

## THEORY AND METHODS

# Comparative analysis of nutrition data from national, household, and individual levels: results from a WHO-CINDI collaborative project in Canada, Finland, Poland, and Spain\*

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**Study objective:** This project determined to what extent data on diet and nutrition, which were collected in a non-uniform manner, could be harmonised and pooled for international and national comparison.

**Design:** Direct comparisons of dietary data between studies were made using food balance sheets (FBS), household budget surveys (HBS), and individual dietary data (IDS); comparisons were also made within countries. Differences in study design and methodological approaches were taken into consideration. Data from research projects from the following four World Health Organisation (WHO) Countrywide Integrated Noncommunicable Disease Intervention (CINDI) countries were included—Canada, Finland, Poland, and Spain.

**Main results:** FBS overestimated food consumption and nutrient intake compared to IDS. Results between HBS and IDS were quite similar, except for fish, meat, pulses and vegetables, which were underestimated by HBS, and sugar and honey and cereals, which were overestimated. Percentages of energy from fat, carbohydrates and proteins were higher when estimated from FBS, HBS, and IDS respectively.

**Conclusions:** Results suggest that estimations from these three sources of dietary data are difficult to compare because they are measuring different levels of dietary information. The understanding of their relations may be important in formulating and evaluating a nutrition policy.

The aim of the Countrywide Integrated Noncommunicable Disease Intervention (CINDI) programme is to support member states in developing integrated policies for non-communicable disease prevention by: (1) combining health promotion and disease prevention through intersectorial collaboration and community involvement; (2) enhancing the role of health professionals, and; (3) making better use of existing resources. The CINDI Protocol and Guidelines for Monitoring and Evaluation Procedures<sup>1</sup> have an annex on dietary surveillance, but this issue needed further attention as the science of monitoring the nutritional status of populations is complex and misunderstood, and has been developed considerably during the past decade.

Classically, most surveillance systems focus on monitoring mortality and morbidity. However, of growing importance for public health is monitoring and comparing distributions of risk factors, including nutrition, in various populations to continuously gain information for subsequent action.<sup>2,3</sup> Within a food policy context, nutrition planning requires an understanding of food consumption patterns. Two types of dietary data are collected regularly in most developed countries: agricultural supply and utilisation data in the form of food balance sheets (FBS) as prepared by the Food and Agriculture Organisation of the United Nations (FAO), the Organisation for Economic Co-operation and Development (OECD), Eurostat, or national administrations, and household budget survey data (HBS). In addition, most countries

sporadically conduct special individual dietary surveys (IDS) based on nationally representative population samples. Special surveys, conducted at regular intervals, could be used to describe the usual food consumption and nutrient intake patterns of the population.<sup>3</sup> However, the high cost of these surveys has prohibited their establishment in many countries on a national level. Instead, they have only been conducted at the regional or local level or in specific population groups, and their methods have not always been the same. HBS tend to overestimate consumption of foods such as bread, potatoes, pulses, vegetables, fruit, milk, and vegetable oils as compared with individual dietary records, and to underestimate data of FBS by at least 20%.<sup>4,5</sup> Obviously, the collection of data does not necessarily imply that a nutrition policy will follow.

At present, no common international surveillance system exists permitting the comparison of nutrition and dietary risk factors that have been identified for different populations across developed countries. Although several comparative prospective cohort or cross sectional studies have been realised,<sup>6–16</sup> almost all collected and analysed data under a standardised core protocol. Only a few projects centrally combined and analysed already existing data from European epidemiological studies,<sup>14–16</sup> but most of them were not conducted in representative samples of the population.<sup>14,15</sup> As the DAFNE (Food data networking) study has already compared data on household availability across some European countries,<sup>16</sup> FAO

\*In memory of Dr Mukund Nargundkar and Dr Andres Petrasovits

**Abbreviations:** FBS, food balance sheets; HBS, household budget surveys; IDS, individual dietary surveys; CINDI, Countrywide Integrated Noncommunicable Disease Intervention

**Table 1** Dietary methods of the four participating countries

FBS		HBS				IDS					
Country	Years	Method	Period studied	Sample size (household)	Year	Sample size	Age groups	Sample area	Number of days	Methods	Year
Canada	1990–1992	Record	2 weeks	18000	1990–92	2212	18 to 74	Nova Scotia	1 (2 in 30%)	24 h recall	1990
Finland	1990–1992	DU	DU	DU	DU	454	25 to 64	North Karelia	3	Food record	1992
Poland	1990–1992	Food list	3 months	29664	1988	4440	20 to 65	National industries	1	24 h recall	1991–94
Spain	1990–1992	Record	1 week	28000	1990–91	2757	6 to 75	Catalonia	2	24 h recall	1992–93

FBS, food balance sheets; HBS, household budget surveys; IDS: Individual dietary surveys; DU: data unavailable.

compares worldwide national food availability<sup>17</sup> and EURO-DIET and EURALIM have used European IDS comparison,<sup>18, 19</sup> we compared national and household food availability with individual food consumption for inter-country and intra-country analysis.

The objectives of the study were:

- To analyse nutritional patterns and evaluate the appropriateness of comparing different levels of dietary information within a health or nutrition policy context, and
- To identify and discuss issues of international comparability of nutritional data in four CINDI countries: Canada, Finland, Poland, and Spain

## METHODS

Three types of dietary information were pooled to make inter-country and intra-country comparisons: data from FBS and data from HBS at national levels and data from IDS at regional levels. Canada, Finland, Poland, and Spain provided these three levels of data, thus representing a unique opportunity to compare data across countries at three levels: national, household, and individual.

### Dietary information

The Apparent Per Capita Food Consumption Data were obtained from FAO FBS, which are compiled from a wide variety of administrative data sources proceeding from Institutes of Statistics, as well as other government departments, farmers' associations, and marketing boards. Data from FBS were obtained for the years 1990, 1991, and 1992 for the four countries.<sup>17</sup>

Family Food Expenditure was obtained from HBS. The main objective of these surveys are to review the ranking in order to calculate the consumer price index. Other objectives are to

study income sources and their distribution, and also the levels and patterns of consumption and expenditure to elaborate national accounting statistics; to carry out specific analyses of areas of social interest such as housing, education, health and moreover, to analyse geographical and time trends.<sup>20</sup> Apart from the fact that HBS collect data on food quantities purchased and not necessary consumed, another important problem is that in many cases, these data are expressed as food categories (for example, seed oils) rather than single food items (for example, olive oil) and different items are included under each food category. Additional information from various sources is needed to decide on the proportion that different food items contribute to the nutrient values in a single food category. In the context of DAFNE II, an exercise was undertaken for the conversion of foods to nutrients. The single food item level or the less aggregated food group level used was also applied in our analysis.

In Canada, the HBS from 1990 and 1992 comprised 18 000 households from urban and rural areas of the 10 provinces and two territories using the Canadian Labour Force Survey Framework, a stratified multistage cluster sampling. People in reserves and institutions were excluded. Two separate instruments were used: a questionnaire and two food expenditure diaries. The questionnaire was primarily for the collection of selected socioeconomic characteristics as well as information on household purchasing habits and food expenditures. After the interview, respondents were asked to maintain a daily record of food expenditures using two one-week diaries. Methods of HBS for Finland were not included as the data were not available for this comparative study analysis. The Poland HBS included a sample size of 29 664 households. Households that refused to participate were replaced by others with similar characteristics. The recording period for food expenditure was three months, and included 72 food items; fieldwork was done in 1988 and the response rate was 60%. In

**Table 2** Mean consumption (g/person/day) of food groups derived from FBS, HBS, and IDS in four countries

	Canada			Finland			Poland			Spain			Mean*		
	FBS	HBS	IDS	FBS	HBS	IDS	FBS	HBS	IDS	FBS	HBS	IDS	FBS	HBS	IDS
Dairy products	586	348	337	910	DU	534	609	332	354	430	379	226	634	353	363
Meats	273	108	141	180	DU	134	210	179	236	278	188	173	235	158	171
Fish	61	11	37	89	DU	43	32	14	DU	104	80	74	72	35	51
Pulses	18	5	8	1	DU	6	6	3	6	16	20	22	10	9	11
Nuts and oil seeds	24	7	6	6	DU	DU	4	DU	DU	33	4	4	17	6	5
Eggs	29	22	23	28	DU	26	27	26	22	41	35	27	31	28	25
Fruits	329	211	164	261	DU	307	114	112	137	410	311	299	279	211	227
Vegetables	296	160	146	152	DU	92	307	195	288	417	168	211	293	174	184
Roots and tubers	165	74	103	209	DU	157	395	315	317	301	147	74	268	179	163
Cereals	246	204	193	252	DU	205	414	309	227	279	245	166	298	253	198
Oils and fats	69	36	33	50	DU	39	68	54	57	82	55	30	67	48	40
Sugar and honey	125	42	39	109	DU	32	110	91	56	90	40	18	109	58	36
Alcoholic beverages	246	DU	114	286	DU	120	140	DU	DU	299	113	143	243	113	126

\* Mean, average of the four countries. Abbreviations as for table 1.

**Table 3** Differences between the food group consumption estimates in each country for FBS, HBS, and IDS and the four country average

	Canada *Difference with mean %			Finland *Difference with mean %			Poland *Difference with mean %			Spain *Difference with mean %		
	FBS	HBS	IDS	FBS	HBS	IDS	FBS	HBS	IDS	FBS	HBS	IDS
Dairy products	-8	-1	-7	44	DU	47	-4	-6	-2	-32	7	-38
Meats	21	-32	-17	-20	DU	-21	-7	13	39	23	19	2
Fish	-15	-69	-28	24	DU	-16	-55	-60	DU	45	129	44
Pulses	76	-46	-24	-90	DU	-43	-41	-68	-43	56	114	110
Nuts and oils	43	27	20	-64	DU	-100	-76	DU	DU	97	-27	-20
Eggs	-7	-20	-6	-10	DU	6	-14	-6	-10	31	27	10
Fruits	18	0	-28	-6	DU	35	-59	-47	-40	47	47	32
Vegetables	1	-8	-21	-48	DU	-50	5	12	56	42	-4	15
Roots and tubers	-38	-59	-37	-22	DU	-4	48	76	95	13	-18	-55
Cereals	-17	-19	-2	-15	DU	4	39	22	15	-6	-3	-16
Oils and fats	3	-26	-40	-26	DU	-29	1	12	4	22	14	-45
Sugar and honey	15	-27	8	0	DU	-12	1	58	54	-17	-31	-50
Alcoholic beverages	1	DU	-9	18	DU	-5	-42	DU	DU	23	0	14

\*Difference with mean %, ((country value–average of the four countries)/average of the four countries)×100. Abbreviations as in table 1.

Spain, the entire country (50 provinces) was included in the HBS. The 50 provinces were grouped into 17 autonomous regions. The study sample for these surveys was selected by a two staged stratified sampling scheme, and included 28 000 households during 1990 to 1991. Trained interviewers visited the households every other day for one week. Record keeping methods were also used to collect data on household daily expenses as a whole, and for each individual family member. The 1990–1991 survey gathered food expenditure data for 257 items, including wine and alcoholic beverages.<sup>5</sup>

IDS consisted of similar methodologies because all countries used 24 hour recalls or records but not food frequency questionnaires. In Canada, the Nova Scotia Nutrition Survey was a collaborative project carried out by the provincial government and the federal Department of Health and Welfare in 1990. A stratified, two staged, replicated probability sample design was used; 2212 people aged 18 to 74 completed the interview. Information was collected on demographic data, food frequency data, dietary knowledge, opinions, and one 24 hour recall by personal interviews at home. To estimate and adjust for the intraindividual variation, a second 24 hour recall was obtained in one third of the sample. Food models were used to ascertain portion sizes. Food conversion into nutrients was calculated using the Canadian Nutrient Data Bank and the software system CANDL.<sup>21</sup>

In Finland, the FINMONICA Survey was utilised, developed by the national Public Health Institute, which comprises a random sample of 1865 (participation rate of 66%) people aged 25 to 64. The survey was carried out in four Finnish areas

(results are presented only for North Karelia n=454) from January to March 1992. After attendance at the local health centre, the subjects were given instruction on how to keep a three day food record and completed records were returned by mail. For portion size estimation a picture book was used, and the NUTNET (Food Composition database of the National Public Health Institute) enabled the conversion of foods into nutrients.<sup>22</sup>

In Poland, data were collected from men and women in separate surveys. In 1994, 2238 adult men aged 20 to 65 years from a number of large industries and enterprises comprised the countrywide sample. Individual subjects were chosen at random using multistage sampling. For women, the data were collected during 1991 to 1994 from a number of large industrial plants covering all of Poland. Some 2202 women aged 20 to 65 years were chosen at random. Information was collected using a 24 hour recall method by trained interviewers.<sup>23, 24</sup>

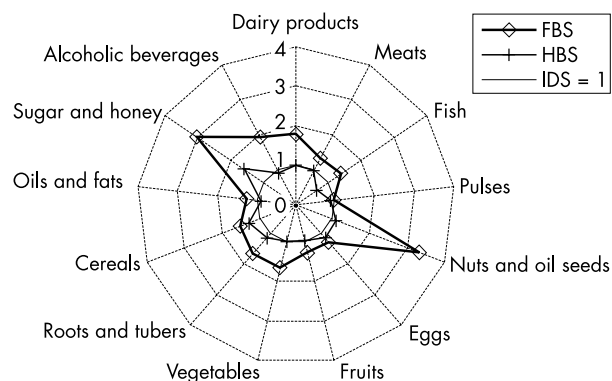
In Spain, the Catalan Nutrition Survey was conducted by the Catalan Autonomous Government and the University of Barcelona in 1992. A two staged random sample of 2757 from 4000 people (69% participation) aged 6 to 75 were interviewed at home by trained personnel who gathered information on food habits and other risk factors. Dietary information included food frequency questionnaire, questions on nutrition knowledge and opinions, and two 24 hour recalls, one during the cold season and the other during the summer. Household food measures were used and conversion of food into nutrients was carried out using the French Food Composition Tables. Adjustment of intraindividual variability was performed by statistical methods as done in the Canadian Survey.<sup>25</sup>

The dietary methods from the four FBS countries are presented in table 1. All the methods refer to the same period (1990–1992) except for Poland where HBS data come from 1988.

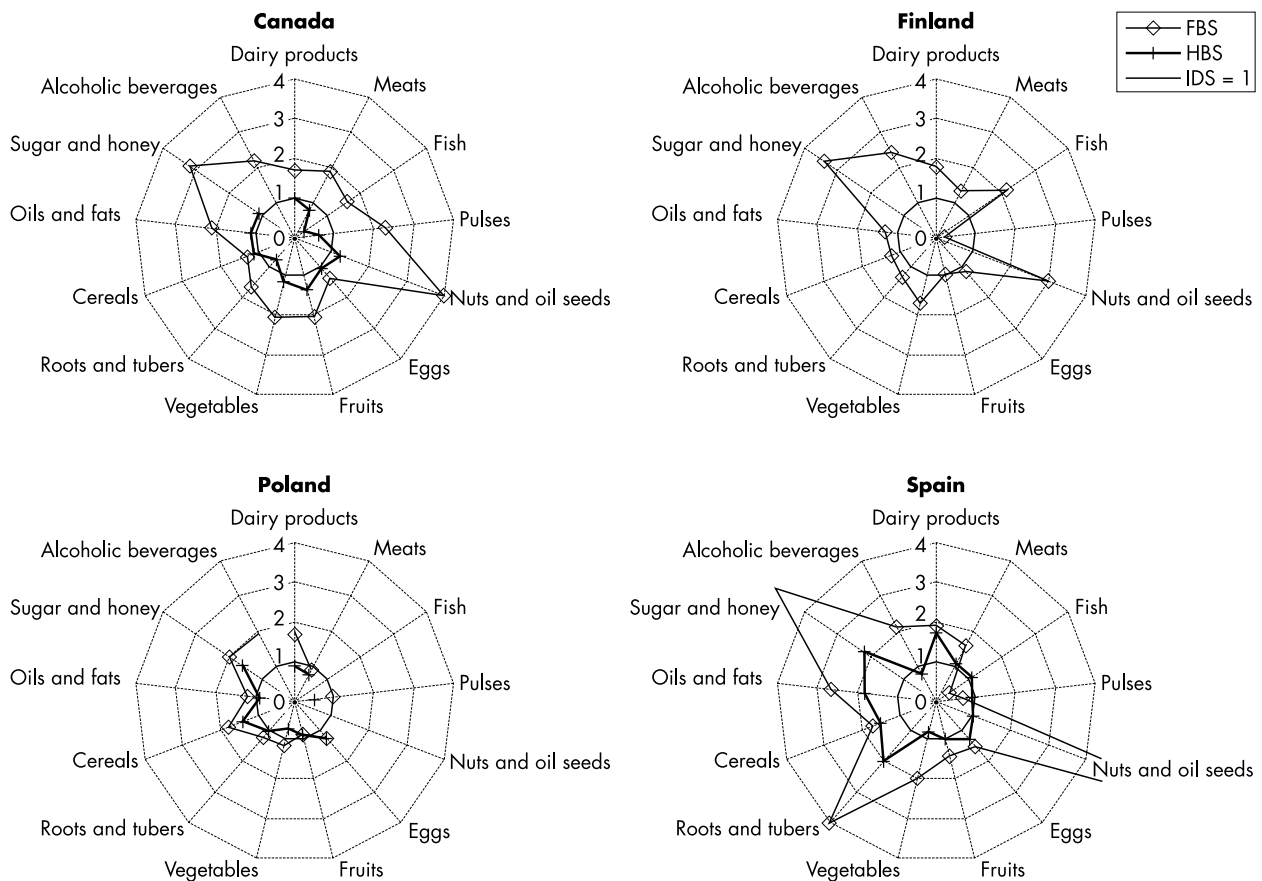
### Analysis

Data were analysed in each collaborative centre following a uniform protocol. Age groups used were as follows 25–34, 35–44, 45–54, 55–64, and 65–74 years. Average consumption of intake and percentages were age and sex standardised for the European population using the indirect method.

With respect to the food data collected by FBS, HBS, and IDS, the initial step taken by the WHO-CINDI working group was to clarify exactly what was included under each food category used by the different survey teams. It was obvious that the level of detail for recorded data varied from one country to another (except FAO-FBS, which used the same groups). Furthermore, in certain cases, food groups seemed to overlap



**Figure 1** Estimations of food availability (FBS and HBS) and consumption (IDS) in reference to IDS calculations for the four countries average. Canada, Finland, Poland, and Spain.



**Figure 2** Estimations of food availability (FBS and HBS) and consumption (IDS) in reference to IDS in Canada, Finland, Poland, and Spain.

between countries. As the data did not share the same degree of detail, aggregations of food items to the lowest level of information became necessary. The groups that were finally selected consisted of the food groupings used in the FAO-FBS: dairy products, meats (including liver and offals), fish, pulses (beans, peas, others), nuts and oil seeds, eggs, fruits (fresh, canned, frozen), vegetables, roots and tubers (starchy roots), cereals, oils and fats, sugar and honey, and alcoholic beverages.

The internal differences (%) of the three levels of information were calculated for each country and for the average of the three levels of dietary data among the four countries. External differences were also calculated comparing the three levels of information in each country with the four country average.

## RESULTS

The mean consumption of food groups estimated by the three methods for each of the four countries and their average are shown in table 2. As an example, dairy product consumption ranged from 910 g/person/day (Finland) to 430 g/person/day (Spain) according to FBS, and from 534 g/person/day (Finland) to 226 g/person/day (Spain) according to IDS. FBS overestimated dairy product consumption by 43% compared with IDS (the percentage being very similar across countries), and by 33% compared with HBS (from 45% to 12%). HBS estimates were similar to IDS except for Spain. Figure 1 includes the different estimation of food availability and consumption in reference to IDS calculations for the average of the four countries and figure 2 the same information for each individual country. Table 3 compares the differences in food group consumption between national estimates and the four country average. Similarity of the percentages of the three columns could reflect better consistency of the data. Percentages were similar for certain foods: dairy products (except for

HBS in Spain), pulses (except for FBS in Canada), meats (except for IDS in Poland), nuts and oil seeds (with the exception of Spain), fruits (excluding Canada and Finland), vegetables (in Finland only), and roots and tubers (excluding Spain). In general, consistency was better for HBS and IDS than for FBS and HBS or FBS and IDS.

Table 4 shows the mean intake of energy, macronutrients, fatty acids, and alcohol. Average intakes of energy were 13 728 kJ/person/day (3281 kcal), 10 290 kJ/person/day (2459 kcal), and 8843 kJ/person/day (2114 kcal), and for fat 138, 104, and 84 g/person/day for FBS, HBS, and IDS, respectively. On average, FBS overestimated energy and fat intake by more than 35% to 40% as compared with HBS, with variations from one country to another. With the exception of Poland, percentages of energy from fat were higher in estimates from FBS, percentages of energy from proteins were higher in estimates from IDS, and excluding Canada, the percentages of energy from carbohydrates were higher in results from HBS. As compared with IDS, FBS overestimated alcohol intake by 60% to 70% in all countries.

When comparing the differences in energy and macronutrient intake between the national estimates and the four country average, percentages were very different from one method to the other. A higher degree of inconsistency was observed between these three levels of nutritional data when comparing nutritional intake or availability across countries. Figure 3 shows the comparability of energy and macronutrient intake for the three methods (average) and figure 4 shows the same for each individual country.

Food patterns clearly differ from one country to another. In Spain there was a higher consumption of fruits and vegetables, fish, and pulses. In Poland more meat, potatoes, and sugar were consumed, and in Finland more dairy products. These differences in dietary patterns were observed



**Table 4** Mean intake of energy, macronutrients, fatty acids, and alcohol derived from FBS, HBS, IDS in four countries

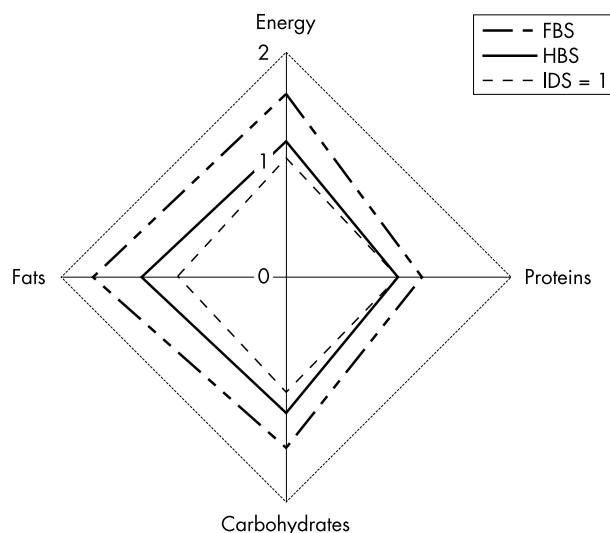
	Canada			Finland			Poland			Spain			Mean*			
	FBS	HBS	IDS	FBS	HBS	IDS	FBS	HBS	IDS	FBS	HBS	IDS	FBS	HBS	IDS	
Energy (kJ)	12632	8849	8605	12849	DU	9551	14008	11000	8756	15432	11021	8461	13728	10290	8843	
Energy (kcal)	3017	2115	2057	3071	DU	2283	3348	2629	2093	3688	2634	2022	3281	2459	2114	
Protein (g)	94.8	81.3	87.2	97.5	DU	90.4	102.5	71.6	68.2	105.0	93.5	90.7	100.0	82.0	84.1	
Carbohydrates (g)	331.0	269.4	239.7	346.0	DU	282.8	442.0	344.0	264.9	364.3	294.0	201.7	370.8	302.3	247.3	
Fat (g)	128.4	84.6	80.4	128.5	DU	86.0	114.7	106.9	83.3	181.2	121.0	84.1	138.0	104.3	83.5	
MUFA (g)	DU	34.1	32.8	DU	DU	31.1	DU	41.8	DU	DU	55.2	38.2	DU	43.7	34.0	
PUFA (g)	DU	14.4	12.6	DU	DU	12.6	DU	18.1	DU	DU	19.8	10.3	DU	17.3	11.8	
SAT (g)	DU	28.4	28.7	DU	DU	39.6	DU	39.5	DU	DU	34.9	27.8	DU	34.0	32.0	
Alcohol (g)	23.0	DU	6.5	21.0	DU	7.8	19.0	DU	DU	26.0	DU	10.5	22.3	DU	8.3	
<i>% Energy contributions without alcohol</i>																
Protein	13.3	15.4	17.5	13.2	DU	15.9	12.8	11.0	13.1	12.0	14.1	19.0	12.8	13.5	16.4	
Carbohydrates	46.3	51.0	47.1	47.4	DU	49.8	55.0	52.3	52.3	41.5	44.6	41.2	47.5	49.3	47.6	
Fat	40.3	36.0	33.9	39.4	DU	33.8	32.2	36.6	35.3	46.5	41.3	38.5	39.5	38.0	35.4	
MUFA	DU	14.5	17.0	DU	DU	12.2	DU	14.4	DU	DU	18.8	17.4	DU	15.9	15.5	
PUFA	DU	6.1	5.0	DU	DU	5.0	DU	6.2	DU	DU	6.8	4.7	DU	6.3	4.9	
SAT	DU	12.1	11.9	DU	DU	15.6	DU	13.4	DU	DU	12.0	12.7	DU	12.4	13.4	

\*Mean, average of the four countries. MUFA, monounsaturated fatty acids; PUFA, polyunsaturated fatty acids; SAT, saturated fatty acid. Other abbreviations as in table 1.

with all the dietary methods (table 2). With respect to the nutritional differences between countries, Poland showed a lower protein intake, and Spain a lower carbohydrate intake, the total fat intake being similar. Estimated saturated fat intake was much higher in Finland, and monounsaturated fat intake was higher in Spain (table 4).

## DISCUSSION

This is the first comparative analysis of the three levels of nutrition information available in different countries: national, household, and individual data. In a nutritional policy context, individual data on food consumption and energy and nutrient intakes provides the most appropriate information as it is segregated by age and sex, thus enabling the identification of high risk population groups. In addition, IDS may provide more suitable information that fits the needs of a national policy.<sup>26, 27</sup> However, household and national data may also be very useful in a nutritional policy context as they provide a useful estimate of food and nutrient availability.



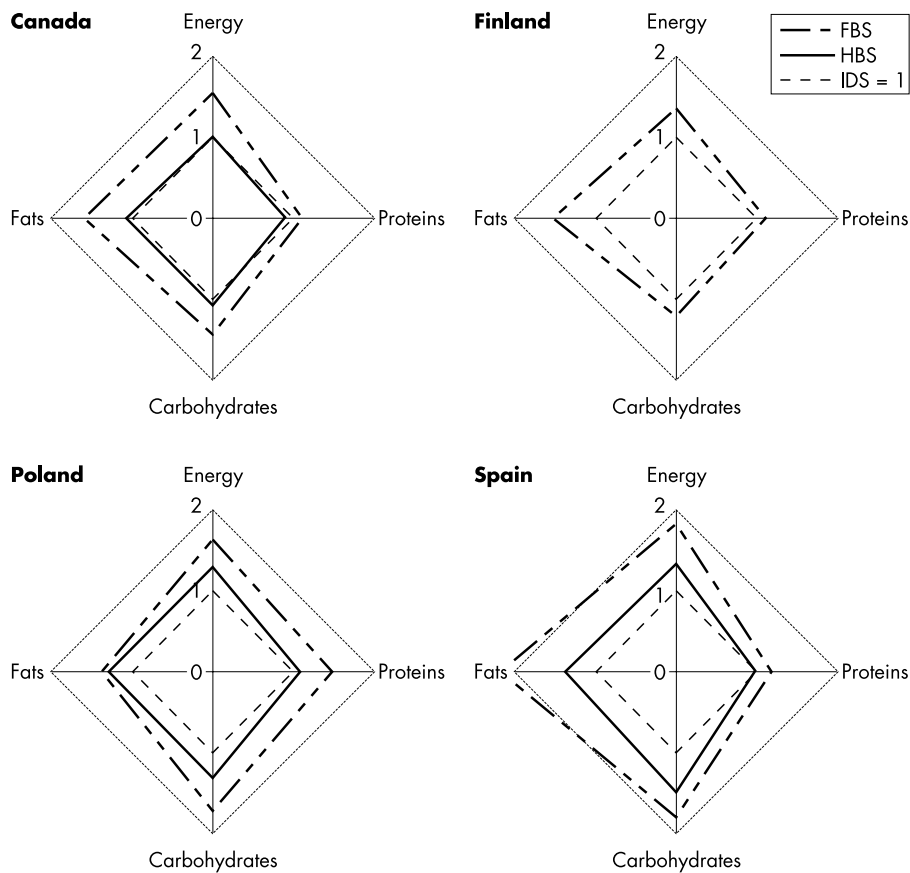
**Figure 3** Comparability between the three methods (FBS, HBS, IDS) for energy and macronutrient intake in reference to IDS calculations for the four countries average. Canada, Finland, Poland, and Spain.

Knowing food and nutrient availability is a very important step when developing dietary guidelines, as average individual consumption levels will only be reached if they are available at a national and household level. If available levels of national food consumption are higher than the desirable individual levels, nutrition education may have an important role in the nutrition policy. In contrast, if apparent levels are lower than recommendations, promotion of supply or trade may have an important role in policy development. Also (from a nutrition intervention perspective), the level of food information required will depend on the scope of the intervention. If the aim is to promote dietary changes at the household level via education or price interventions, HBS may be the best dietary tool for monitoring changes. If the scope is to promote national food supply changes by legislation, agricultural incentives, or international trade, FBS would be the most appropriate tool. However, if interventions are aiming to change the nutritional status of individuals by education, fortification, or supplementation, IDS together with anthropometrical and biochemical indicators would be the most adequate tools.<sup>26-28</sup>

While FBS and HBS can easily be compared between countries as, in principle, their reproducibility is high, IDS include several methods (food frequency questionnaires, 24 hour recall, food records, etc), which make comparisons more difficult. However, the methods used in the IDS pooled in this study are similar because they incorporated 24 hour recalls or food records as dietary tools. Although the number of days of observations varies from Finland (three days) to Poland (one day), this factor particularly affects food and nutrient distribution, but not average estimates.<sup>29</sup>

In general, when compared with home food consumption studies, HBS overestimates consumption,<sup>30</sup> mainly because of storage, consumption of food by visitors, or under-recording of intakes. The analysis of time trends of food availability and consumption show important discrepancies. Additionally, they show different tendencies between availability and consumption for fat and other macronutrients, which should be taken into consideration when interpreting these trends in a policy or research context.<sup>31-34</sup> This should be particularly relevant in the case of international ecological or correlational studies of diet and disease.

In this study, FBS overestimated food consumption compared with IDS; results between HBS and IDS were quite similar, except for fish, meats, pulses and vegetables, which were underestimated by HBS, and sugar and honey and cereals, which were clearly overestimated.



**Figure 4** Comparability between the three methods (FBS, HBS, IDS) for energy and macronutrient intake in reference to IDS in Canada, Finland, Poland, and Spain.

### Key points

- Within a food policy context, nutrition planning requires an understanding of food consumption patterns.
- This is the first comparative analysis evaluating the three levels of nutrition information available in different countries: national, household, and individual data.
- The three levels of dietary data provide unique information about food availability and reported intake. Their comparisons are difficult to interpret because each method represents different stages of the food chain.

The differences between the estimates of FBS, HBS, and IDS may be attributable to: (1) differences in method; each methodology has its own advantages and disadvantages, (2) differences in the indicator measured (food availability, food consumption, food waste, etc), and (3) differences in the population group analysed. FBS and HBS comprise the entire population and country, but IDS only consider certain population groups (that is, 20 to 64 years) and regions (that is, Catalonia or Nova Scotia).

It is very difficult to explain if observed differences are attributable to the method, measurement, or population, but usually food availability at national level estimates (FBS) are higher than household levels (HBS), and they are higher than the results from IDS. If results from IDS are greater than results from HBS, differences may be explained by the different age group categories (if the IDS sample excludes children, who consume less fruits and vegetables, IDS may show higher levels of fruit and vegetable consumption than HBS, as has been observed in our study) or the influence of underreporting, which is particularly important among obese people.<sup>35</sup> If

FBS results are higher than HBS for certain foods, the differences may be explained by the fact that certain products are mainly consumed in the home, but not in institutions or restaurants. It may also indicate weaknesses in both methods, as they are affected by several sources of error.

The three levels of dietary data provide unique information about the availability and reported intake of food in populations and their comparisons are difficult to interpret because each represents different steps of the food chain. The understanding of their relations could play an important part when formulating, evaluating, and monitoring a nutrition policy in a country or region.

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