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Food frequency questionnaire assessing traditional food consumption in Dene/Métis communities, Northwest Territories, Canada

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ABSTRACT

Food Frequency Questionnaires (FFQ) can be used to document food consumption and to estimate the intake of contaminants for Indigenous populations. The objective of this project was to refine and implement an FFQ to estimate the consumption of traditional locally harvested foods for Dene/Métis in the Northwest Territories, Canada. The strategy consisted of: 1) refining the FFQ through three focus groups and, 2) implementing the FFQ in Indigenous communities. Participants were asked to complete the FFQ using an iPad to document the types of traditional foods consumed over the past 12 months, as well as the consumption frequency, the portion size, and the preparation methods. Focus groups supported the refinement of the FFQ on the format, the list of foods, and the preparation methods listed in the questionnaire. The refined FFQ was then implemented with participants (n = 237). Findings indicated that the traditional foods most frequently consumed were moose, whitefish and lake trout. Participants who consumed fish and land animals reported, on average, a portion size for one serving of between 126 and 143 g, depending on age and sex. These findings increase knowledge of the current traditional food consumption of Dene/Métis communities and will support the assessment of contaminant exposure.

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Indigenous; food Frequency Questionnaire; contaminants; traditional foods; Northwest Territories; Dene; country foods

Introduction

Food Frequency Questionnaires (FFQ) are surveys used to assess dietary behaviour and to estimate the frequency and the composition of specific foods or groups of food [1]. One challenge encountered in epidemiological studies on diet has been the unreliability of dietary intake; FFQs are generally designed to assess the ranking of intakes but not to provide an absolute estimate of intake [1]. However, the simplicity in administering FFQs and their cost-effectiveness are strong advantages. As such, FFQs have been used in previous projects for traditional food consumption assessment and nutrient intake estimation [2–8], and in some cases to estimate contaminant intakes [9–11].

While traditional foods are part of healthy living, the consumption of these foods may contribute significantly to human exposure to numerous contaminants, including mercury and cadmium, especially for northern populations [12]. Elevated levels of mercury and cadmium were reported in several wild-harvested fish species and moose organs (e.g., liver and kidney) in the Northwest Territories (NWT). Accordingly, the Government of the NWT Department of Health and Social Services disseminated this information to the public via the release of a series of consumption notices [13]. These notices recommend limiting the consumption of locally harvested moose liver and kidney from the South Mackenzie Mountain, as well as several fish species (according to waterbody and fish length). However, traditional foods are an important source of nutrients and are associated with an improved nutrition status [7,14], which may aid in increasing food security for Indigenous people in Canada. Therefore, to better understand the public health challenges posed by contaminants in traditional food, a community-based human biomonitoring project *Contaminant Biomonitoring in the Northwest Territories Mackenzie Valley* was implemented in nine First Nations communities of the NWT. The aim of this biomonitoring project was to assess contaminant exposures, nutrition markers, and the role of traditional foods in participating communities in the Mackenzie Valley, NWT [15,16]. As part of this project, participants completed a pair of foods surveys (i.e., 24-h recall, FFQ).

As part of the larger project, the objective of the research reported here was to refine and implement

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The supplemental data for this article can be accessed here.

an FFQ to estimate dietary consumption of environmental contaminants through traditional foods for Indigenous communities in the Sahtú and Dehcho regions in the NWT. This research consisted of: 1) using multiple focus groups to refine the food list and question format used in the FFQ, 2) implementing the refined survey in nine communities of the Dehcho and Sahtú regions for which food consumption patterns are presented below.

Materials and methods

Study design

A fish monitoring project overseen by the Dehcho Aboriginal Aquatic Resources & Ocean Management program (AAROM), in collaboration with University of Waterloo scientists, investigated the role of waterbody and fish species on the level of mercury, selenium, and omega-3 fatty acids in wild-harvested fish in the Dehcho region. While reporting the results from this work, community members expressed an interest in conducting human biomonitoring research in order to better understand the human health implications of the mercury results. Accordingly, a human biomonitoring project was implemented in several Dehcho communities in 2015–2017 [15]. Subsequently, the Sahtú Renewable Resources Board (SRRB) expressed interest in the expansion of the project into the neighbouring Sahtú region. Founded on a community-based approach, community members and leaders were consulted and involved in the development of the project. The research team worked with local partnering communities to refine a Community Research Agreement (CRA) mentioning the responsibilities and expectations of both parties, the scope of the work, principles of informed consent procedures and data management plans.

The project was implemented in nine communities: Jean Marie River, K'atl'odeeche, West Point, Deh Gah Gotie, Ka'a'gee Tu, Sambaa K'e, Tulit'a, Déline, and K'asho Got'ine in the NWT (Figure 1). A total of 537 participants in the NWT consented to participate in the project. This project, funded by the Northern Contaminants Program (NCP), involved the collection of three biological samples (human hair, urine, and blood), the administration of two dietary surveys (an FFQ and a 24-h dietary recall) and a Health Messages Survey to characterise knowledge awareness, risk perception, and communication preferences [16]. Participants had the choice to take part in any number of the six components. Results were returned to participating communities and individuals in the following year after the sampling. The FFQ was used to document peoples' use of traditional, locally harvested foods (e.g., types of foods, frequency of consumption), in the Dehcho and Sahtú regions.

Ethics and consent forms

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all

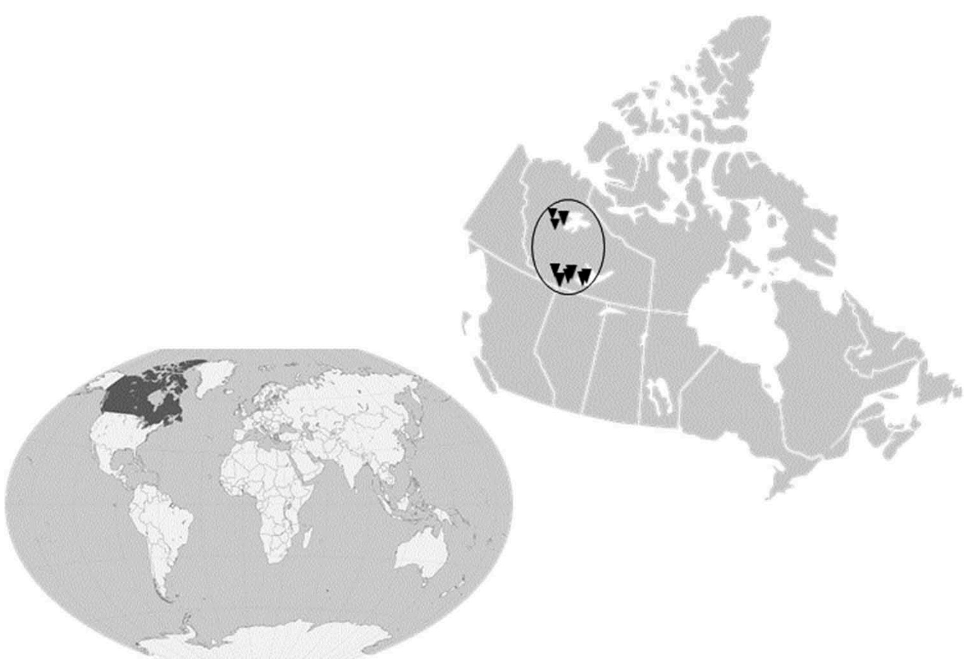

Figure 1. Communities participating in the project.

procedures involving research study participants were approved by the following ethics committees: the University of Waterloo Research Ethics Committee (#20173, #20950, # 30543), the Stanton Territorial Health Authority for Human Research (29/12/2015), and the Aurora Research Institute (#15560, #15775, #15966, #15977, #16021).

Informed written consent was obtained from participants. Interpreters were available to translate in North Slavey and South Slavey according to community input. Only adults were invited to take part in the refinement of the FFQ. For the implementation of the FFQ, those 6 years of age and older were invited to take part. Young children were assisted by their parents/guardians in completing the FFQ. In recognition of their involvement, each participant received a remuneration in the form of a gift card from a local general store. For both the refinement and the implementation of the FFQ, ethics approvals were obtained.

FFQ

The first draft of the FFQ was based upon the questions previously used by Kuhnlein and Receveur from the Centre for Indigenous Peoples' Nutrition and Environment (CINE) (McGill University) in the NWT in the 1990 s with further direction from the FFQ of the First Nations Food, Nutrition & Environment Study (FNFNES) [4,12,17,18]. The adapted FFQ was built in QuickTapSurvey and was administered on iPads through the QuickTapSurvey app. This FFQ gathered information about the traditional foods participants had eaten over the past year. FFQ questions asked about the traditional foods consumed and how often the foods were eaten. Preparation methods, which can affect the levels and bioaccessibility of methylmercury in fish tissues [19], were therefore also documented in the FFQ. The FFQ not only documented the type of processing (e.g. smoking/drying), but included also the cooking methods (e.g. stew, soup) to capture a greater breadth of food preparation methods.

The locally harvested traditional foods were grouped into four categories in the survey (fish, land animals, game birds, and plants and berries) (see Table 1 for the species and Supplementary Material for the complete FFQ Survey Template). The FFQ documents information on the types of foods and the frequency by which these foods were consumed. The FFQ was designed to be user-friendly with a photo of each food included, and to every extent possible, the photos were taken by collaborators from the Northwest Territories. The FFQ includes up to 319 questions, which are conditional upon previous answers. These questions are on the frequency of consumption of foods in each category of species, types of organs consumed, and the cooking/preparation methods used for these foods. Some questions had a binary structure (e.g., yes/no) while some had several options listed where participants could select multiple responses. Additional open-ended questions were asked after each category. These included, for example, other foods not asked about in the survey, water bodies where fish were harvested, and other cooking types. Meal size was also documented as some authors reported the importance of adapting locally relevant portion sizes when using an FFQ [20]. Meal sizes were estimated according to six photos that each represented different meal sizes across each of the locally harvested food categories (fish, land animals, birds, plants and berries). These six photos were pan fried sole, pan fried beef, pan fried chicken, and blueberries, respectively, to represent fish, land animals, birds, and plants/berries. The meal size characterisation was based on the serving size from the Canada Food Guide (0.5, 1, 1.5, 2, 2.5, 3 servings for meat), (1 teaspoon (0.04 servings), 1 tablespoon (0.12 servings), ¼ (0.5 servings), ½ (1 servings), 3/4 (1.5 servings), 1 cup (2 servings) for berries). This visual approach was based on work done previously on digital images tailored to different types and formats of food to improve the estimation of food intake [21].

Refinement of the FFQ

The research team, with the collaboration of local research coordinators, recruited adult volunteers (including males, females, Elders, and local harvesters) to participate in focus groups. Focus groups were hosted in three locations, based on previous partnerships and they happened to be held during the spring season (March to June). Recruitment of the volunteers for those three focus groups was done by a local coordinator who was able to translate if needed. The FFQ was designed and administered only in English. No validation process was completed due to logistical challenges.

These focus groups aimed to refine the list of foods and images included in the FFQ and ensure the questions were phrased clearly. Participants were asked open-ended questions on which land animals, fish, game birds and wild plants/berries they ate. The types of organs consumed were also documented. The researchers initially asked questions about favourite foods, most consumed foods, availability, seasonal variation of some foods, and preparation method. Based on an initial list of traditional foods presumably consumed in the region with local input of further foods added to the list, the proposed list of species, names,

Table 1. The final options selected to be in the refined FFQ for the types of foods, consumed organs and cooking method.

Class	Food	Organ	Cooking method
Fish	Whitefish	Head	Cooked
	Inconnu (Coney) [†]	Eggs	Fried
	Cisco (Herring) [†]	Fish-pipe (Oesophagus) [†]	Roasted/Baked
	Lake Trout	Other	Smoked [†]
	Loche (Burbot) [†]		Raw [†]
	Jackfish (Northern Pike) [†]		Boiled/Soup
	Grayling (Bluefish) [†]		Smoked/Fully dried [†]
	Walleye (pickerel) [†]		Smoked/Half dried [†]
	Red Sucker [†]		Campfire [‡]
	Other		Other
Land animal	Woodland Caribou	Ribs	Cooked
	Barrenland Caribou	Tongue	Fried
	Bison	Liver	Roasted/Baked
	Moose	Bone Marrow	Smoked [†]
	Elk	Stomach	Raw [†]
	White-tailed Deer	Heart	Boiled/Soup
	Rabbit	Fat (Fresh, dried or stored)	Smoked/Fully dried [†]
	Beaver	Kidney	Smoked/Half dried [†]
	Porcupine	Brain	Campfire [‡]
	Muskrat	Blood	Other
	Lynx	Bones in soup/Broth with bone [†]	
	Dall Sheep (Stone Sheep) [†]	Head	
	Bear	Other	
	Other		
Bird	Spruce Grouse (Spruce Hen) [†]	Gizzard	Cooked
	Sharp-Tailed Grouse (Prairie Chicken) [†]	Kidney	Fried
	Ptarmigan	Heart	Roasted/Baked
	Black Duck (Scoter) [†]	Fat	Smoked [†]
	Mallard	Liver	Raw [†]
	Wigeon (Whistling Duck) [†]	Eggs	Boiled/Soup
	Canada Goose	Other	Smoked/Fully dried [†]
	Snow Goose (Wavies) [†]		Smoked/Half dried [†]
	Fish Duck (Hooded, Merganser, Arctic Loon) [†]		Campfire [‡]
	Oldsquaw		Other
	Canvasback		
	Pintail		
	Swan		
	Other		
Plants	Low (Grey) blueberries [†]		Fresh
	High (Black) blueberries [†]		Frozen
	Bog cranberries		Bottled
	Gooseberries (Green) [†]		Jam [‡]
	Blackberries		Dried [‡]
	Wild raspberries		Other
	Wild strawberries		
	Cloud berries/Knuckleberries [†]		
	Saskatoon berries		
	Gooseberries (Purple)		
	Red currants		
	Black currants		
	Rosehips		
	Rat root		
	Labrador tea		
	Wild peppermint		
	Mushroom		
	Wild greens		
	Wild onion		
	Wild rhubarb		
	Spruce gum		
	High Bush Cranberries [‡]		
	Other		

[†]Modified option for food name or preparation detail.
[‡]New option for food.

organs and parts, water bodies, and preparation methods, was reviewed with the participants during a 3-h session. The session was audio-recorded and a local community research assistant as well as a local known researcher facilitated the discussion.

The survey included the same series of questions used in the FNFNES [17] and by the CINE, so the design could generate complementary data and be compared to those collected through other Indigenous exposure assessments. After making revisions to the FFQ questions according to focus group feedback, participants were invited to complete the FFQ.

Implementing the FFQ in the Mackenzie Valley Biomonitoring Project

Full details of participant recruitment for the project can be found in Ratelle et al. [16]. Recruitment was done during the winter season (November to March) and efforts were aimed for participants to represent the sex and age distribution of the combined population (i.e., children, young adults, Elders). Once at the clinic, a research team member explained the study and the participant was required to sign a consent form to participate in the project. Those who chose to complete all the components of the project could take up to 2 hours to participate. With the assistance of a local research coordinator if required, completing the FFQ typically required about 15–30 minutes, depending on the number of traditional foods reported as eaten over the prior year. For those who consumed many different types of traditional foods and were less familiar with electronic tablets, completing the FFQ on the iPad could take up to 1 h. Children completed the survey, assisted by their guardians if needed.

Results

Refinement of the FFQ

The FFQ was based on the work of previous research conducted in the NWT [12]. Individuals who agreed to take part in the focus groups assisted in the refinement of the list of foods, the photos used in the survey, the common names of traditional foods used in the region, and to make sure the questions were understandable and options appropriate. The FFQ refinement took place between March and July 2015. Overall, the individuals who participated in the refinement component included 36 adult participants (44% from the Dehcho region; 56% from the Sahtú region). Focus groups involved between 8 and 20 participants in each session.

The focus groups confirmed that the FFQ iPad interface was user-friendly and the level of language was appropriate. Focus group participants verified the options listed, the names of the foods, the types of organs included, and the cooking/preparation methods. The open-ended questions in the FFQ allowed participants to identify any information that they wanted to add. Overall, the main comments were related to the availability of foods in the region not previously mentioned, local common names used, methods of preparation and additional parts/organs potentially consumed. The modifications or additions were made to the food choices, organs, or cooking methods. The final options are found in Table 1 and the aggregate results from the focus groups are found in Table 2.

For the findings from the focus group data in Table 2, food consumption was grouped for the fish, land animal and bird categories by preparation type (cooked; smoked), and by type of fish in the food chain (predatory, non-predatory), potentially having an impact on the dose reconstruction of mercury exposure as predatory fish generally have mercury levels that are higher than those in non–predatory fish [22]. Cooked fish tended to be more frequently consumed than smoked fish and the meats from wild game were more frequently consumed than fish and game birds. A total of 56% of the participants reported eating moose kidney in the last year.

Then, all the comments and supplementary questions were integrated into the final electronic version of the refined survey, ready to be implemented in the project. Further questions related to portion size and seasonality of fish consumption were added in the second sampling year of the project. As such, results from the portion size and seasonality of fish consumption were based on responses from participants of 8 of 9 communities that took part in the project.

Table 2. Frequency of consumption of the categories of food from the FFQ focus groups (n = 36).

		Consumption (%)	Mean[‡] [§] (frequency/ week)
Fish	All fish (cooked)	89	3.6
	All fish (smoked/dried)	83	2.9
	Predatory fish[†]	78	2.7
	Non-predatory fish	89	4.0
Land animals	All meat (cooked)	97	4.1
	All meat (smoked/dried)	92	3.2
	Moose kidney	56	0.9
Birds	All bird (cooked)	92	2.9
	All bird – (smoked/ dried)	75	1.7
Plants	All berries	44	1.3
	All others plants	8	1.0

[†]Lake Trout, Loche (Burbot), Jackfish (Northern Pike), Walleye (pickerel). [‡] Consumers Only. [§] Based on the sum of the species consumed in average per week over the year.

Results from the main project

Study participants

A total of 44% (n = 237) of all the participants from the larger project completed the refined FFQ. Of these participants, 65% were from the Dehcho and 35% were from the Sahtú. Table 3 reports the characteristics of participants. Of these participants, 17.8% were minors (6–17 years). The recruitment rate corresponds to

Table 3. Characterisation of participants during the implementation of the refined FFQ (n = 237).

Parameters	Values	Categories
Age	Range	6 to 79 years old
	Mean	41.6 years old
	Refusal	3.8%
Sex	Males	48.5%
	Females	51.5%
	Refusal	0.0%
Categories	Children 6–13	23 (9.7%)
	Female 14–18	12 (5.1%)
	Male 14–18	7 (3.0%)
	Female 19–50	54 (22.8%)
	Male 19–50	50 (21.1%)
	Female 51+	38 (16.0%)
	Male 51+	44 (18.6%)
	Unknown	9 (3.8%)

8.0% of the participating communities' residents. Overall, participants included children, adults, and Elders of both sexes. As such, the results detailed in this report provide a reasonable snapshot of traditional food patterns in these communities.

Frequency of food consumption

The traditional locally harvested foods consumed by the most participants (and the percent of participants who reported eating each of those foods) are reported in Table 4. Moose (94%), whitefish (87%), and lake trout (62%) were consumed by the largest number of participants. Canada goose (57%) was the most commonly consumed game bird while the most commonly consumed berries were wild raspberries (42%). All other animals and fish mentioned in the survey were consumed. In addition, participants reported eating: tu fish, Arctic char, chinook salmon, pink salmon, cod, halibut, duck salmon, Pacific salmon, muskox, sandhill crane, ruffed grouse, crowberries, salmonberries, frog berries, knuckle berries and partridgeberries. Overall, 59% of the respondents reporting consuming organs and/or other parts of at least one land animal. Traditional foods often used for medicines were consumed by 31% of participants for more than once a week on average over the past year (i.e., Labrador tea, rat root, spruce gum). Consumption frequencies of the most eaten traditional foods slightly differed between males and females.

The average frequency of consumption for each food group according to Canada's Food Guide age and sex group categories is found in Table 5. Land animals were consumed more often (5.2 times/week) than fish (4.9 times/week), followed by berries (4.1 times/week) and game birds (4.0 times/week). The frequency of traditional food consumption varied according to the age and sex group categories. Older males and females reported consuming fish more frequently, while younger males reported eating land animals and game birds more frequently. Males reported a higher consumption of any food groups per age categories, except for male teenagers (14–18 y.o.). The frequency of consumption of fish and game birds was very similar for children (6–13 y.o.) and females (19–50 y.o.). In contrast, females (19–50 y.o.) reported consuming game meats (land animals and birds) substantially less often than other age/sex categories.

The frequency of fish consumption was calculated using two methods: 1) the sum of the species

Table 4. Frequency and consumption of the foods consumed by the most participants.†

Traditional food consumed		Latin name‡	Percent consuming (%) Total	Male	Female	Average Frequency (cooked) (days/week)
1	Moose	*Alces alces*	94	90	97	1.9
2	Whitefish	*Coregonus sp.*	87	87	88	1.5
3	Lake Trout	*Salvelinus namaycush*	62	60	64	1.2
4	Canada Goose	*Branta canadensis*	57	61	54	1.1
5	Rabbit	*Sylvilagus sp./Lepus sp.*	57	52	61	1.2
6	Woodland Caribou	*Rangifer tarandus*	56	62	50	1.7
9	Mallard	*Anas platyrhynchos*	44	51	38	1.1
7	Northern Pike	*Esox lucius*	44	48	40	1.1
8	Wild Raspberries	*Rubus sp.*	42	42	42	1.1
10	Beaver	*Castor canadensis*	37	41	34	0.9
11	Walleye	*Sander vitreus*	34	40	28	1.1
12	Low Grey Blueberries	*Vaccinium sp.*	33	38	29	1.1
13	Wild Strawberries	*Fragaria sp.*	32	37	29	1.3
14	Black Duck	(uncertain)	29	31	27	0.9
15	Inconnu	*Stenodus leucichthys*	29	38	20	1.1
16	Spruce Grouse	*Falcipennis canadensis*	28	37	20	1.0
17	Ptarmigan	*Lagopus sp.*	25	32	19	0.8

†For at least 25% of the participants that reported eating that food item.
‡Working Group on General Status of NWT Species. 2006. NWT Species 2006–2010 – General. Status Ranks of Wild Species in the Northwest Territories, Department of Environment and Natural Resources, Government of the Northwest Territories, Yellowknife, NT. III pp. http://www.nwtspeciesatrisk.ca/sites/default/files/nwt_species2006.pdf

Table 5. Average meal size, size standard deviation and frequency of food group consumption according to age and sex categories.

	Fish			Land animals		Large Game Organs[‖]		Birds		Berries	
Category[§]	Size (g) (SD)	F[†]	F[‡]	Size (g) (SD)	F[‡]	Size (g) (SD)	F[‡]	Size (g) (SD)	F[‡]	Size (ml) (SD)	F[‡]
Children, 6–13	124 (56)	1.2	3.3	148 (52)	4.4	105 (56)	5.9	131 (63)	3.7	143 (88)	7.2
Females, 14–18	97 (25)	1.1	3.7	143 (53)	4.8	NA	NA	122 (39)	4.1	172 (89)	4.1
Males, 14–18	125 (39)	0.8	2.7	156 (44)	1.7	NA	NA	138 (43)	2.8	NA	NA
Females, 19–50	129 (46)	1.2	4.1	149 (54)	5.1	121 (54)	7.4	130 (45)	3.8	157 (92)	2.9
Males, 19–50	129 (47)	1.3	5.8	141 (50)	5.7	95 (54)	9.2	137 (49)	4.8	131 (90)	3.9
Females, 51+	122 (42)	1.6	4.6	141 (49)	5.0	84 (29)	8.1	139 (51)	3.0	171 (86)	3.9
Males, 51+	134 (53)	1.6	6.6	136 (47)	5.4	97 (46)	9.1	147 (50)	4.2	152 (87)	4.4
TOTAL	**125 (48)**	**1.3**	**4.9**	**143 (50)**	**5.2**	**100 (48)**	**8.4**	**136 (49)**	**4.0**	**155 (88)**	**4.1**

[†]Frequency per week; based on reported frequencies for all wild-harvested fish (according to bimonthly frequencies).
[‡]Frequency per week; based on the sum of frequencies for each animal species.
[§]These categories are from the Canada Food Guide for the general population [42].
‖ The organs of interest for contaminant assessment include kidney and liver, from Woodland caribou, Barrenland caribou, bison, moose, elk and bear.
NA. Not applicable. No participant within the group reported having berries. Only one participant within the group reported having organs and birds.

consumed over the year, and; 2) the average bimonthly consumption of all fish. This last method was asked uniquely for fish, as these species potentially represent the main exposure source(s) for mercury (which was retrospectively assessed by season using hair segments). Notably, these two approaches showed strikingly different results, with higher frequencies when summing the annual consumption of fish species. When FFQ results for cooked and smoked/dried fish were summed, the overall average fish consumption across all participants was 4.9 times a week over the past year. In contrast, FFQ participants reported the average bimonthly consumption of all fish to range between 1.1 times a week (November–December) to 1.7 times a week (July–August). When weighted over the year, the average overall fish consumption of participants was 1.3 times a week (Table 5). This difference in consumption frequencies between these approaches was observed for each age/sex category. Based on community feedback, adding frequencies across species and preparation method may overestimate absolute intake. However, the extent to which the summed frequencies overestimate intake may differ among age/sex groups. For example, among children (6–13 y.o.), overall fish consumption (via the sum of species-specific frequencies) was 2-fold higher than according to seasonal consumption rates. In contrast, among males (19–50 y.o.), overall fish consumption (via sum of species-specific frequencies) was nearly 5-fold higher than according to seasonal consumption rates.

The average frequency of fish consumption differed significantly among seasons. For example, fish consumption was lowest in November/December with 82% of the respondents consuming fish an average of 1.1 times/week. This was followed by January/February (88%, 1.1 times/week), March/April (86%, 1.2 times/week), September/October (87%, 1.5 times/week), and May/June (89%, 1.5 times/week). Fish consumption was reported to be highest in July/August with 94% of respondents eating fish an average of 1.7 times a week.

There were differences between the Sahtú and Dehcho regions in terms of the most consumed species, and also the parts and organs consumed (Table 6). This finding was expected as the consumption of these foods is dependent on availability and there are 700 km between the centres of these regions. Thus, availability of species may vary across regions. Access to these foods was also shown to be dependent on several factors, such as resources management (e.g., quota limits, permits required to harvest), household network (e.g., harvester and traditional food support) and economical context (e.g., modern economy, full-time job, financial component of going on the land) [23–25], which can have an impact on food insecurity.

Preparation methods

A range of preparation methods were documented (cooked, pan fried/deep fried, grilled/roasted/baked, smoked, raw, boiled/soup/stew, smoked/fully dried, smoked/half dried, campfire). While smoked/dried fish was consumed approximately one-third as often as cooked fish, smoked/dried fish was still consumed by over half of the respondents (55%). Similar patterns were also observed for other traditional food categories. For example, as shown in Tables 4 and 5, the average consumption frequency of cooked moose was 1.3-fold higher than reported for smoked/dried moose (which is commonly referred to as dry meat in communities). Seven foods were consumed smoked by at least 10% of the participants: moose, whitefish. woodland caribou, lake trout, barrenland caribou, inconnu and northern pike. Further, at least half of participants that ate the following species reported eating them as smoked/dried: moose, whitefish, woodland caribou, barrenland caribou and sucker (Table 7).

Table 6. Consumption of animals and parts for which at least 50% of the adult respondents report a consumption of the cooked food.

		Dehcho		Sahtú	
		(n = 125)		(n = 83)	
		Consumers (%)	Frequency per week	Consumers (%)	Frequency per week
Fish					
Whitefish	Meat: Cooked	94	1.7	85	1.6
	Head	13	0.9	24	0.7
	Eggs	34	1.1	33	1.1
	Fish-pipe	38	1	34	1.2
Lake Trout	Meat: Cooked	58	1	63	1.3
	Head	10	1.2	23	1.4
	Eggs	6	1.4	10	1.4
	Fish-pipe	9	1.4	20	1.1
Northern Pike	Meat: Cooked	60	1.3	41	1.2
(Jackfish)	Head	4	0.7	5	0.7
	Eggs	11	0.9	11	0.9
	Fish-pipe	15	0.8	12	0.8
Walleye	Meat: Cooked	51	1.2	21	1.1
(Pickerel)	Head	2	1	2	0.5
	Eggs	2	1.2	1	0.5
	Fish-pipe	5	1.2	2	1
Land animals					
Woodland Caribou	Meat: Cooked	47	1.2	66	1.9
	Ribs	20	1.2	36	1.4
	Head	11	1.1	20	1.1
	Heart	17	0.9	31	0.8
	Tongue	16	0.9	31	1
	Liver	15	0.9	17	0.7
	Blood	3	0.8	9	0.9
	Stomach	7	0.9	12	1
	Kidney	14	0.9	22	0.8
	Bone Marrow	17	1	25	1
	Bones in soup	12	0.9	25	1.2
	Fat	12	0.9	23	0.9
	Brain	2	0.8	6	0.6
Moose	Meat: Cooked	94	2	91	1.8
	Ribs	53	1.4	49	1.4
	Head	30	0.8	27	0.9
	Tongue	42	1	37	1.2
	Heart	34	0.8	35	1
	Liver	30	0.8	23	0.8
	Kidney	38	0.9	28	0.7
	Blood	7	0.5	10	0.9
	Bone Marrow	48	1	36	1.1
	Bones in soup	31	1.2	34	1.4
	Fat	38	1.2	32	1.1
	Brain	2	0.8	4	0.5
Rabbit	Meat: Cooked	66	1.3	58	1.2
	Head	17	1.3	15	0.7
	Liver	13	1	12	0.7
	Blood	3	0.8	5	0.7
	Brain	14	1.5	11	0.9
Birds					
Mallard	Meat: Cooked	52	1.2	40	1
	Gizzard	12	0.8	7	1.1
	Kidney	7	0.8	4	0.9
	Heart	11	1	9	1.4
	Liver	9	0.8	5	0.8
	Eggs	6	0.8	3	0.8
Canada Goose	Meat: Cooked	57	1.1	63	1
	Gizzard	17	0.8	15	0.8
	Kidney	11	0.8	11	0.7
	Heart	17	0.8	17	0.9
	Liver	12	0.8	9	0.9
	Fat	13	0.8	15	0.8
	Eggs	5	0.8	3	1

The most commonly consumed land animal and game bird foods and their preparation/cooking methods were: moose meat boiled/soup/stew (74%), cooked moose meat (72%), smoked moose meat (59%), rabbit meat boiled/soup/stew (52%), Canada goose boiled/soup/stew (51%), moose meat cooked over the

Table 7. Foods most commonly eaten as dried/smoked.

	Food†	Percent consuming smoked – on all FFQ participants (%)	Percent consuming smoked – by consumers of the food (%)	Average frequency by consumers (days/ week)
1	Moose	55	59	1.5
2	Whitefish	45	52	1.2
3	Woodland Caribou	30	54	1.3
4	Lake Trout	20	33	1.1
5	Barrenland Caribou	11	60	0.7
6	Inconnu	10	35	1.0
7	Northern Pike	11	25	1.4
8	Sucker	8	50	0.8
9	Canada Goose	8	15	1.1
10	Bison	7	34	0.8
11	Grayling	5	25	0.8
12	Beaver	5	14	1.0
13	Swan	4	20	0.8
14	Walleye	4	13	0.7
15	Snow Goose	3	16	0.5
16	Cisco	2	33	0.9
17	Black Duck	2	6	1.6
18	Wigeon	0.8	13	0.5
19	Elk	0.8	25	0.5
20	Pintail	0.8	7	0.5
21	Canvasback	0.4	8	0.5
22	Muskrat	0.4	7	0.5

†For at least 5% of the participants that reported eating that food item (either smoked/dried or otherwise).

campfire (49%), and pan fried/deep fried moose meat (49%). Berries and plants were reported to be eaten fresh, frozen, bottled, dried, and as jam. However, berries were mainly consumed fresh while some other plants (e.g., rat root) were consumed fresh or dried.

Meal size and servings

The meal size for each traditional locally harvested food group is found in Table 5. For fish, land animals and game birds, the meal size was on average 125 to 143 g, and an intake of berries was 155 ml. In contrast, the average meal size for wild game organs (100 g) was somewhat lower. However, the standard deviations showed a wide range of reported meal size within the same category. For the categories of the participants reporting consumption of these foods, females tended to eat smaller meal sizes for fish (for 14 + y.o.) and birds (for 14 + y.o.), but larger sizes for berries (adults only), meat (adults only) and wild game organs (14–50 y.o.) than males.

Comparison between focus groups and the whole project

The food consumption for adults from the focus groups (n = 36) and the main project (n = 191) shows similarities. Whitefish was the most consumed fish (92% and 90%) with a frequency of 1.5 and 1.6 times a week. Canada goose was the most consumed bird (81% and 60%) with a frequency of 1.0 times a week for both groups. The most consumed land animal, moose (89% and 94%) was also similarly consumed with a frequency of 2.1 and 2.0 times a week. For animals less frequently consumed (e.g., less than 50% of participants), the number of consumers was similarly constant (e.g. beaver: 42% and 38%; snow goose: 22% and 22%, porcupine: 3% and 6%, respectively). When adults consumption rates were summed within the four categories, consumption of fish, land animals, birds and berries were similar or higher among focus group participants. In contrast, the consumption frequencies of land animals, birds and berries were lower among focus group participants. The focus group's FFQ did not include questions about seasonal variability of fish consumption.

Discussion

The refinement of the FFQ was beneficial by adding common food names relevant for participants and adapting the preparation methods to local practices. However, we did not validate the questionnaire as the validation of questionnaires usually involves a larger sample size [26–29] which is a challenge for small and remote communities.

Traditional food consumption

In these nine communities, we observed a high consumption of traditional foods, with several meals a week prepared with traditional locally harvested foods. Unsurprisingly, children (6–13 y.o.) and adult females (19–50 y.o.) eat similar meal sizes and have similar consumption frequencies. Perhaps that reflects the traditional role of women in making decisions about meals in the household, and serving meals to children.

November and December were on average the months associated with the least frequent fish consumption. These seasonal differences are driven, in part, by the safety of the ice during freeze-up. In addition, harvesters reported focusing their efforts on other traditional foods (e.g., moose) during these times of year. Overall, moose and whitefish were the most frequently consumed traditional locally harvested foods in this project.

The findings from the refinement and the implemented FFQs show that both the consumers' responses and frequency were similar for the foods listed in both FFQs. This comparison is especially interesting in that the focus groups completed the FFQ in spring season, while the main project was implemented in winter season. These findings indicate that this refined FFQ used to document food consumption over a one-year period appears to provide consistent results over the year.

Traditional food continues to be an important source of energy and nutrient intake in the diets of First Nations and Métis, with animal and fish species being the main species consumed [30]. Traditional food is also important for food security in remote Indigenous communities [31,32]. Due to expensive fresh food in remote communities, food insecurity greatly affects northern Indigenous populations [32]. Food insecurity has been associated with lower levels of vitamins, such as vitamins A, B1, B2, B6, B12, and D [31,33], but there are important nutritional benefits of traditional foods as they are major sources of vitamins B6, B12 and D for Indigenous people in Canada [34].

Impacts on contaminant intake assessment

As part of the larger project, we are documenting associations between contaminant biomarkers (e.g., hair mercury; blood cadmium), and participant responses from the FFQ. In addition, the FFQ findings are being linked with results from environmental monitoring studies describing, for example, fish mercury levels, to estimate the main sources of exposure. As such, the FFQ consumption findings will inform human health risk assessments for the contaminants studied through the larger project. For example, the FFQ data reported herein will support contaminant intake estimates. As we investigate the roles of traditional foods in contaminant exposure, mercury intake will be reconstructed via predatory fish consumption (meal size and frequency) and cadmium intake will be reconstructed via moose and caribou kidney and liver consumption (meal size and frequency). For example, several participants eating moose kidneys will play a major role in the assessment as moose organs (kidney and liver) can present high levels of cadmium [35]; this information will assist future dose reconstructions for cadmium and the interpretation of environmental monitoring data.

Despite a general decent relative reliability of food consumption estimates from FFQs, the absolute reliability is a challenge [36,37]. Overestimates in consumption frequency are common, especially for foods perceived as healthy or socially desirable [38], and this bias may increase with the length of the food list [1]. While the over estimation of healthy foods might affect both the individual frequency and the sum of frequencies of each food, the over estimation caused by a long list of foods will mainly affect the aggregate frequencies of foods, and it seems to be the current case in this project for fish species.

These findings are relevant to the design of dose reconstruction models for mercury from fish harvested in the NWT. Specifically, adding additional, infrequently consumed fish species to such models may present diminishing returns to model validity, stability, and frequency may need to be adjusted to a shorter period of time. Finally, the relatively long recall period employed in this FFQ (i.e., over the previous year) may challenge the use of this dataset to non-persistent chemicals. These issues highlight the added value offered by the human biomonitoring results for understanding contaminant exposures from traditional foods.

Understanding current traditional food consumption practices is important to the crafting of guidance to promote traditional foods. For example, consumption notices that suggest people limit their consumption of large northern pike from specific lakes in the NWT often note whitefish to be a safe alternative known to be low in mercury [13]. Knowing that whitefish is among the most commonly consumed traditional foods in Dene/Métis communities of the Northwest Territories reinforces the relevance of this message. Moreover, since each participating community received their own community-level FFQ data, we hope that these results assist local Indigenous governments in responding to emerging environmental monitoring issues.

This work provided insights on how to improve future dietary surveys supporting contaminant risk assessment among Indigenous populations. For example, the seasonal fish consumption data will likely provide useful data for modelling mercury intake from fish consumption, as fish consumption is the main diet determinant of mercury exposure [39,40]. Seasonal consumption data for other traditional food categories (e.g., land animals, game birds) may prove similarly useful.

FFQ continuous improvement

Further, some participants of the project suggested that the FFQ be stream-lined to allow individuals to provide this information more quickly and easily, avoiding repetition of similar questions, for example, by joining together the cooking methods of all land animal organs. At the time of the project implementation, completing the FFQ could take up to an hour for some participants (depending, for example, on how many traditional foods had been consumed). Interestingly, although the length of time focus group participants needed to complete the FFQ was similar to that in the larger biomonitoring project, this comment had not been previously mentioned during the refinement of the survey. Therefore, it is possible that this issue was compounded by the addition of other components (e.g., biological sampling, 24-h recall, the Health Messages Survey). In addition, one of the local coordinators that assisted participants with the survey mentioned that some community members (e.g., Elders) are less familiar with western concepts of metrics, potentially introducing systematic errors in the structure of the self-reported FFQ data.

Imprecision within frequency estimates may compound FFQ results reported on a one-year basis (e.g., "less than once a week" could mean once a year to 51 times a year). To improve the design of the survey for contaminant risk assessment, future food consumption surveys should allow for more precise documentation of infrequent intakes of particular foods. Accordingly, the frequency categories will be expanded (e.g. once a year, once a month, etc.). To verify the impact of the re-coded values for the smallest frequency category, we re-coded values for "less than once a week" to 0.2, 0.1 and 0.01 times a week. We then assessed the extent to which the choice for this re-coded value affected average fish intakes using the two methods mentioned above (i.e., the average of the sum of all fish species frequencies versus the average bimonthly frequency of all fish). The pattern described above (i.e., greater frequencies when calculated according to the sum of species frequencies) held true regardless of re-coded value. For example, when "less than 1 time per week" was, re-coded as 0.01 times a week, the sum of all fish species consumed remained approximately 3-fold higher than when calculated from the bimonthly consumption rates. In other words, even if we consider that the category *less than once a week* corresponds to approximately once a year, the sum of all fish represents over three times the sum of the seasonal fish consumption. Therefore, assessing the associations between contaminant biomarkers and traditional food consumption should likely rely on the consumption data for individual food items (i.e., rather than using summed frequencies within traditional food categories).

While the report of the food frequency consumed 1 year ago might be difficult to recall, the FFQ can be a good relative indicator of trends for traditional food consumption (e.g., participants were more likely to report eating whitefish than northern pike). In terms of identifying foods consumed, the recall will still have some accuracy. First, several foods mentioned in the FFQ are seasonally dependent (e.g. blueberries, Canada goose), which facilitates the recall to be asked for the past 12 months. Second, the organ meats are not consumed frequently (e.g., a moose can provide several meals of meat, but there is only one heart). In addition, the FFQ was meant to investigate exposures of very persistent chemicals. Short recall periods (e.g., from the past week) would be irrelevant to the investigation of persistent contaminants. As such, this survey may lead to an over estimation of traditional food consumption, but the impact on the one-year recall challenge is uncertain. The survey was not validated by re-testing the same group of participants. However, it is worth noting that Kirkpatrick et al. [41] suggested that "inferences should be nuanced, recognizing that constructs such as validity and reliability operate on continuums from low to high, and degrees in between maybe appropriate depending on the research objective." The main purpose of the larger project is to assess contaminant exposure. As it is usually the case for biomonitoring surveys, our project has the aim to look at the population distribution. As such, we aim to assess the intake mainly of a group, and not at the individual level. Producing data comparable to other populations (e.g., FNFNES) is definitely a strength of the project.

Next steps of the study

Work done in these same Dene communities in the 1990 s, using a similar survey [12] will be part of a future comparison of traditional food consumption from this study and temporal changes over a 25-year period. In a climate change context, and a period of dietary transition for First Nations and Métis, promoting traditional food consumption can provide several health benefits including increased consumption of low-fat foods, intake of healthy fatty acids through fish consumption, and physical outdoor activities on the land [31–33].

Overall, this project: 1) provides updated guidance on the refinement, implementation, and utilisation of FFQs for characterising traditional food consumption in Indigenous populations, and; 2) reports current traditional food consumption rates (as of 2017–2018) in Dene/Métis communities of the NWT. These results will support the exposure assessment of contaminants through traditional food consumption and will provide knowledge to promote traditional foods while limiting food associated with elevated environmental contaminants.

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