## ABSTRACT

*Objectives:* As part of a larger study of polychlorinated dibenzodioxin (PCDD) and dibenzofuran (PCDF) pollution, to describe and compare Aboriginal and non-Aboriginal residents' recalled diets.
*Methods:* We surveyed a stratified random sample aged 25 to 64 years: forest products mill employees (n=84), Aboriginal reserve residents (n=78), and other residents (n=80). We administered a questionnaire on intake of fish/seafood, wild game and plants, domesticated animal meat and eggs, dairy products, vegetable oils and cereals; age, gender, childbearing, lactation, residence and smoking. We measured height and weight.
*Results:* Reserve residents ate less seafood, but more fish roe, eulachon grease, smoked salmon, clams and sea urchins, more deer organs, hamburger meat, pork, fried chicken, and hotdogs, but less rabbit, beef steaks/roasts, high-fibre cereals, potato chips, bread, cheese and milk.
*Conclusions:* We cannot yet quantify PCDD and PCDF intakes. The wild food consumption data are unique and may be useful for risk assessments in the target population and similar communities.

## ABRÉGÉ

*Objectifs :* Dans le cadre d'une étude plus générale de la pollution par les dibenzodioxines polychlorées (PCDD) et les dibenzofurannes polychlorés (PCDF), décrire et comparer les régimes alimentaires que se rappellent avoir consommés tant les autochtones que les non autochtones.
*Méthodes :* Nous avons interrogé un échantillon aléatoire stratifié de personnes âgées de 25 à 64 ans : des employés des usines de produits de la forêt (N = 84), des résidents autochtones vivant dans les réserves (n = 78), ainsi que d'autres résidents (n = 80). Nous leur avons demandé de répondre à un questionnaire sur leur consommation de poisson/produits de la mer, gibier et plantes, viande provenant d'animaux d'élevage et oeufs, produits laitiers, huiles végétales et céréales; leur âge, leur sexe, s'ils ont eu des enfants, si les femmes ont allaité, leur lieu de résidence et s'ils fument. Nous avons mesuré le poids et la taille des individus.
*Résultats :* Les résidents des réserves consomment moins de produits de la mer mais davantage d'oeufs de poisson, de graisse d'eulakane, de saumon fumé, de grosses palourdes et d'oursins, d'organes de cerf, de viande hâchée, de porc, de poulet frit et de hotdogs, mais moins de lapin, de rôtis/steaks de boeuf, de céréales à haute teneur en fibres, de croustilles de pomme de terre, de pain, de fromage et de lait.
*Conclusions :* Il n'est pas encore possible de quantifier l'ingestion de PCDD et de PCDF. Les données relatives à la consommation d'aliments non industriels sont uniques en leur genre et peuvent être utiles pour évaluer les risques dans la population ciblée ainsi que dans des communautés similaires.


# Diet Survey of Two Cultural Groups in a Coastal British Columbia Community


*Andrew Jin, MD, MHSc, Kay Teschke, PhD, CIH, Stephen A. Marion, MD, FRCPC*


The purpose of this report is to describe and compare the recalled diets of Aboriginal and non-Aboriginal residents of a coastal British Columbia (BC) community, where concern existed about the potential for wild foods to be contaminated with the environmental pollutants polychlorinated dibenzo-*para*-dioxins (PCDDs or dioxins) and polychlorinated dibenzofurans (PCDFs).

In BC, industries which may contribute to human exposure to PCDDs and PCDFs include the production of chlorine-bleached pulp and paper, antifungal wood preservation with chlorophenols, agricultural/silvicultural pesticide application, electrical utilities' use of polychlorinated biphenyls (PCBs) and waste incineration. PCDDs and PCDFs are persistent in the environment.[1,2] They accumulate in the fatty tissues of plants and animals and magnify as they pass up the food chain to humans. Tissues rich in lipids or from organisms higher up in the food chain, particularly fish and marine mammals, are thus the food items with the greatest propensity for PCDD and PCDF contamination. Human exposure[1-4] to PCDDs and PCDFs also occurs from direct ingestion of polluted soil, dust or water, ingestion, inhalation or contact with contaminated dusts, fumes or liquids in the workplace, and possibly also from smoking and second-hand tobacco smoke.

We surveyed a Census Agglomeration on the ocean coast of BC, where residents had opportunities for exposure to a variety of PCDD and PCDF sources. The community's largest single employer is a large pulp, paper and lumber mill. The mill produces bleached kraft pulp and before 1990 it treated lumber with chlorophenols. Logging and silviculture have also occurred. The mill produces its own steam (much of it from the combustion of wood waste and waste-water sludge) and its own electricity (from both steam-driven and hydroelectric generators). The community has active local commercial, sport and Aboriginal fisheries, the latter by members of an Aboriginal band with a reserve in the Census Agglomeration.

Our diet survey was part of a larger study to document human exposure to PCDDs and PCDFs in the target community, to identify subgroups at higher risk for exposure and to quantify contributions from various risk factors and sources of PCDDs and PCDFs. The part conducted in 1995 consisted of a questionnaire survey of diet, occupation, and selected demographic and lifestyle factors in a stratified random sample of the community's population.

## METHODS

The target population was residents of the Census Agglomeration community aged 25 to 64 years as of January 1, 1995. To ensure sufficient representation of pulp, paper and lumber mill employees and Aboriginal persons, we used stratified random sampling, intentionally over-sampling


Department of Health Care and Epidemiology, Faculty of Medicine, University of British Columbia, Vancouver, BC
**Correspondence:** Dr. Andrew Jin, 2762-133 Street, Surrey, BC, V4P 1X9, Tel. & Fax: 604-531-1454, E-mail: ajin@unixg.ubc.ca


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the smaller strata. We randomly selected approximately equal numbers from each of three separate sampling frames: pulp, paper and lumber mill employees, accessed through a seniority list of all unionized production, maintenance and service workers currently employed by the mill; Aboriginal reserve residents, accessed through a list of names, birth dates and addresses of current members of the Aboriginal band; and other residents of the survey area, accessed through a list of names and addresses of persons eligible to vote in the 1991 provincial election (within this list, persons were grouped by gender and 5-year age categories).

Persons selected from the voter list who were no longer residents of the Census Agglomeration or who were current employees of the mill were excluded as ineligible, and replaced with others randomly selected in supplemental draws. Aboriginal persons selected from the voter list were retained in the "other residents of the survey area" sample, provided that they were not residents of the reserve. If any person selected from the Aboriginal band membership list had been a current employee of the mill, he or she would have been retained in the "Aboriginal reserve resident" sample, but this possibility never occurred.

We mailed each randomly selected person an introductory letter and then contacted individuals by telephone or in person. Methods received prior ethical review and approval from the University of British Columbia Behavioural Sciences Screening Committee for Research and Other Studies Involving Human Subjects.

We assessed diet retrospectively using a list-based food frequency questionnaire adapted from the US National Cancer Institute's Health Habits and History Questionnaire (HHHQ).[5,6] We borrowed items about domesticated animal meat and eggs, dairy products, vegetable oil products and cereals. We added items about foods of local importance: fish and other sea foods, wild game meat and eggs, and wild plants. These we identified from lists prepared by Health Canada nutritionists and health workers from the community's Aboriginal band. For each specified food, we asked respondents to recall frequency of consumption and usual portion size during the year 1980, about the midpoint of the accumulation period for the chemicals of interest. The most toxic of the PCDDs, 2,3,7,8-tetrachlorodibenzo-p-dioxin, has an elimination half-life in humans of 5 to 8 years[3,4] and would require 3 to 5 half-lives to reach a steady state in human tissues. Strategies for improving past dietary recall were developed based on literature information[7-11] and included open-ended questions about who cooked the subject's meals and typical daily diet during that year. We pretested the questionnaire in three groups: a convenience sample of 2 individuals to check the duration and feasibility of the interview, a convenience sample of 10 individuals during the interviewers' training, and 7 Aboriginal band members and 7 other community residents randomly selected from the target populations.

The questionnaire was administered in a face-to-face interview, in English, by one of three interviewers. Interviewers showed standard-sized vessels (a 400 mL bowl, a 400 mL plastic food saver container, a 20 mL plastic food saver lid, a 250 mL drinking glass and a 15 mL tablespoon) to help respondents estimate sizes of food servings. The researchers calculated each respondent's annual intake of each food item by multiplying the recalled frequency per year by the usual portion size. Interviewers measured the weights and heights of participants.

For purposes of this report, we tabulated diet survey data for two separate subpopulations within the community: Aboriginal reserve residents and non-reserve residents (i.e., mill employees and other community residents combined). For the combined non-reserve group, any summary statistic (i.e., the sample size, a proportion, a mean or a standard deviation) was calculated as the weighted mean of the statistics for each of the two component strata, with weights inversely proportional to the sampling fractions. Table I shows the stratum weights and how they were calculated. We com-

**TABLE I**
**Survey Participation**

| | N | Female n | Female (%) | Age in Years mean | Age in Years (s.d.) |
|---|---|---|---|---|---|
| Pulp/paper/lumber Mill Employees | | | | | |
| Sampling frame, age 25-64 | 1131 | unknown | | unknown | |
| Randomly selected | 101 | 1 | (1.0%) | unknown | |
| Excluded (found ineligible) | 1 | 0 | | unknown | |
| Unable to contact/locate | 0 | 0 | | unknown | |
| Refusers | 16 | 0 | | unknown | |
| Participants | 84 | 1 | (1.2%) | 45.6 | (8.6) |
| Participation ratio* | 84.0% | | | | |
| Stratum weight† | 0.1178 | | | | |
| Aboriginal Reserve Residents | | | | | |
| Sampling frame, age 25-64 | 290 | 144 | (49.7%) | 39.2 | |
| Randomly selected | 100 | 49 | (49.0%) | unknown | |
| Excluded (found ineligible) | 1 | 0 | | unknown | |
| Unable to contact/locate | 6 | 4 | | unknown | |
| Refusers | 15 | 7 | | unknown | |
| Participants | 78 | 38 | (48.7%) | 40.9 | (10.0) |
| Participation ratio* | 78.8% | | | | |
| Stratum weight | 1.0000 | | | | |
| Other Residents of the Area‡ | | | | | |
| 1991 Census population, age 25-64 | 9895 | 4830 | (48.8%) | 43.5 | |
| Randomly selected¶ | 123 | 60 | (48.8%) | unknown | |
| Excluded (found ineligible)¶ | 22 | 9 | | unknown | |
| Unable to contact/locate | 0 | 0 | | unknown | |
| Refusers | 21 | 7 | | unknown | |
| Participants | 80 | 44 | (55.0%) | 45.8 | (10.6) |
| Participation ratio* | 79.2% | | | | |
| Stratum weight§ | 0.8822 | | | | |

* participants / (refusers + participants + unable to contact or locate)
† (mill frame)/(Census pop. - reserve frame)
‡ Census Agglomeration, comprised of District Municipality, surrounding Census Subdivision A and Aboriginal reserve lands
¶ not including an unrecorded number of persons randomly selected but then excluded because they were current mill employees
§ (Census pop. - mill frame - reserve frame)/(Census pop. - reserve frame)

**TABLE II**
**Personal and Demographic Characteristics of Survey Participants**

| Participants | N (%) | Non-reserve* 80.5(100.0%) | Reserve 78(100.0%) | p |
|---|---|---|---|---|
| Age, years | mean (s.d.) | 45.8 (10.4) | 40.9 (10.0) | 0.003§ |
| Age, years | min - max | 25.9 - 64.8 | 26.1 - 64.5 | |
| Female | N (%) | 39.2 (48.7%) | 38 (48.7%) | 0.995†† |
| Had child | N (% of females) | 29.4 (75.1%) | 35 (94.6%) | 0.018†† |
| Breastfed child | N (% of females with child) | 21.4 (72.8%) | 22 (62.9%) | 0.395†† |
| Height, inches | mean (s.d.) | 67.5 (3.9) | 65.6 (3.4) | 0.001§ |
| Height, inches | min - max | 60.0 - 77.0 | 58.0 - 76.0 | |
| Body Mass Index† | mean (s.d.) | 26.1 (4.7) | 27.3 (4.1) | 0.105§ |
| Body Mass Index† | min - max | 17.0 - 47.1 | 19.9 - 38.1 | |
| Cigarette Smoking | | | | |
| Ever | N (%) | 49.2 (61.9%) | 48 (61.5%) | 0.964†† |
| Now | N (%) | 17.9 (22.5%) | 6 (7.7%) | 0.010†† |
| Pack*years, 0 if never | mean (s.d.) | 10.6 (15.5) | 5.6 (11.0) | 0.022§ |
| Pack*years, 0 if never | min - max | 0.0 -88.0 | 0.0 - 77.0 | |
| Residence in Survey Area‡ | | | | |
| Now | N (%) | 80.3 (99.9%) | 78 (100.0%) | ‡‡ |
| Continuous years duration¶ | mean (s.d.) | 23.9 (11.4) | 30.4 (15.9) | 0.004§ |
| Continuous years duration¶ | min - max | 2.0 - 57.0 | 1.0 - 61.0 | |
| Ate fish in 1980 | N (%) | 77.2 (96.0%) | 68 (87.2%) | 0.045†† |
| Ate smoked fish in 1980 | N (%) | 57.3 (71.2%) | 63 (80.8%) | 0.161†† |
| Ate shellfish in 1980 | N (%) | 59.9 (74.5%) | 55 (70.5%) | 0.578†† |
| Ate other seafood in 1980 | N (%) | 13.2 (16.5%) | 8 (10.3%) | 0.252†† |
| Ate wild game in 1980 | N (%) | 36.8 (45.7%) | 59 (75.6%) | 0.000†† |
| Ate smoked wild game in 1980 | N (%) | 0.9 (1.1%) | 5 (6.4%) | ‡‡ |

* non-reserve = mill employees and other community residents combined, see Table I for stratum weights
N weighted mean number of responses
% (weighted mean number of responses) / (weighted mean sample size)
mean = weighted mean
s.d. = weighted standard deviation
† Body Mass Index = (weight in kg) / [(height in metres) x (height in metres)]
‡ Census Agglomeration, comprised of District Municipality, surrounding Census Subdivision A and Aboriginal reserve lands
¶ duration of most recent period of continuous residence (no interruptions of 6 months or longer)
§ t-test approximation of Wilcoxon rank-sum test, p (2-tailed) for Ho: no difference in medians (i.e., weighted mean ranks)
†† Chi-squared test for Ho: no association with reserve
‡‡ more than 20% of cells have less than 5 expected, chi-squared test may not be valid

pared weighted estimates for the non-reserve group with unweighted estimates for the reserve group. For dichotomous (1=yes, 0=no) variables, we used a chi-squared test of the null hypothesis of no association between group membership and a particular variable. For continuous interval-ratio variables we used a non-parametric t-test approximation of the Wilcoxon rank sum test[12] of the null hypothesis of no difference between the group medians for a particular variable (i.e., the t-statistic was based on the difference between the weighted mean rank score for the non-reserve group and the mean rank score for the reserve group).

Frequency tabulations, calculation of summary statistics and group comparisons were performed by the statistical software package SAS, Release 6.04 for Personal Computers (SAS Institute Inc., Cary, NC, USA).

## RESULTS

For each of the three sampling strata, Table I shows the size of the sampling frame, the numbers of randomly selected, excluded, participating and non-participating persons, and the calculated stratum weight and participation ratio. Table I also shows available data on the mean age and the gender composition of the sampling frame, the selected sample and the participants.

For participants in the Aboriginal reserve sample and for the combined non-reserve sample, Table II describes personal and demographic characteristics; Table III, recalled dietary intake of fish and other seafood; Table IV, wild game; Table V, other foods; and Table VI, diet stability over the past 15 years.

Although Table II indicates that, compared to participants from the non-reserve group, participating reserve residents were slightly *less* likely to include fish in their diet (87.2% versus 96.0%, p=0.045), and no more or less likely to include smoked fish, shellfish or other seafood in their diet, as shown in Table III we observed differences (p<0.05, 2-tailed) in the types of fish and other seafood consumed. Reserve residents ate more lingcod eggs, herring and herring eggs, eulachon grease, smoked salmon, butter clams, Japanese (Manila) clams, native clams and Mesikw sea urchins. They ate less trout, red snapper/rockfish, grey/black/Alaska cod, halibut, sole/flounder, unspecified other fish, Dungeness crab meat, shrimp and prawns.

Table II indicates that, compared to participants from the non-reserve group, participating Aboriginal reserve residents were more likely to include wild game in their diet (75.6% versus 45.7%, p<0.0005). As for specific types of wild game, as shown in Table IV, we observed the following differences (p<0.05, 2-tailed): reserve residents consumed less deer meat, more deer liver/organs and less rabbit meat.

As shown in Table V, for the various other foods we observed the following differences (p<0.05, 2-tailed): reserve residents ate more hamburger meat, pork chops/roasts, fried chicken and hot dogs. They ate less beef steaks/roasts, roasted/stewed/broiled chicken/turkey, high fibre cereals, potato chips, bread, cottage cheese, other cheese and 2% milk.

Table VI shows that over the past 15 years, reserve residents had more stable diet patterns than did non-reserve residents in every measured food category except wild game meat.

## DISCUSSION

Participants appeared similar to persons randomly selected and to persons in the target population in terms of age and gender. Although the mill employee sample is

**TABLE III**
**Recalled Dietary Intake of Fish, Smoked Fish, Shellfish and Other Seafood**

| Food Item†† | Units | Non-reserve* n† | Non-reserve* mean‡ | Non-reserve* (s.d.)¶ | Reserve n | Reserve mean | Reserve (s.d.) | p§ |
|---|---|---|---|---|---|---|---|---|
| Salmon | Litres per year | 80.5 | 8.323 | (11.863) | 78 | 14.979 | (28.531) | 0.319 |
| Trout | Number per year | 80.5 | 4.9 | (13.8) | 78 | 0.3 | (1.1) | 0.000 |
| Red snapper / rockfish | Litres per year | 80.5 | 2.674 | (5.378) | 78 | 2.561 | (7.941) | 0.024 |
| Cod (grey/black/Alaska) | Litres per year | 80.5 | 0.410 | (1.790) | 78 | 0.185 | (1.172) | 0.035 |
| Lingcod | Litres per year | 80.3 | 4.465 | (11.818) | 78 | 4.795 | (21.415) | 0.484 |
| Lingcod eggs (roe) | Litres per year | 80.5 | 0.000 | (0.000) | 78 | 0.073 | (0.258) | 0.002 |
| Tommy cod | Litres per year | 80.5 | 0.027 | (0.253) | 78 | 0.023 | (0.121) | 0.305 |
| Halibut | Litres per year | 80.5 | 0.919 | (2.808) | 78 | 0.552 | (2.634) | 0.029 |
| Sole / flounder | Litres per year | 80.5 | 0.585 | (1.665) | 78 | 0.067 | (0.471) | 0.000 |
| Herring | Number per year | 80.5 | 1.3 | (12.5) | 78 | 8.7 | (14.7) | 0.000 |
| Herring eggs (roe) | Litres per year | 80.5 | 0.003 | (0.026) | 78 | 1.422 | (3.144) | 0.000 |
| Smelt | Number per year | 80.5 | 0.3 | (1.9) | 78 | 0.3 | (1.8) | 0.786 |
| Perch | Number per year | 80.5 | 1.0 | (6.1) | 78 | 0.6 | (5.4) | 0.295 |
| Eulachon fish | Number per year | 80.5 | 0.6 | (6.5) | 78 | 0.2 | (1.4) | 0.357 |
| Eulachon grease | Litres per year | 80.5 | 0.001 | (0.009) | 78 | 0.013 | (0.039) | 0.000 |
| Other fish | Litres per year | 80.3 | 2.753 | (10.121) | 78 | 1.523 | (11.303) | 0.000 |
| Salmon (smoked) | Litres per year | 80.3 | 1.730 | (4.870) | 78 | 7.709 | (16.535) | 0.000 |
| Trout (smoked) | Number per year | 80.5 | 0.0 | (0.2) | 78 | 0.0 | (0.0) | 0.743 |
| Cod (grey/black/Alaska) (smoked) | Litres per year | 80.5 | 0.061 | (0.512) | 78 | 0.000 | (0.000) | 0.152 |
| Herring eggs (roe) (smoked) | Litres per year | 80.5 | 0.020 | (0.189) | 78 | 0.000 | (0.000) | 0.356 |
| Eulachon fish (smoked) | Number per year | 80.5 | 0.2 | (4.5) | 78 | 0.0 | (0.0) | 0.743 |
| Other fish (smoked) | Litres per year | 80.5 | 0.001 | (0.019) | 78 | 0.000 | (0.000) | 0.743 |
| Butter clams | Litres per year | 73.2 | 1.511 | (6.160) | 71 | 1.570 | (2.564) | 0.000 |
| Japanese (Manila) clams | Litres per year | 76.5 | 0.337 | (1.671) | 75 | 2.334 | (9.661) | 0.000 |
| Horse clams | Litres per year | 80.3 | 0.001 | (0.030) | 77 | 0.000 | (0.000) | 0.744 |
| Geoduck | Litres per year | 80.5 | 0.160 | (1.354) | 78 | 0.072 | (0.550) | 0.937 |
| Native clams | Litres per year | 77.5 | 0.672 | (4.562) | 77 | 1.814 | (9.568) | 0.001 |
| Dungeness crab meat | Litres per year | 80.5 | 1.265 | (8.787) | 78 | 1.201 | (9.455) | 0.009 |
| Dungeness crab marrow (hepatopancreas) | Number per year | 80.5 | 4.8 | (43.9) | 78 | 0.0 | (0.0) | 0.107 |
| Mussels | Number per year | 80.5 | 2.4 | (13.4) | 78 | 0.8 | (3.2) | 0.328 |
| Shrimp | Litres per year | 71.7 | 0.988 | (2.869) | 78 | 0.746 | (2.592) | 0.349 |
| Prawns | Number per year | 80.2 | 80.6 | (133.2) | 78 | 45.1 | (127.5) | 0.006 |
| Oysters | Number per year | 73.7 | 13.9 | (39.9) | 50 | 14.3 | (34.4) | 0.951 |
| Limpets | Number per year | 80.5 | 0.0 | (0.2) | 78 | 0.0 | (0.0) | 0.743 |
| Other shellfish | Litres per year | 79.5 | 0.637 | (4.560) | 78 | 0.872 | (6.542) | 0.640 |
| Sea urchins (Mesikw, red/large) | Number per year | 80.5 | 0.0 | (0.0) | 78 | 0.9 | (3.4) | 0.011 |
| Sea urchins (Ap'ten, green/small) | Number per year | 80.5 | 0.0 | (0.4) | 78 | 1.0 | (4.8) | 0.076 |
| Sea cucumbers | Number per year | 80.5 | 0.1 | (0.5) | 78 | 0.0 | (0.0) | 0.163 |
| Seaweed | Litres per year | 80.5 | 0.274 | (2.242) | 78 | 0.028 | (0.187) | 0.953 |
| Octopus / squid | Litres per year | 80.1 | 0.185 | (0.716) | 78 | 0.058 | (0.314) | 0.186 |
| Seal / sea lion meat | Litres per year | 80.5 | 0.009 | (0.155) | 78 | 0.000 | (0.000) | 0.236 |
| Seagull eggs | Number per year | 80.5 | 0.000 | (0.000) | 78 | 0.077 | (0.477) | 0.077 |
| Other seafood | Litres per year | 80.3 | 0.002 | (0.034) | 78 | 0.000 | (0.000) | 0.642 |

* mill employees and other community residents combined
† weighted mean number of responses
‡ weighted mean
¶ weighted standard deviation
§ t-test approximation of Wilcoxon rank-sum test, p (2-tailed) for Ho: no difference in medians (i.e., weighted mean ranks)
†† items not eaten by any respondent omitted: smoked red snapper/rockfish, smoked lingcod, smoked lingcod eggs, smoked tommy cod, smoked halibut, smoked sole/flounder, smoked herring, smoked smelt, smoked perch, smoked eulachon grease; sea prunes (chitons), seal/sea lion fat (blubber), seal/sea lion liver or other organs, seagull meat

predominantly male and the sample of "other residents" is mostly female (see Table I), the gender composition of the weighted aggregate non-reserve sample (48.7% female) is virtually identical to that of the Census population (48.8% female, see Table II). The participation ratios are high, so if volunteer biases did occur, the effect on survey results was probably small.

The National Cancer Institute HHHQ has been validated against multiple day diet records and nutritional biomarkers for a variety of demographic groups in the US, though not for American Indians or Alaskan Natives specifically.[13-18] For recall of diet 10-15 years in the past, when compared to previous multiple day diet records, the HHHQ can be expected to yield correlation coefficients of 0.28 to 0.63 for nutrient intakes.[10] As with other list-based food frequency questionnaires, correlations are higher among respondents who report fewer changes in diet.[7,10] In our study, reserve residents had more stable diets, so they likely recalled more accurately than did the other community residents. The usual effect of dietary recall inaccuracy is random error[7,10] so the only likely bias would be towards the null hypothesis. In our study, this would strengthen the argument that the observed dietary differences between groups are real.

Our survey respondents consumed a wide variety of fish/seafood types. Although we observed no overall increase in fish/seafood consumption among Aboriginal reserve residents (compared to other residents of the community), we did see differences in the types of fish and seafood eaten, and differing intakes of wild game and other foods. We are not yet able to quantify dietary exposure to persistent organochlorine pollutants. Of the fish/seafood consumed, we do not know how much was harvested locally. The ques-

**TABLE IV**
**Recalled Dietary Intake of Wild Game and Smoked Wild Game**

| Food Item†† | Units | Non-reserve* n† | Non-reserve* mean‡ | Non-reserve* (s.d.)¶ | Reserve n | Reserve mean | Reserve (s.d.) | p§ |
|---|---|---|---|---|---|---|---|---|
| Deer meat | Litres per year | 80.5 | 5.510 | (31.193) | 78 | 4.815 | (15.966) | 0.000 |
| Deer liver/organs | Litres per year | 80.5 | 0.143 | (0.624) | 78 | 0.834 | (4.769) | 0.018 |
| Elk meat | Litres per year | 80.5 | 0.122 | (0.924) | 78 | 0.556 | (3.319) | 0.867 |
| Elk liver/organs | Litres per year | 80.5 | 0.007 | (0.181) | 78 | 0.005 | (0.045) | 0.475 |
| Moose meat | Litres per year | 80.5 | 5.384 | (38.735) | 78 | 0.326 | (1.367) | 0.111 |
| Moose liver/organs | Litres per year | 80.5 | 0.075 | (0.559) | 78 | 0.021 | (0.181) | 0.263 |
| Bear meat | Litres per year | 80.5 | 0.353 | (2.441) | 78 | 0.569 | (4.727) | 0.643 |
| Mountain goat meat | Litres per year | 80.5 | 0.025 | (0.406) | 78 | 0.010 | (0.091) | 0.903 |
| Rabbit meat | Litres per year | 80.5 | 0.334 | (2.248) | 78 | 0.008 | (0.050) | 0.036 |
| Rabbit liver/organs | Number per year | 80.5 | 0.0 | (0.4) | 78 | 0.0 | (0.0) | 0.277 |
| Goose/duck meat | Litres per year | 80.5 | 0.071 | (0.294) | 78 | 0.049 | (0.214) | 0.952 |
| Goose/duck liver/organs | Number per year | 80.5 | 0.0 | (0.1) | 78 | 0.0 | (0.0) | 0.300 |
| Goose/duck eggs | Number per year | 80.5 | 0.1 | (3.9) | 78 | 0.0 | (0.0) | 0.743 |
| Grouse meat | Litres per year | 80.5 | 0.261 | (1.230) | 78 | 0.403 | (2.418) | 0.985 |
| Grouse liver/organs | Number per year | 80.5 | 0.0 | (0.0) | 78 | 0.0 | (0.0) | 0.743 |
| Other wild game | Litres per year | 80.5 | 0.024 | (0.155) | 78 | 0.000 | (0.000) | 0.092 |
| Deer meat, smoked | Litres per year | 80.5 | 0.000 | (0.000) | 78 | 0.082 | (0.556) | 0.077 |
| Elk meat, smoked | Litres per year | 80.5 | 0.000 | (0.000) | 78 | 0.001 | (0.011) | 0.311 |
| Moose meat, smoked | Litres per year | 80.5 | 0.002 | (0.021) | 78 | 0.010 | (0.091) | 0.913 |

* mill employees and other community residents combined
† weighted mean number of responses
‡ weighted mean
¶ weighted standard deviation
§ t-test approximation of Wilcoxon rank-sum test, p (2-tailed) for Ho: no difference in medians (i.e., weighted mean ranks)
†† items not eaten by any respondent omitted: bear organs, mountain goat liver/organs, beaver/porcupine meat/liver/organs, smoked deer/elk/moose liver/organs, smoked bear, mountain goat, rabbit, beaver, goose, duck, grouse, porcupine or other wild game meat/liver/organs, smoked goose/duck eggs

**TABLE V**
**Recalled Dietary Intake of Other Foods**

| Food Item | Units | Non-reserve* n† | Non-reserve* mean‡ | Non-reserve* (s.d.)¶ | Reserve n | Reserve mean | Reserve (s.d.) | p§ |
|---|---|---|---|---|---|---|---|---|
| Hamburger meat | Litres per year | 80.5 | 22.477 | (21.391) | 78 | 37.929 | (23.834) | 0.000 |
| Beef, steaks/roasts | Litres per year | 80.5 | 25.271 | (25.089) | 78 | 14.048 | (9.961) | 0.011 |
| Liver, chicken/beef | Litres per year | 80.5 | 2.820 | (5.738) | 78 | 4.422 | (6.967) | 0.747 |
| Pork, chops/roasts | Litres per year | 80.5 | 13.868 | (12.673) | 78 | 17.443 | (13.310) | 0.018 |
| Chicken, fried | Litres per year | 80.3 | 8.190 | (11.179) | 78 | 10.813 | (9.745) | 0.016 |
| Chicken/turkey, roasted/stewed,broiled | Litres per year | 80.2 | 12.734 | (14.968) | 78 | 6.544 | (8.316) | 0.000 |
| Hot dogs | Number per year | 80.5 | 34.5 | (64.4) | 78 | 73.1 | (89.0) | 0.000 |
| Ham/lunch meats | Litres per year | 80.5 | 6.263 | (12.818) | 78 | 2.534 | (2.221) | 0.179 |
| Potatoes, french fried | Litres per year | 80.3 | 33.338 | (116.822) | 78 | 13.389 | (20.224) | 0.950 |
| Potato chips | Litres per year | 80.5 | 24.874 | (67.235) | 78 | 22.729 | (24.542) | 0.022 |
| Potatoes, other | Litres per year | 80.5 | 61.510 | (43.222) | 78 | 57.332 | (36.849) | 0.645 |
| Bread | Slices per year | 80.5 | 1,405.8 | (1,719.2) | 78 | 725.5 | (388.6) | 0.000 |
| Rolls/bagels/crackers | Number per year | 80.5 | 748.7 | (1,361.6) | 78 | 384.8 | (516.4) | 0.087 |
| Muffins/cakes/cookies | Number per year | 80.5 | 902.6 | (989.7) | 78 | 721.2 | (757.2) | 0.398 |
| Margarine/cooking oil | Litres per year | 80.5 | 5.576 | (5.455) | 78 | 5.511 | (3.271) | 0.123 |
| Butter/lard | Litres per year | 80.5 | 3.636 | (5.838) | 78 | 2.266 | (4.942) | 0.229 |
| Cereals, high fibre/bran/granola/shredded wheat | Litres per year | 80.5 | 27.239 | (42.655) | 78 | 7.490 | (21.528) | 0.000 |
| Cereals, cold, other | Litres per year | 80.3 | 19.649 | (31.748) | 78 | 27.598 | (35.109) | 0.068 |
| Cereals, cooked | Litres per year | 80.5 | 13.558 | (27.020) | 78 | 17.713 | (51.750) | 0.160 |
| Eggs | Number per year | 80.5 | 246.3 | (441.6) | 78 | 190.0 | (236.4) | 0.439 |
| Bacon | Strips per year | 80.5 | 242.7 | (647.9) | 78 | 175.4 | (277.8) | 0.435 |
| Sausage | Number per year | 80.5 | 71.3 | (120.9) | 78 | 62.9 | (95.4) | 0.721 |
| Cheese, cottage | Litres per year | 78.7 | 5.504 | (10.272) | 78 | 3.467 | (16.927) | 0.002 |
| Cheese, other (incl. spreads) | Litres per year | 79.6 | 6.810 | (8.020) | 78 | 2.744 | (3.978) | 0.000 |
| Milk, whole | Litres per year | 79.6 | 36.970 | (89.892) | 78 | 19.697 | (31.256) | 0.138 |
| Milk, 2% | Litres per year | 79.5 | 120.258 | (246.094) | 78 | 26.706 | (52.271) | 0.000 |
| Milk, 1%/buttermilk/skim | Litres per year | 79.5 | 10.194 | (38.874) | 78 | 7.569 | (43.056) | 0.496 |
| Ice cream | Litres per year | 79.6 | 23.858 | (54.348) | 78 | 16.547 | (22.846) | 0.981 |
| Milk/cream in coffee/tea | Litres per year | 79.6 | 12.970 | (22.004) | 78 | 8.754 | (15.502) | 0.423 |
| Milk, canned evaporated | Litres per year | 79.6 | 2.974 | (10.495) | 78 | 3.342 | (13.108) | 0.738 |
| Yoghurt | Litres per year | 79.6 | 9.417 | (22.913) | 78 | 3.534 | (8.678) | 0.131 |
| Sour cream | Litres per year | 79.6 | 0.505 | (1.143) | 78 | 0.168 | (0.431) | 0.261 |

* mill employees and other community residents combined
† weighted mean number of responses
‡ weighted mean
¶ weighted standard deviation
§ t-test approximation of Wilcoxon rank-sum test, p (2-tailed) for Ho: no difference in medians (i.e., weighted mean ranks)

tionnaire asked, but many answered "unknown" or ambiguously. The Government of Canada's Department of the Environment monitors levels of PCDDs and PCDFs in the tissues of marine organisms in coastal BC waters, but the only food types being monitored near our survey community were oysters and Dungeness crab.[19] There has never been a comprehensive survey of organochlorine levels in all comestible species, marine and land, around our survey community.

This study provides valuable data about the diets of the residents of an Aboriginal reserve and the broader nearby community on the coast of British Columbia. Rarely included in diet surveys, wild food consumption patterns have often been the subject of speculation rather than science. Daily intakes of specific foods are often needed as inputs to human health risk assessments of diseases related to foods or their contaminants. Our survey provides empirical data for such risk assessments in the target population and similar communities. Also, our questionnaire, which includes items on wild foods, may be useful to researchers designing similar studies in other Pacific Northwest coast communities.

**TABLE VI**
**Diet Stability of Survey Participants Over Past 15 Years**

| | | Non-reserve* | | Reserve | | |
|---|---|---|---|---|---|---|
| | | n | (%) | n | (%) | p†‡ |
| **Participants** | | **80.5** | **(100.0%)** | **78** | **(100.0%)** | |
| Fish | Don't eat | 0.9 | (1.1%) | 0 | (0.0%) | 0.000 |
| | Eat less than in 1980 | 31.1 | (39.1%) | 8 | (10.3%) | |
| | Eat same as in 1980 | 26.5 | (33.3%) | 54 | (69.2%) | |
| | Eat more than in 1980 | 21.1 | (26.5%) | 16 | (20.5%) | |
| Shellfish | Don't eat | 5.9 | (7.4%) | 1 | (1.3%) | 0.000 |
| | Eat less than in 1980 | 24.0 | (30.1%) | 9 | (11.5%) | |
| | Eat same as in 1980 | 23.6 | (29.7%) | 52 | (66.7%) | |
| | Eat more than in 1980 | 26.1 | (32.8%) | 16 | (20.5%) | |
| Other seafood | Don't eat | 6.9 | (8.7%) | 5 | (6.4%) | 0.011 ¶ |
| | Eat less than in 1980 | 2.0 | (2.5%) | 3 | (3.8%) | |
| | Eat same as in 1980 | 53.7 | (67.4%) | 66 | (84.6%) | |
| | Eat more than in 1980 | 17.0 | (21.3%) | 4 | (5.1%) | |
| Wild game | Don't eat | 13.1 | (16.5%) | 2 | (2.6%) | 0.873 |
| | Eat less than in 1980 | 13.7 | (17.2%) | 12 | (15.4%) | |
| | Eat same as in 1980 | 41.7 | (52.4%) | 51 | (65.4%) | |
| | Eat more than in 1980 | 11.1 | (14.0%) | 13 | (16.7%) | |
| Wild plants | Don't eat | 3.6 | (4.5%) | 0 | (0.0%) | 0.006 |
| | Eat less than in 1980 | 17.1 | (21.5%) | 7 | (9.0%) | |
| | Eat same as in 1980 | 43.0 | (54.1%) | 64 | (82.1%) | |
| | Eat more than in 1980 | 15.9 | (19.9%) | 7 | (9.0%) | |
| Meat | Don't eat | 1.8 | (2.2%) | 0 | (0.0%) | 0.000 |
| | Eat less than in 1980 | 37.1 | (46.6%) | 5 | (6.4%) | |
| | Eat same as in 1980 | 32.0 | (40.3%) | 68 | (87.2%) | |
| | Eat more than in 1980 | 8.7 | (10.9%) | 5 | (6.4%) | |
| Potatoes | Don't eat | 0.0 | (0.0%) | 0 | (0.0%) | 0.000 |
| | Eat less than in 1980 | 32.0 | (40.2%) | 6 | (7.7%) | |
| | Eat same as in 1980 | 39.6 | (49.8%) | 70 | (89.7%) | |
| | Eat more than in 1980 | 8.0 | (10.1%) | 2 | (2.6%) | |
| Bread/cereals | Don't eat | 0.0 | (0.0%) | 1 | (1.3%) | 0.000 |
| | Eat less than in 1980 | 14.7 | (18.4%) | 7 | (9.0%) | |
| | Eat same as in 1980 | 46.9 | (59.0%) | 67 | (85.9%) | |
| | Eat more than in 1980 | 18.0 | (22.6%) | 3 | (3.8%) | |
| Butter/margarine | Don't eat | 0.0 | (0.0%) | 0 | (0.0%) | 0.000 |
| | Eat less than in 1980 | 24.0 | (30.2%) | 7 | (9.0%) | |
| | Eat same as in 1980 | 46.4 | (58.3%) | 70 | (89.7%) | |
| | Eat more than in 1980 | 9.2 | (11.6%) | 1 | (1.3%) | |
| Bacon/eggs | Don't eat | 0.9 | (1.1%) | 0 | (0.0%) | 0.000 |
| | Eat less than in 1980 | 35.5 | (44.7%) | 8 | (10.3%) | |
| | Eat same as in 1980 | 33.1 | (41.7%) | 66 | (84.6%) | |
| | Eat more than in 1980 | 10.0 | (12.5%) | 4 | (5.1%) | |
| Dairy products | Don't eat | 0.9 | (1.1%) | 1 | (1.3%) | 0.000 |
| | Eat less than in 1980 | 24.7 | (31.0%) | 9 | (11.5%) | |
| | Eat same as in 1980 | 41.9 | (52.7%) | 64 | (82.1%) | |
| | Eat more than in 1980 | 12.1 | (15.2%) | 4 | (5.1%) | |

* non-reserve = mill employees and other community residents combined, see Table I for stratum weights
n weighted mean number of responses
% ( weighted mean number of responses) / (weighted mean sample size)
† Chi-squared test for Ho: no association with reserve
‡ responses of "don't eat" and "eat same" combined into one category for analysis
¶ more than 20% of cells have less than 5 expected, chi-squared test may not be valid

## REFERENCES


1. IPCS International Programme on Chemical Safety. Environmental Health Criteria 88: Polychlorinated Dibenzo-para-dioxins and Dibenzofurans. Geneva, Switzerland: World Health Organization, 1989.
2. Government of Canada, Environment Canada, Health and Welfare Canada. Canadian Environmental Protection Act Priority Substances List Assessment Report No.1: Polychlorinated Dibenzodioxins and Polychlorinated Dibenzofurans. DSS cat. no. En40-215/1E; ISBN-0-662-17644-8. Ottawa, ON: Minister of Supply and Services Canada, 1990.
3. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chlorodibenzofurans. Report No: ATSDR/TP-93/04; NTIS No: PB95-100129. Atlanta, GA: Public Health Service, U.S. Dept. of Health and Human Services, May 1994.
4. Ryan JJ, Norstrom RJ. Occurrence of polychlorinated dibenzo-p-dioxins and dibenzofurans in humans and major exposure routes, in Rappe C, Buser HR, Dodet B, O'Neill IK (Eds.), *Environmental Carcinogens: Methods of Analysis and Exposure Measurement, Vol. 11: Polychlorinated Dioxins and Dibenzofurans, IARC Scientific Publications No. 108*. Lyon, France: International Agency for Research on Cancer, 1991;51-104.
5. Block G. Health Habits and History Questionnaire: Diet History and Other Risk Factors. Washington, DC: National Cancer Institute, March 1989.
6. Block G, Hartman AM, Dresser CM, et al. A data-based approach to diet questionnaire design and testing. *Am J Epidemiol* 1986;124:453-69.
7. Friedenreich CM, Slimani N, Riboli E. Measurement of past diet: Review of previous and proposed methods. *Epidemiol Rev* 1992;14:177-96.
8. Krall EA, Dwyer JT, Coleman KA. Factors influencing accuracy of dietary recall. *Nutrition Res* 1988;8:829-41.
9. McKeown-Eyssen GE, Yeung KS, Bright-See E. Assessment of past diet in epidemiologic studies. *Am J Epidemiol* 1986;124:94-103.
10. Sobell J, Block G, Koslowe P, et al. Validation of a retrospective questionnaire assessing diet 10-15 years ago. *Am J Epidemiol* 1989;130:173-87.
11. Friedenreich CM, Howe GR, Miller AB. An investigation of recall bias in the reporting of past food intake among breast cancer cases and controls. *Ann Epidemiol* 1991;1:439-53.

12. SAS Institute Inc. The RANK Procedure. *SAS Procedures Guide, Release 6.03 Edition*. Cary, NC: SAS Institute Inc., 1988.
13. Block G, Woods M, Potosky A, Clifford C. Validation of a self-administered diet history questionnaire using multiple diet records. *J Clin Epidemiol* 1990;43(12):1327-35.
14. Coates RJ, Eley JW, Block G, et al. An evaluation of a food frequency questionnaire for assessing dietary intake of specific carotenoids and vitamin E among low-income black women. *Am J Epidemiol* 1991;134(6):658-71.
15. Cummings SR, Block G, McHenry K, Baron RB. Evaluation of two food frequency methods of measuring dietary calcium intake. *Am J Epidemiol* 1987; 126(5):796-802.
16. Block G, Thompson FE, Hartman AM, et al. Comparison of two dietary questionnaires validated against multiple dietary records collected during a 1-year period. *J Am Diet Assoc* 1992;92:686-93.
17. Block G, Coyle LM, Hartman AM, Scoppa SM. Revision of dietary analysis software for the Health Habits and History Questionnaire. *Am J Epidemiol* 1994;139(12):1190-96.
18. Hartman AM, Block G, Chan W, et al. Reproducibility of a self-administered diet history questionnaire administered three times over three different seasons. *Nutr Cancer* 1996;25:305-15.
19. Personal communication from Mike Hagen (Industrial Programs, Pollution Abatement, Environmental Protection, Environment Canada, North Vancouver, BC) regarding the Dioxin and Furan Trend Monitoring Database.

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