004)[35]	First Nations (Oji-Cree and Ojibway) adults in north-western Ontario	122 (forty-seven men, seventy-five women)	(i) Highlight foods for a nutrition intervention (ii) Evaluate the intervention (iii) Assess food, nutrient and food group intake
Food store-based programme to reduce risk of chronic disease in the White Mountain and San Carlos Apache reservations (2002)[23]	Apache adults on San Carlos and White Mountain reservations in south-western US	Fifty-three (nineteen men, thirty-four women)	(i) Describe the food intake (ii) Provide data to guide nutrition education programmes (iii) Evaluate the programme through baseline and post-intervention assessment
Evaluation of a feasibility study for a food store-based intervention for inner-city residents of Baltimore City[26]	African–American adults in Baltimore, Maryland, US	Eighty-four (twenty-four men, sixty women)	(i) Characterise the diets (ii) Highlight foods and nutrients for the nutrition intervention programme (iii) Assess impact of the intervention on the overall diet
Intervention for a Chronic Disease Epidemic: Community Health Initiatives and Promotion Strategies for Diabetes Prevention (ICE CHIPS) in Native North Americans (2006–2007)[36,37]	Inuit and Inuvialuit adults in Nunavut and the Northwest Territories (NWT), Canada	Eighty-three Inuit (thirty-nine men, forty-four women). Ninety-eight Inuvialuit (forty-six men, fifty-two women)	(i) Characterise the diets of adult Inuit in Nunavut and Inuvialuit in the NWT (ii) Highlight foods and nutrients to target for the nutrition intervention programme (iii) Evaluate the programme (iv) Monitor the nutrition transition over time
Cameroon (1996)[17]	Rural and urban Cameroonian adults	Sixty-one urban (twenty-eight men, thirty-three women). Sixty-two rural (twenty-six men, thirty-six women)	(i) Examine relationship between diet and chronic disease prevalence (ii) Monitor the diet over time to determine the risk factors predictive of disease incidence (iii) Conduct cross-country comparison of African-origin populations
African-origin Caribbean migrants to the UK (1996)[17]	African-origin Caribbean migrant adults in Manchester, UK	Twenty-nine (thirteen men, sixteen women)	
African-origin Jamaicans (1996)[17]	African-origin Jamaican adults	102 (fifty-one men, fifty-one women)	

include 24-h dietary recalls conducted with a population-based sample and dietary databases generated by national and community surveys[39–41]. The collection of 24-h dietary recalls to develop the FFQ has the additional advantage of providing preliminary characteristics on the dietary and nutrient intakes of understudied populations (Table 3).

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Table 2. Quantitative FFQ developed by first author presented by study population

	Apache[23]	Navajo[25]	Japanese Brazilians[16]	First Nations[35]	Inuit[37]	Inuvialuit[36]
Number of line items	155	177	161	119	153	144
Number of groups	12	11	15	14	8	12
Selected unique food and drink items	• Fry bread • Tennis bread, Donkey bread • Indian dumplings or Indian tamale • Hushpuppies • Liver, kidney, other organ meats	• Navajo taco • Navajo roast mutton sandwich • Pueblo bread or homemade oven bread • Menudo stew • Achee	• Coxinha (small) • Missoshiru • Empanada • Nishime (with beef or chicken) • Boiled cassava	• Fried bannock • Pilot biscuits • Moose, caribou or deer stew or soup • Boiled, oven-roasted or smoked goose or duck • Poutine	• Bannock, fried • Muskox fat • Char, dried • Polar bear, boiled • Caribou, aged	• Caribou, frozen (raw) • Wild birds incl. duck, ptarmigan, geese, swan and crane • Muktuk, raw incl. fermented • Eskimo ice cream with caribou fat • Blood soup

	African-origin Barbadians[28]	Cameroonians[17]	African-origin Jamaicans[17]	African-origin Caribbean migrants to the UK[17]	African American adults in Baltimore City[26]
Number of line items	148	76	69	108	113
Number of groups	9	–	–	–	17
Selected unique food and drink items	• Coconut bread • Flying fish, fried • Cou cou • Golden apple • Tamarind balls	• Snail soup • Foo foo cassava • Bobolo/miondo • Ndole/keleng keleng • Palm wine	• Ackee • Chips: banana, plantain, potato • Pickled mackerel • Salted fish • Fried dumpling	• Saltfish fritters • Cho Cho • Oxtail WI soup • Meat pie/ pastie • Curry: beef, lamb, goat	• Sweet potato pie • Chili (incl. on top of the hot dog) • Fried fish • Collards, spinach, cabbage other cooked greens • Scrapple

–, Not specified; WI, West Indian.

The recalls can also highlight foods to target as part of a nutrition intervention programme. For example, Sharma *et al.*[23] found that for Apaches in Arizona, non-nutrient-dense, high-fat, high-sugar foods were the major contributors to energy intake[23] (Table 4). Among the Apache and Navajo, five foods and beverages (i.e. crisps and popcorn, fried potato dishes, breads, tortillas and burritos, and sugary drinks) collectively contributed 30–35 % of energy intake[23,25]. These foods can be substituted with nutrient-dense, low-fat, low-sugar foods, such as whole-wheat bread, diet carbonated drinks, and unsweetened 100 % fruit juice. Substitution of preparation methods that reduce or have no impact on fat content (such as frying with cooking spray instead of oil or baking without added fat) can also significantly ameliorate nutrient intake, dietary adequacy, and chronic disease risk in these populations and, depending on the study objectives, can be added to an FFQ to evaluate intervention success.

In addition, the preliminary characterisation of the diet can elucidate nutrition transitions occurring, and the FFQ can be used to monitor any changes in diet that occur. For example, the traditional foods of the Inuit and Inuvialuit study populations in the Canadian Arctic, such as caribou and locally gathered fish, were shown to be the highest contributors of protein intake (Table 5), but as traditional foods become less available, they will likely be replaced by high-fat, high-sugar store-bought foods[36,37]. Currently, traditional foods are not among the highest five sources of total fat among Inuit. In fact, similar to other populations, non-nutrient-dense, high-fat foods are the highest contributors to the total fat among Inuit (Table 6).

The collection of portion sizes is needed to assess the amount of food consumed[18,31]. The average portion sizes from one population are not always applicable to other populations, particularly other ethnic/racial groups. For example, Sharma *et al.*[31] found that African-Caribbean

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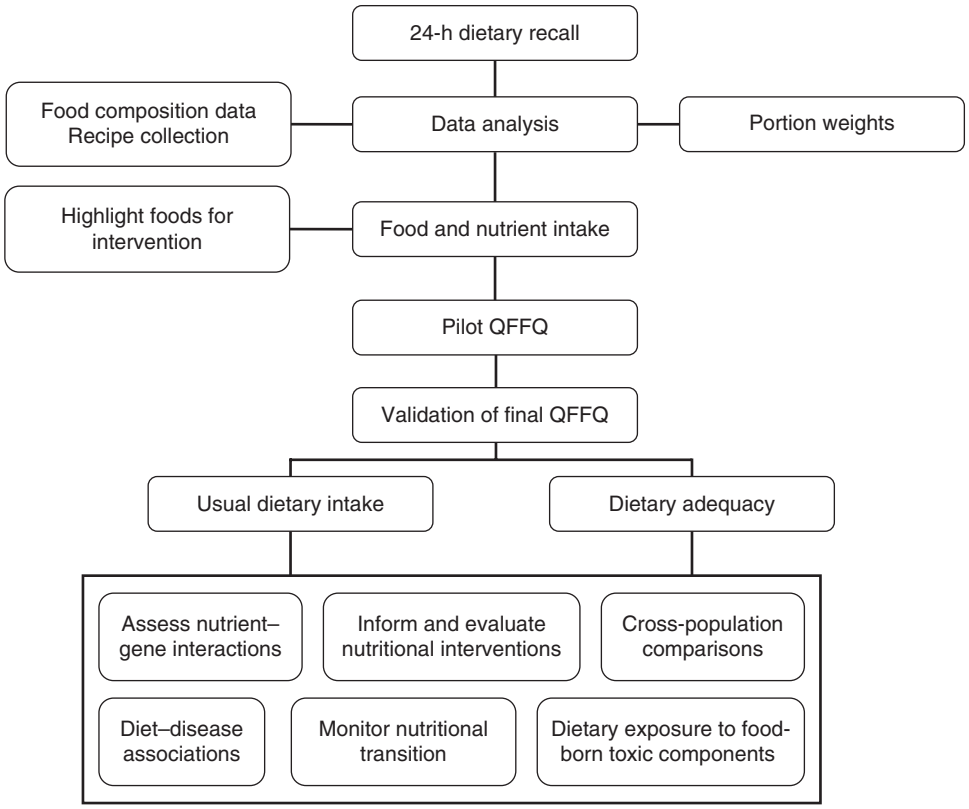

Fig. 1. Diagram of the process for developing and using a validated quantitative food frequency questionnaire (QFFQ).

adults in the UK had average portion sizes of boiled potatoes and crisps that were 1·4–1·9 times (60–158 g) and 1·3–1·5 times (56–84 g), respectively, more than the Caucasian population[31]. Food models, photographs and measurements used to assist participants in accurately estimating portion sizes must be culturally and locally appropriate.

To assign valid nutrient values to each of the line items on the quantitative FFQ (QFFQ), the use of an appropriate dietary database is crucial and requires the creation of a food composition table and collection of portion size weights[18,21,30,42]. When the nutrient content of a food is unknown, a chemical analysis should be conducted or, for mixed or composite dishes, the nutrient content can be estimated based on established nutrient analyses of the ingredients using existing food composition databases and locally collected recipes[18,21,24,27,32,34,43]. The author and her research team have collected 1172 weighed recipes for 262 local dishes for six unique populations (Table 7). Community involvement is an essential element in the FFQ development process for all studies, and particularly for culturally distinct populations. When available, local dietitians and public health nutritionists play a key role in bridging the gap between researchers and the local community. The community can be involved in the selection of appropriate food models and portion sizes, the ordering and grouping of foods, providing local terminology for foods (such as the term *muktuk* for whale skin and fat in Inuit communities), identifying important but easily forgotten foods (especially seasonally available foods), and providing feedback on the questionnaire[17,21,23,25,26,28,35–37,45]. This process can take many forms, including the involvement of local community members in the role of field staff, or through their participation in focus groups.

Population-specific FFQ have great utility and can be constructed with relative ease in different settings around the world, and several examples will be presented to illustrate this diversity. First, an example is presented from the Arctic regions of Canada, where FFQ were developed to inform and evaluate a community-based nutrition and lifestyle intervention study and track the rapid dietary changes occurring among Inuit and Inuvialuit[36, 37, 46–60]. Second, an example is presented from the Caribbean, where an FFQ has been developed[28] and is being utilised to monitor sodium intake and will evaluate a sodium reduction study aiming to reduce the risk of hypertension in Barbados, where the majority of the population is at increased risk of high blood pressure[61]. The final example is from Brazil, where an FFQ was developed to assess associations between diet (including heterocyclic aromatic amines (HAA) from well-done meat) and colorectal adenoma among Japanese Brazilians, which were then compared with Japanese living in Hawaii and Tokyo[16].

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Table 3. Daily energy and select nutrient intake from the 24-h dietary recalls used to develop the quantitative food frequency questionnaires, presented by study population

	First Nations men[35] (*n* 47)		First Nations women[35] (*n* 75)		Inuit men[37] (*n* 39)		Inuit women[37] (*n* 44)		Inuvialuit men[36] (*n* 46)		Inuvialuit women[36] (*n* 52)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Energy (kJ)	11 200	4240	8620	4120	9530	4565	6939	3268	9840	3904	7278	3543
% of energy from fat	34	10	32	10	30	11	29	9	32	9	31	11
% of energy from carbohydrate	49	9	52	12	47	13	51	15	50	11	51	13
% of energy from protein	17	6	16	6	21	9	20	11	17	6	18	9
Total fat (g)	106	56	79	53	77	51	55	34	85	41	63	43
Protein (g)	109	45	76	38	105	67	77	49	99	48	83	72

	Apache men[23] (*n* 19)		Apache women[23] (*n* 34)		Navajo men[25] (*n* 40)		Navajo women[25] (*n* 38)		African-origin Barbadian men[28] (*n* 22)		African-origin Barbadian women[28] (*n* 28)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Energy (kJ)	10 304	4580	8315	3672	16 498	14 125	9029	4268	8851	3324	6891	2834
% of energy from fat	30	14	32	10	35	11	34	11	22	8	27	9
% of energy from carbohydrate	52	16	55	12	51	12	52	11	60	12	56	12
% of energy from protein	14	6	13	4	13	3	14	4	15	4	15	4
Total fat (g)	88	59	71	38	158	146	86	54	52	27	52	28
Protein (g)	91	77	66	32	116	80	74	37	77	35	64	32

	Baltimore City African American men[26] (*n* 24)		Baltimore City African American women[26] (*n* 60)		
	Mean	SD	Mean	SD	DRI[128] men/women
Energy (kJ)	10 513	4487	9071	3746	*9211/7536**
% of energy from fat	33	11	34	9	*20–35/20–35*†
% of energy from carbohydrate	51	13	51	12	*45–65/45–65*†
% of energy from protein	13	5	15	6	*10–35/10–35*†
Total fat (g)	94	53	85	45	–
Protein (g)	79	40	81	52	–

*DRI, dietary reference intakes. Estimated amount of energies needed to maintain energy balance for men and women aged between 31 and 50 years at the level of very low physical activity-sedentary level.
†Acceptable macronutrient distribution ranges.

Table 4. Highest five food sources of energy from 24-h dietary recalls used to develop the quantitative food frequency questionnaires, presented by study population

Apache[23]	% energy contribution	Navajo[25]	% energy contribution	First Nations[35]	% energy contribution	Inuit[37]	% energy contribution
Crisps, popcorn	11	Fried potato dishes	9	Breads	8	Sweetened juices/drinks	12
Fry bread	8	Sweetened juices/drinks	6	Pasta dishes	6	Caribou, any kind	5
Carbonated drinks, regular	6	Carbonated drinks, regular	6	Crisps and popcorn	6	Bread, white	5
Fried potato dishes	5	Bread, wheat and white	5	Chicken dishes	5	Sugar	4
Apache tortilla and burritos	5	Navajo tortillas and burritos	4	Potato dishes	5	Bannock, fried	4
Total	35		30		30		30

Inuvialuit[36]	% energy contribution	Urban Cameroonians[17]	% energy contribution	Rural Cameroonians[17]	% energy contribution
Sugar	6	White bread	10	Cassava	17
Sweetened juices/drinks	5	Tomato soup	10	Palm wine	13
Carbonated drinks, regular	5	Foo foo corn	8	Okra soup	8
Bread, white	4	White rice	5	Groundnuts, fresh	6
Crisps	4	Groundnut	5	Groundnuts, soup	6
Total	24		38		50

African-origin Jamaicans[17]	% energy contribution	British African-origin Caribbeans[17]	% energy contribution	African American adults in Baltimore[26]	% energy contribution	African-origin Barbadians[28]	% energy contribution
Rice, boiled	10	Curried mutton	8	Sodas	10	Fish dishes	10
Rice and peas	9	Rice boiled	5	Chicken dishes	8	Chicken dishes	7
Hard dough bread	7	Rice and peas	4	Bread	6	Rice dishes	6
Dumplings fried and boiled	7	Fried chicken	4	Cake and pastries	4	White bread/bun	5
Condensed milk	6	Homemade soup	3	Sandwiches and burgers	4	Sweetened fruit juices/drinks	5
Total	39		24		32		33

Table 5. Highest five food sources of protein from 24-h dietary recalls to develop the quantitative FFQ, presented by study population

Inuit[37]	% contribution	Inuvialuit[36]	% contribution	British African-origin Caribbeans[17]	% contribution
Caribou, any kind	18	Caribou, roasted	8	Roast chicken	11
Pork chops/ribs	13	Caribou soup/stew	8	Curried mutton	9
Trout, any kind	8	Pork chop/rib	6	Fried chicken	8
Arctic char, any kind	7	Caribou, raw/dried	5	West Indian soup	4
Pizza	4	White fish, raw/dried	5	Dried cod/saltfish	3
Total	50		32		35

Urban Cameroonians[17]	% contribution	Rural Cameroonians[17]	% contribution	African-origin Jamaicans[17]	% contribution
Beef	12	Groundnuts, fresh	10	Rice and peas	9
Bread, white	12	Fish, grilled	8	Callalloo and saltfish	8
Fish, grilled	11	Okra soup	7	Hard dough bread	7
Tomato soup	7	Groundnut soup	7	Curried chicken	6
Chicken	6	Snail soup	6	Rice, boiled	6
Total	48		38		36

Table 6. Highest five food sources of total fat from 24-h dietary recalls used to develop the quantitative FFQ, presented by study population

Apache[23]	% contribution	Navajo[25]	% contribution	First Nations[35]	% contribution	Inuit[37]	% contribution
Crisps, popcorn	17	Fried potato dishes	17	Butter, margarine	8	Sausages, lunchmeats	7
Fry bread	8	Hot dogs, sausages	8	Chicken dishes	8	Crisps	7
Fried potato dishes	8	Eggs, any kind	7	Crisps, popcorn	7	Pork chops/ribs	7
Eggs	5	Crisps, popcorn	6	Meat dishes	6	Butter, margarine	6
Hotdogs, sausages	5	Hamburgers	4	Pasta dishes	5	Pizza	5
Total	43		42		34		32

Inuvialuit[36]	% contribution	Urban Cameroonians[17]	% contribution	Rural Cameroonians[17]	% contribution
Butter/margarine	10	Tomato soup	23	Okra soup	15
Crisps	6	Groundnut soup	11	Palm wine	11
Muktuk/whale blubber	6	Bean stew	5	Groundnut soup	10
Sausages/lunchmeats	5	Groundnuts fresh	5	Groundnuts fresh	10
Chicken eggs	5	Ndole	5	Avocado	7
Total	32		49		53

African-origin Jamaicans[17]	% contribution	British African-origin Caribbeans[17]	% contribution	African American adults in Baltimore[26]	% contribution	African-origin Barbadians[28]	% contribution
Dumplings	10	Curried mutton	19	Chicken dishes	12	Fish dishes	17
Curried chicken	6	Fried chicken	6	Frankfurters, sausages	8	Chicken dishes	10
Rice and peas	6	Polyunsaturated margarine	6	Crisps	6	Nuts	6
Condensed milk	6	Vegetable oil	4	Meat dishes	5	Hard cheese	4
Curried mutton	5	West Indian soup	4	Margarine, butter	5	Evaporated milk-full cream	3
Total	33		39		36		40

Use of quantitative FFQ in the Arctic to track the nutrition transition and develop and evaluate an intervention programme

Within the last century, aboriginal populations in the Canadian Arctic have undergone rapid changes in diet and lifestyle from nomadic hunter-gatherers with a largely protein-based diet to decreased physical activity, greater amounts of market foods and fewer traditional foods procured from hunting, fishing and gathering[46,62–67]. This nutrition transition is associated with greater, often excessive, intake of refined carbohydrate and fat and insufficient intake of many nutrients (e.g. dietary fibre, folate, potassium, vitamins A, B6, and D), leading to a double burden of under-nutrition and over-nutrition[46,63,68–78]. Moreover, food security presents a growing issue, particularly for

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Table 7. Recipe collection by study population

	Apache[21]	African-origin Barbadians[22]	Japanese Brazilians[38]	Cameroonians[34]	British Afro-Caribbeans[32]	Trinidadians[44]
Total number collected	47	152	387	197	30	359
Number of different types	13	32	76	34	18	89
Bread and other grains	6	2	6	–	1	–
Meat soup and stew (e.g. beef, poultry, pork, wild game)	3	4	2	3	2	–
Fish or seafood soup and stew	–	1	–	2	–	–
Vegetable soup and stew	2	–	1	8	–	–
Tortilla-based dish	1	–	–	–	–	–
Dumpling	1	3	–	–	1	–
Fish- and seafood-based dish	–	4	4	1	6	8
Meat-based dish (excl. curried dishes; e.g. beef, poultry, pork)	–	3	18	–	3	21
Offal-based dish	–	2	–	–	–	–
Rice- and pasta-based dish	–	4	5	–	1	–
Vegetable dish	–	2	26	9	–	19
Curried meat dishes	–	–	–	–	3	–
Starches	–	–	–	–	–	15
Seasoning, gravy, sauces	–	2	–	4	–	–
Miscellaneous items	–	2	2	7	–	11
Beverage	–	3	1	–	1	5
Desserts	–	–	11	–	–	10

traditional foods, as climate change alters the physical landscape and poverty rates among the Aboriginal populations remain high[46,79–88]. The rapid lifestyle and nutrition transition may explain the rising prevalence of chronic diseases and higher rates of mortality among aboriginal populations in Canada compared to the general population[89–93]. Recent data from Inuit and Inuvialuit living in the Arctic regions of Nunavut and the Northwest Territories (NWT) showed that 24% were overweight and 43% were obese; 5% had type 2 diabetes and 22% were hypertensive[48,49,55]. Clearly, there is a need to monitor the changes in diet over time among these populations and develop an informed nutrition and lifestyle intervention programme to improve dietary adequacy and reduce the risk of chronic disease.

Researchers have conducted dietary assessments on Inuit, Inuvialuit and other Aboriginal Canadian populations using various methodologies, including FFQ (with and without portion sizes) and single 24-h dietary recalls[35,62,66,70,94–96]. Methods for FFQ development were consultations with nutrition experts, researchers, community members and local government representatives and community workshops. Until now, no comprehensive, population-specific, culturally competent and cost-effective dietary assessment instrument has been developed that can monitor changes in these populations over time. Of the FFQ that were developed, none have been developed using an evidence-based food list generated from up-to-date dietary data collected using scientific research methodology, combined with community consultations and including all foods consumed and with proper validation.

The author and her research team therefore developed two culturally competent, evidence-based, interviewer-administered QFFQ to fulfil these needs and to evaluate a nutritional and lifestyle intervention programme, one for Inuvialuit in the Beaufort Delta region in the NWT and one for Inuit in the Kitikmeot region in Nunavut[36,37]. To develop the QFFQ, single 24-h dietary recalls were conducted by trained staff in two communities in each territory to generate a complete and accurate food list, and items recalled more than once were included on the questionnaire, except for items very low in energy and nutrients, such as condiments and spices[36,37]. Three-dimensional food models, local household utensils, standard units (e.g. slice of bread) and packaging from foods commonly purchased in local stores (e.g. crisps packets, sweet wrappers) were used to assess portion size in the recalls, and the models were later assigned to QFFQ line items based on portion sizes reported in the recalls and consultation with community staff. The recalls were analysed using the Canadian Nutrient File database (10th edition) in NutriBase Clinical Nutrition Manager version 5.18 to provide an initial overview of dietary patterns and to identify the major contributors to energy and selected nutrients. The recalls showed inadequate intakes of dietary fibre, calcium, vitamins A, C, D, and E and folate among Inuit and Inuvialuit[36,37].

Focus groups were held with local staff and residents to list all the traditional foods to ensure that foods consumed in other seasons were not inadvertently omitted. A manual of procedures was developed for the QFFQ, and the data collectors piloted the QFFQ with eighteen to twenty participants in the four communities. In consultation with community staff and stakeholders after piloting, the QFFQ were refined, and the foods were grouped and ordered to fit into the local conceptual framework[21]. For example, traditional meats were separated from store-bought meats and were placed first in the food group order.

The final NWT QFFQ contained 144 line items while the final Nunavut QFFQ contained 153 line items. Both

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questionnaires had eight frequency categories ranging from 'never' to 'two times per day or more,' and additional questions concerning supplement use and smoking habits. Although they contain many of the same food and beverage items, the two questionnaires were developed separately so as to be tailored for each region during the intervention study. Sample pages from the QFFQ are presented in Appendices 1 and 2.

In addition to being a useful tool for QFFQ development, the recalls highlighted foods for a nutrition intervention programme. For example, in the NWT, sugar (added to tea or coffee), sweetened juice/drinks, carbonated drinks, white bread and crisps were the greatest contributors to energy intake, contributing to nearly a quarter of total energy intake (Table 4)[36]. Clearly, replacing these non-nutrient-dense items with nutrient-rich alternatives, such as unsweetened juice, whole-wheat bread, or low-sugar low-fat alternatives, such as artificial sweeteners or diet carbonated drinks, would significantly improve dietary quality and prevent excessive energy intake. These results were presented back to the communities in workshops, and the workshop participants used these results to identify the 'problem' foods in their communities, acceptable healthier alternatives, dietary behaviours to target for a behaviour change strategy and key messages for a nutrition intervention[97]. The foods selected by the community for promotion and demotion aligned very well with the findings from the dietary recalls. These foods were included in the QFFQ to construct a comprehensive instrument for an intervention evaluation.

The data from the dietary recalls, community workshops and qualitative in-depth interviews were used to develop the Healthy Foods North programme. This is a community-based, multi-institutional, multi-level nutrition and lifestyle intervention programme that aims to reduce the risk of chronic disease and improve dietary adequacy among Inuit and Inuvialuit[97]. Healthy Foods North has been described previously in detail[47]. An example of culturally appropriate media, developed from the workshops and consultations with community partners, is presented in Appendix 3. The pilot programme was conducted in 2008–2009 in the two NWT and two Nunavut communities that participated in the formative phase. The QFFQ were administered prior to Healthy Foods North implementation in the four intervention communities plus two delayed intervention communities (who would receive the intervention after the evaluation was completed). Data collection for a QFFQ validation study was additionally undertaken in one intervention community in each territory with the baseline QFFQ collection. A series of up to three 24-h dietary recalls were conducted with seventy-one Inuit and sixty Inuvialuit adults in a 7-d period on non-consecutive days, capturing both weekend and weekday consumption[50,56]. The validation analysis for the NWT and Nunavut QFFQ, respectively, showed that 76% and 80% of the observations of the estimation of nutrient intake by the QFFQ and validation recalls were in the same or adjacent quartiles; consequently, the QFFQ were determined to be valid dietary assessment tools for these populations[58,59]. The QFFQ were re-administered after the intervention was completed. The data collectors consisted of local community members and Community Health Representatives, research assistants, and university students, and all were trained and certified by the author.

To accurately characterise the diet in these populations, the analysis of the QFFQ also needed to be population specific and culturally appropriate. A food composition table was developed for the NWT QFFQ and for the Nunavut QFFQ, using the Canadian Nutrient File database (10th edition) in NutriBase as the basis, or the United States Department of Agriculture (USDA) database for commercial food products (USDA SR 20 Search and What's In The Foods You Eat Search Tool, 3.0) if a particular item was unavailable in Canadian Nutrient File[46]. For items that were the same between the two questionnaires, the same NutriBase entries were selected for inclusion in the food composition tables to ensure comparability and consistency between the two QFFQ. Seventeen recipes for nine different traditional dishes were collected by trained data collectors in the Nunavut field sites using a standardised protocol and were used for both food composition tables. Each ingredient was recorded and weighed before cooking, and the final weight of the dish was recorded to capture moisture loss during cooking. Portion weights were obtained for both the QFFQ and the 24-h dietary recalls for every food model and household utensil. The average weight for the foods in the models was calculated using ten consecutive weightings, and similar foods were substituted when a food item was unavailable. For items reported in standard units (e.g. slice of bread), the weight from the Canadian Nutrient File or USDA was used.

This setting presents a unique case in that, unlike other populations, QFFQ developed specifically for these populations may be able capture the total diet because of the limited variety in the diet and available food sources[46]. Analysis of the baseline QFFQ is currently underway to estimate nutrient intake and dietary adequacy from the questionnaires. In addition, dietary adequacy was calculated from the validation 24-h dietary recalls[50,56]. The changes in consumption from baseline to post intervention captured by the QFFQ are also currently being analysed, and preliminary results indicate that the instrument is sensitive enough to evaluate the impact of Healthy Foods North on the diet of Inuit and Inuvialuit. Moreover, these QFFQ will be implemented over time to capture long-term changes in dietary intake.

As illustrated in this example, QFFQ are a valuable approach for informing nutrition interventions and relatively easy to construct. Comprehensive, feasible, population-specific and culturally competent instruments are needed for vulnerable populations undergoing drastic changes in diet and lifestyle.

Development of a quantitative FFQ for dietary salt evaluation in Barbados

CVD is a leading cause of death in the Caribbean, and hypertension has been identified as the primary risk factor[98,99]. In Barbados, an estimated 55·4% of the African-origin population aged 40–84 years has hypertension, with moderate rates of treatment and low rates of control[61].

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The relationship between excess dietary sodium and high blood pressure is well documented[100–105], and sodium reduction has been shown to improve hypertension, cardiovascular and stroke health outcomes[106–109]. To reduce the burden of cardiovascular and other hypertension-related chronic disease in Barbados, the Chronic Disease Research Centre of the University of the West Indies, Cave Hill, is collaborating with the author in the Barbados Salt Intake Survey to design a comprehensive, locally appropriate dietary assessment instrument that is able to monitor salt and sodium intakes in the Barbadian population over time, assess both dietary intake and adequacy and evaluate the efficacy of a planned intervention. As part of the Barbados National Cancer Study (BNCS) in 2005, a QFFQ was developed and validated[28,110] to assess total dietary intake in the Barbadian population, and local recipes for mixed dishes were collected to aid in the analysis[27]. A sample page from the QFFQ is presented in Appendix 4. The results of BNCS highlighted the need for a nutrition intervention to reduce the risk of chronic disease in this population[29]. Because of the elapsed time and different aims of the two studies, the original QFFQ requires updating to maintain relevance for the population as well as modification to capture dietary sodium intake and to be used as an intervention evaluation tool.

To update and modify the BNCS QFFQ, pilot work was undertaken to identify important sources of sodium in the current Barbadian diet. Up to three 24-h dietary recalls were collected from fifty randomly selected Barbadian adults in March and April of 2010 and were analysed using NutriBase Nutrition and Fitness Manager version 8.3.8 (CyberSoft, Inc., Phoenix, AZ) and USDA SR 20 Search. Portion size was assessed using a collection of food models from the BNCS. The primary contributors to sodium intake were identified for inclusion in the adapted QFFQ. New foods reported by more than one person in the multiple 24-h recalls were added to the BNCS QFFQ food list, as were additional foods identified by a focus group of Barbadian nurses, a dietitian and other public health researchers as important contributors to the diet. These foods included energy drinks, cereal bars, fruit smoothies and other products that were not widely available during the development of the BNCS QFFQ.

The Barbados Salt Intake Survey QFFQ has been pilot tested among Barbadian adults. It will be used to identify significant foods contributing to sodium intake in Barbados that may be targeted in a sodium reduction intervention. The QFFQ is being used to measure baseline sodium intake and overall dietary intake, as well as to track intakes and food consumption patterns post intervention and over time. The QFFQ developed for a previous study among Barbadian adults was culturally competent and was, therefore, an ideal tool for adaptation for the Barbados Salt Intake Survey.

Assessment of dietary risk factors for colorectal adenoma using a quantitative FFQ specifically developed for Japanese Brazilians

Brazil has the largest population of Japanese living outside Japan, and in 1998 São Paulo, Brazil had a population of 350 000 Japanese[111]. Colorectal cancer (CRC) is the fourth commonest cancer in São Paulo, Brazil, and its incidence doubled between 1969 and 1993[112]. CRC incidence among Japanese populations in Japan has considerably increased over the past 30 years, and the incidence in Japanese migrants to Hawaii, US, markedly increased upon migration. It is likely that this is in part due to Westernisation of the diet characterised by low intakes of calcium and dietary fibre and high consumption of animal fat and meat[113–115]. However, CRC incidence rates did not increase among Japanese populations upon migration to São Paulo, despite high meat intake, a relatively affluent urban lifestyle, and higher BMI compared to Japanese in Japan[116]. Further research is needed to improve our understanding of CRC aetiology and to develop new strategies for its prevention among Japanese populations.

Substantial evidence suggests that dietary factors play an important role in the development of CRC and colorectal adenoma, a precursor lesion for most CRC[117–120]. Recent studies have emphasised high intakes of red meat and processed meat as likely risk factors for colorectal neoplasia[121–123]. Research has implicated this association to be at least partly mediated by the known chemical carcinogens HAA and polycyclic aromatic hydrocarbons. HAA are formed when meat is cooked at a high temperature for a long duration, and polycyclic aromatic hydrocarbons are formed when meat is cooked directly above a heat source[121,122,124,125]. Conversely, fruit and vegetables may have a protective effect against CRC[126]. Despite high exposure to HAA and polycyclic aromatic hydrocarbons in churrasco meat, a commonly consumed barbecued meat in Brazil, Japanese in São Paulo appear to have a relatively low risk of CRC compared to Japanese populations in Japan or Hawaii. Low risk in this group may be attributed, at least in part, to protective factors such as high intakes of fruits and vegetables (including legumes)[127]. Further research is needed to characterise the diet of Japanese Brazilians living in São Paulo, including their HAA intake, and subsequent risk of colorectal neoplasia, and to compare these with Japanese populations in Hawaii and Japan.

A colonoscopy-based, case–control study of adenoma was initiated to investigate dietary intake, nutrient–gene interactions and the risk for adenoma among Japanese Brazilians in São Paulo, and also to compare findings with those of parallel studies among Japanese in Hawaii and Japan. Using single 24-h dietary recalls from sixty Japanese Brazilian outpatients men (*n* 29) and women (*n* 31) (mean ages 58 years and 57 years, respectively) in a hospital in São Paulo, a culturally competent QFFQ was developed to assess food, nutrient and HAA intake[16]. Recall data showed that salad (e.g. vegetable salad and tomato salad) was the most commonly reported food, with rice second and oranges and tangerines the third most commonly reported food items. Seventy percent of respondents reported consuming a red-meat-based dish or sausages, and more than one third of the items reported were vegetables (including legumes), fruit or fruit juices.

The QFFQ contains 161 food and drink items, put into fifteen food groups. A local dietitian consulted on the most appropriate method of assessing portion size to determine

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amounts consumed for each item listed on the QFFQ. Specific meat items were listed individually on the QFFQ to capture differences in HAA content depending on cooking method, level of doneness, use of marinades and type of meat. Coloured photographs were added with meat cooked at several 'doneness' levels (rare; medium rare; medium; well cooked; very well cooked) for fourteen grilled, churrasco or pan-fried foods (four beef, one pork, six chicken and three fish items) to obtain accurate preparation method information and to determine the food sources of HAA. In addition, questions were included on the frequency and amount of consumption of gravy made with drippings from pan-fried and roasted meats and poultry to capture the intake of HAA from all the possible sources. A sample page from the QFFQ is presented in Appendix 5. A validation of the QFFQ using 4-d food diaries is currently under review. Some 387 weighed recipes for seventy-six local mixed dishes commonly consumed by Japanese Brazilians in São Paulo, Brazil, were collected and analysed for nutrition composition using NutriBase Clinical Nutrition Manager[38]. Additionally, a laboratory analysis of the concentrations of HAA in meat and fish prepared in accordance with the cooking practices of Japanese Brazilians was conducted to allow estimation of dietary HAA exposure using the QFFQ and to study the association between HAA and cancer risk[43].

This comprehensive, study-specific and up-to-date QFFQ is being used to estimate HAA intake, assess dietary adequacy and investigate diet–gene interactions in colorectal neoplasia among Japanese Brazilians and to compare the findings with Japanese in Hawaii and Japan.

Conclusion

Despite their inherent limitations and especially regarding the 'self-report' nature of the collected data, FFQ are the most feasible and cost-effective dietary assessment tool currently available for large epidemiological studies. They allow for the characterisation of dietary patterns and intake, investigation of diet–disease associations, intervention evaluation, assessment of nutrient–gene interactions, cross-population comparison and monitoring of the nutrition transition taking place globally. The examples presented here illustrate the QFFQ development process and demonstrate the use of QFFQ for multiple purposes in diverse settings with multi-ethnic populations. It is of utmost importance that an FFQ is developed and validated specifically for the study population in nutritional epidemiology and intervention studies.

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Appendix 1

Sample page from the quantitative FFQ developed for Inuvialuit in the Northwest Territories, Canada

How often during the last 30 d did you usually eat the following foods	How much do you usually eat at one time?	Never	1/last 30 d	2–3 times/ last 30 d	1/ week	2–3 times/ week	4–6 times/ week	Once a day	2 or more times a day
Meats (not incl. soups or stews) remember to praise respondents! Meat is the amount eaten WITHOUT THE BONE. Mention all Caribou first.									
Caribou, boiled, baked or roasted	___ ZZ	1	2	3	4	5	6	7	8
Caribou, frozen (raw)	___ ZZ	1	2	3	4	5	6	7	8
Caribou, dried meat	___ YY	1	2	3	4	5	6	7	8
Caribou, fried incl. steak (but not burgers)	___ ZZ	1	2	3	4	5	6	7	8
Caribou burger	___ M	1	2	3	4	5	6	7	8
Caribou stir-fried with vegetables	___ 'O'	1	2	3	4	5	6	7	8
Caribou offal incl. liver, heart and kidney	___ P	1	2	3	4	5	6	7	8
Muskox, boiled, baked or roasted	___ ZZ	1	2	3	4	5	6	7	8
Muskox, dried meat	___ YY	1	2	3	4	5	6	7	8
Muskox, fried incl. steak (excluding burger)	___ ZZ	1	2	3	4	5	6	7	8
Muskox, burger	___ M	1	2	3	4	5	6	7	8
Muskox stir-fried with vegetables	___ 'O'	1	2	3	4	5	6	7	8
Moose, boiled, baked or roasted	___ ZZ	1	2	3	4	5	6	7	8
Moose, dried meat	___ YY	1	2	3	4	5	6	7	8
Moose, fried incl. steak (excluding burgers)	___ ZZ	1	2	3	4	5	6	7	8
Moose burger	___ M	1	2	3	4	5	6	7	8
Moose, stir-fried with vegetables	___ 'O'	1	2	3	4	5	6	7	8
Beef burgers patty (not incl. bun – ask patty only)	___ M	1	2	3	4	5	6	7	8
Ground beef or beef ravioli or hamburger helper	___ 'O'	1	2	3	4	5	6	7	8
Meat pie incl. Shepherd's pie	___ BB	1	2	3	4	5	6	7	8
Beef steak fried without vegetables	___ ZZ	1	2	3	4	5	6	7	8
Beef steak stir-fried with vegetables	___ 'O'	1	2	3	4	5	6	7	8
Beef jerky	___ YY	1	2	3	4	5	6	7	8
Pork chops, boiled, baked, roasted or fried	___ U	1	2	3	4	5	6	7	8
Polar bear, raw, boiled or roasted	___ ZZ	1	2	3	4	5	6	7	8
Seal meat, boiled	___ E	1	2	3	4	5	6	7	8
Rabbit or musk rat	___ ZZ	1	2	3	4	5	6	7	8
Bacon	___YY	1	2	3	4	5	6	7	8

Sharma S, De Roose E, Cao X *et al.* (2009) Dietary intake in a population undergoing a rapid transition in diet and lifestyle: the Inuvialuit in the Northwest Territories of Arctic Canada. *Can J Public Health* **100**, 442–448.
'ZZ', 'YY' and so forth in the second column represent the names of the models used to collect portion size.

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Appendix 2

Sample page from the quantitative FFQ developed for Inuit in Nunavut, Canada

	How often during the last 30 d did you usually eat the following foods and how much do you usually eat at one time	Usual portion size	Never	Once in the last 30 d	2–3 times in last 30 d	Once a week	2–3 times a week	4–6 times a week	Once a day	2 times a day or more
	Breads									
8	Bannock, fried	FF	1	2	3	4	5	6	7	8
9	Bannock, baked	FF	1	2	3	4	5	6	7	8
10	White bread including toast, sandwiches, rolls and bagels	Slice	1	2	3	4	5	6	7	8
11	Whole wheat bread	Slice	1	2	3	4	5	6	7	8
12	Pancakes or Waffles including Eggo waffles	#	1	2	3	4	5	6	7	8
13	Butter or margarine	N	1	2	3	4	5	6	7	8
14	Peanut butter	N	1	2	3	4	5	6	7	8
15	Jam or marmalade	N	1	2	3	4	5	6	7	8
	Cereal: I am going to ask you about different kinds of cereals. This is DRY cereal before you add milk.									
16	Homemade porridge	SS	1	2	3	4	5	6	7	8
17	Quaker Oats or porridge in a package	pkg	1	2	3	4	5	6	7	8
18	Sweet cereals including Frosted Flakes or Honey Nut Cheerios	SS	1	2	3	4	5	6	7	8
19	Low sugar cereals like Corn Flakes, Rice Krispies, Cheerios	SS	1	2	3	4	5	6	7	8
	Meats, poultry, fish (not including meats in soups, stews, or stir fries) Remember to praise respondents!									
20	Caribou, boiled, baked or roast	ZZ	1	2	3	4	5	6	7	8
21	Caribou, raw	ZZ	1	2	3	4	5	6	7	8
22	Caribou, dried	ZZ	1	2	3	4	5	6	7	8
23	Caribou, fried (not including stir fry)	K	1	2	3	4	5	6	7	8
24	Caribou aged	ZZ	1	2	3	4	5	6	7	8
25	Caribou fat, hard	Q	1	2	3	4	5	6	7	8
26	Polar bear, boiled	ZZ	1	2	3	4	5	6	7	8
27	Beef steak (not including stir fry)	ZZ	1	2	3	4	5	6	7	8
28	Beef hamburgers	M	1	2	3	4	5	6	7	8
29	Meat pie	BB	1	2	3	4	5	6	7	8
30	Sloppy Joe	VV	1	2	3	4	5	6	7	8
31	Pork or beef ribs	4′	1	2	3	4	5	6	7	8
32	Pork chops	U	1	2	3	4	5	6	7	8
33	Pork roast	K	1	2	3	4	5	6	7	8
34	Seal liver	ZZ	1	2	3	4	5	6	7	8
35	Seal cooked	ZZ	1	2	3	4	5	6	7	8
36	Seal fat, fermented or fresh, hard	N	1	2	3	4	5	6	7	8
37	Seal fat, fermented, liquid	Teasp	1	2	3	4	5	6	7	8
38	Seal raw, not including liver	ZZ	1	2	3	4	5	6	7	8
39	Muktuk	E	1	2	3	4	5	6	7	8

Sharma S, Cao X, Roache C *et al.* (2010) Assessing dietary intake in a population undergoing a rapid transition in diet and lifestyle: the Arctic Inuit in Nunavut, Canada. *Br J Nutr* **103**, 749–759.

'ZZ', 'YY' and so forth in the Usual Portion Size column represent the names of the models used to collect portion size.

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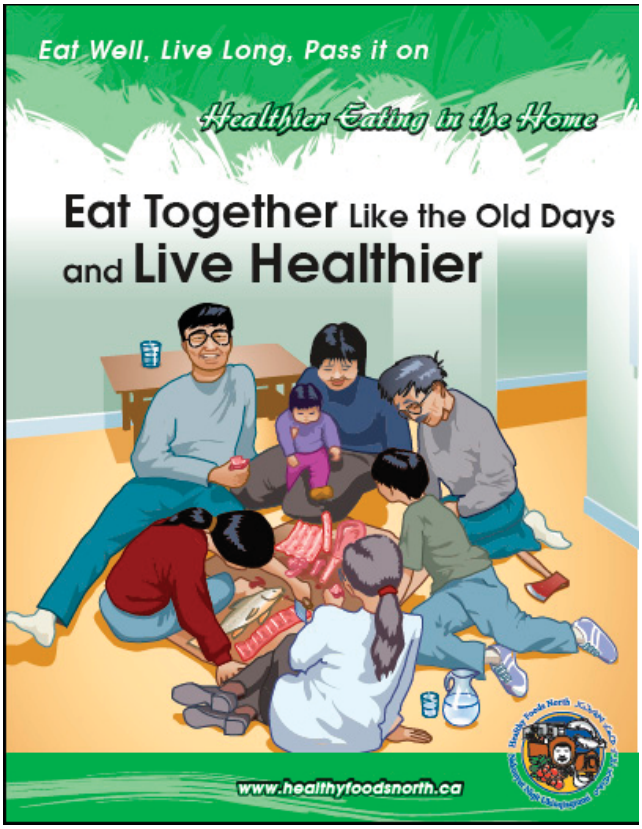
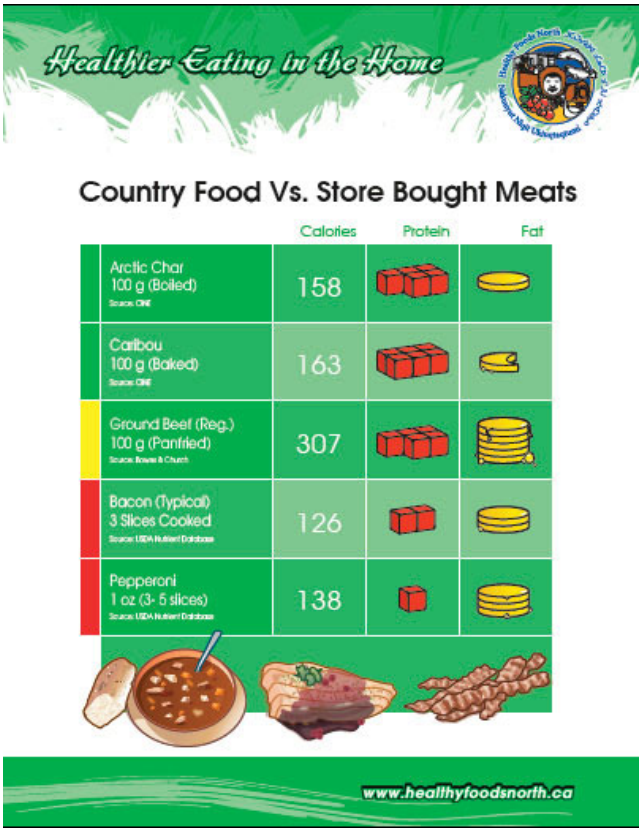
Appendix 3

A sample poster from Phase 3 of the Healthy Foods North Intervention Programme





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Appendix 4

Sample page from the quantitative FFQ developed for the Barbados National Cancer Study

How often during the 12 month period prior to (reference date), did you usually eat the following foods and how much do you usually eat at one time?

Food	Portion	Never < 1/mo	Once a month	2-3x a month	Once a week	2-3x a week	4-6x a week	Once a day	2 or > x a day
Breads, cakes and cereals 1. Salt bread, white	□□.□□ #	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)
2. Salt bread, whole wheat	□□.□□ #	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)
3. Turnover, white/whole wheat	□□.□□ #	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)
4. Buns, hot dog buns, rolls	□□.□□ #	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)
5. Other white bread	□□.□□ A	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)
6. Other whole wheat bread	□□.□□ A	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)
7. Crackers, white/whole wheat (Sodabix, Eclipse, Wibix, Crix)	□□.□□ #	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)
8. Coconut bread	□□.□□ B	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)
9. Cake, any kind	□□.□□ C	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)
10. Doughnuts, currant slices, jam puffs	□□.□□ #	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)
11. Sweet biscuits (Teatime, Digestive, Shirley, Ovaltine)	□□.□□ #	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)
12. Conkies (in season)	□□.□□ #	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)
13. Cold cereals: Cornflakes, Rice Krispies, Bran Flakes **(bwl)**	□□.□□ #	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)
14. Weetabix, Shredded Wheat	□□.□□ #	O (1)	O (2)	O (3)	O (4)	O (5)	O (6)	O (7)	O (8)

-2-

Enrollment Number □ - □□□□ - □

Sharma S, Cao X, Harris R *et al.* (2007) Dietary intake and development of a quantitative food-frequency questionnaire for the Barbados National Cancer Study (BNCS). *Public Health Nutr* **10**, 464–470.

'A', 'C' and so forth in the portion column represent the names of the models used to collect portion size.

Appendix 5

Sample page from the quantitative FFQ developed for Japanese Brazilians in São Paulo, Brazil

No.	Description of food item (English)	Portion			Never or hardly ever	Once a month or 12 times a year	2-3 times a month	Once a week	2-3 times a week	4-6 times a week	Once a day	2 times a day or more
		Complete	Unit	Office use only								
61	Stroganoff (beef or chicken)		# D flat		1	2	3	4	5	6	7	8
62	Nishime (with beef or chicken)		# T		1	2	3	4	5	6	7	8
63	Beef (stir-fried) (with or without vegetables)		# GG heaped		1	2	3	4	5	6	7	8
64	Ground beef (stir-fried) (with or without vegetables)		# GG heaped		1	2	3	4	5	6	7	8
65	Beef Milanese		# EE		1	2	3	4	5	6	7	8
66	Beef (roasted)		# W		1	2	3	4	5	6	7	8
67	Beef (pan-fried)		# Y		1	2	3	4	5	6	7	8
68	Beef (grilled in a frying pan without oil or fat)		# Y		1	2	3	4	5	6	7	8
69	Beef (Churrasco, grelha), (Please refer to the explanation drawing)		# W		1	2	3	4	5	6	7	8
70	Beef (Churrasco, espeto), (Please refer to the explanation drawing)		# W		1	2	3	4	5	6	7	8
71	Feijoada		# D heaped		1	2	3	4	5	6	7	8
72	Sausage (stir-fried or stewed with vegetables)		# GG heaped		1	2	3	4	5	6	7	8
73	Pork (stir-fried) (with or without vegetables)		# GG heaped		1	2	3	4	5	6	7	8
74	Hamburger (pan-fried)		# BB		1	2	3	4	5	6	7	8
75	Sausage (pan-fried or fried)		# TT		1	2	3	4	5	6	7	8
76	Sausage (Churrasco, grelha)		# TT		1	2	3	4	5	6	7	8
77	Pork (pan-fried)		# Q		1	2	3	4	5	6	7	8

Sharma S, Iwasaki M, Kunieda C *et al.* (2009) Development of a quantitative food frequency questionnaire for assessing food, nutrient, and heterocyclic aromatic amines intake in Japanese Brazilians for a colorectal adenoma case-control study. *Int J Food Sci Nutr* **60**, Suppl 7, 128–139.

'T', 'W' and so forth in the Unit column represent the names of the models used to collect portion size.