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Monitoring food and nutrient availability in a nationally representative sample of Bolivian households

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The study objective was to estimate food and nutrient availability in Bolivian households using data from the nationally representative under the Programme for the household surveys undertaken yearly from 1999 to 2002 Improvement of Surveys and the Measurement of Living Conditions in Latin America and the Caribbean (MECOVI). In the present study, we analysed data from four repeated, cross-sectional surveys and applied European Data Food Networking (DAFNE) methodology for post-harmonising the data. Raw data of 19 483 households in Bolivia (3035 in 1999, 4857 in 2000, 5845 in 2001 and 5746 in 2002) were retrieved from the databases of the national household surveys. Results showed that the Bolivian diet is characterised by higher availability of foods of plant origin (cereals, fruits, potatoes and vegetables). Meat, milk and their products follow in the dietary preferences of Bolivians. Disparities in food availability within the country were also observed. Rural households systematically recorded lower amounts of food available, in comparison with the urban ones. Households of higher social status recorded higher availability values for all food groups, except for potatoes and cereals. Findings suggest that Bolivian households of lower socio-economic status prefer energy-dense and cheaper food sources. We concluded the dietary and socio-demographic data collected in the MECOVI household surveys could serve nutrition surveillance purposes. In addition, the application of DAFNE methodology for post-harmonising the data allows both national and international comparisons.

Bolivia: Nutritional transition: Food availability: Food security: Household surveys

Nutritional transition in developing countries is characterised by the concurrence of the following: undernutrition *v.* increasing levels of overweight; shift from traditional food habits towards dietary patterns of higher energy intake; reduction of physical activity (Popkin, 2001). These changes have been identified as predictors of undesirable health outcomes, namely the increase of chronic non-communicable diseases, which are taking epidemic proportions in developing countries, stressing the need to implement preventive measures (Monteiro *et al.* 2004; Caballero, 2005).

The need to monitor the transition in developing countries is becoming increasingly important, and nutritional surveillance programmes may need to extend beyond the risk of undernutrition. It is thus necessary to identify country-representative, cost-effective and sustainable sources of information on dietary patterns, in order to set up recommendations and preventive actions (Beghin *et al.* 2002).

Bolivia is situated in the heart of South America. The country is divided politically intxo nine Departments, with three main metropolitan centres (the cities of La Paz, Santa Cruz and Cochabamba) that gather more than 50 % of the total country's population, as most of the migrants from rural areas are also settled around these cities. The main population groups are the Mestizos, the descendants of marriages between natives and Europeans, while large numbers of native groups still remain. Geographically, three regions can be identified; the highlands, the valleys and the tropical lowlands. Agricultural production is different in each region: the highlands basically produce Andean cereals, potatoes and pulses; the valleys produce cattle, milk, fruits, vegetables and cereals; while the lowlands, that experienced the most rapid economic development in the past 30 years, are mostly devoted to cattle and meat and tropical fruit production.

A sharp increase in the prevalence of overweight among Bolivian women has recently been reported (Perez-Cueto & Kolsteren, 2004), as well as the increased levels of overweight in a sample of adolescents in the Bolivian capital city of La Paz (Perez-Cueto *et al.* 2005). However, nationally representative

Abbreviations: DAFNE, European Data Food Networking; HBS, Household Budget Survey; MECOVI, Programme for the Improvement of Surveys and the Measurement of Living Conditions in Latin America and the Caribbean.

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dietary data that may be associated to the nutritional status of this population have not yet been described. Recent food intake studies are scarce in Bolivia and, when available, they are based on small samples of selective populations (Antezana, 2001; Plaza *et al.* 2002).

In the late 1990s, the Programme for the Improvement of Surveys and the Measurement of Living Conditions in Latin America and the Caribbean (MECOVI) was initiated, jointly supported by the Inter-American Development Bank, the World Bank and the UN Economic Commission for Latin America and the Caribbean. The programme was aiming at strengthening the institutional capacities in the partner countries and enhancing the application of uniform methodologies, in order to collect data for policymaking. Ten Latin American countries (Argentina, Bolivia, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Peru and Paraguay) participated in the programme.

Within the framework of the MECOVI programme, Bolivia carried out four annual household surveys from 1999 to 2002, which were designed to provide country-representative data on various demographic and socio-economic characteristics, as well as on the availability of foods and beverages within the households.

We have analysed the data collected in these four annual MECOVI household surveys, in order to monitor food availability among representative samples of Bolivian households during the period of 1999 to 2002. In addition, to allow comparisons with data collected in other countries, we applied the methodology developed in the European Data Food Networking (DAFNE) project for post-harmonising and analysing the European Household Budget Survey (HBS) data (Lagiou & Trichopoulou, 2001; Trichopoulou *et al.* 2002).

Methodology

The household surveys under the Improvement of Surveys and the Measurement of Living Conditions in Latin America and the Caribbean programme

The household surveys were carried out in nationally representative samples of households, which were different in each survey year and were derived using a two-stage complex design for each survey year. Monthly food acquisitions (purchases and own production) were recorded through an interviewer-administered, quantitative frequency questionnaire, which included sixty food items and beverages (fifty-eight items in 1999). Information on the monetary values of the acquired foods was also recorded. Payment in kind received during the recording period was only reported in monetary values. The selection of the items to be included in the list was based on the Bolivian HBS of 1990, and on the Follow-up of Food Consumption in 1992 (National Institute of Statistics, 1995). All interviews were carried out during 4 weeks between the months of November and December of each survey year. Further details on methodological issues are available at the website of the Bolivian National Institute of Statistics (http://www.ine.gov.bo). For the present study, data of 19 483 households (3035 in 1999, 4857 in 2000, 5845 in 2001 and 5746 in 2002) were retrieved.

Data management

Data were cleaned, harmonised and analysed according to the methodology developed in the DAFNE project for the estimation of daily individual food availability based on national HBS data (Lagiou & Trichopoulou, 2001). The DAFNE initiative refers to a collaborative effort of twenty-four European countries to compare the food habits of their populations and monitor trends in food availability over time, through the creation of a regularly updated food databank. Making use of the comparable between-countries HBS, the DAFNE project aims at post-harmonising the available food and socio-demographic data and at storing them in a standardised database which can serve as a nutrition monitoring tool assisting the formulation, implementation and evaluation of nutritional policies across Europe.

According to DAFNE methodology, food availability was estimated as the sum of food purchases, own production and gifts. Since food gifts were only recorded in monetary values, quantities were estimated using the average price per unit weight of each food item (Friel *et al.* 2001). To express the daily food availability in g per individual, intra-household food allocation was assumed to be equal among all members. Food items were aggregated according to the DAFNE food classification scheme (European Commission, 2005). The Bolivian food composition tables (Ministry of Social Forecast and Public Health, 1979; SVEN, 1988) were used to estimate the daily individual availability of selected nutrients.

Socio-demographic disparities in food availability were evaluated, taking into consideration the area where the household was located (grouped as rural and urban), the educational attainment of the household head (classified as illiterate or elementary education not completed, elementary education completed, secondary education not completed, secondary education completed, and higher education) and the household expenditure on food:total household expenditure ratio. This expenditure ratio has commonly been used as a proxy for the household's income and has been recognised as a measure of intra-household food security, since those households with a high proportion of food expenses are more vulnerable when an unexpected event (for example, job loss, natural disaster) limits their purchasing capacity (James *et al.* 1997; Maxwell & Frankenberger, 2003).

Statistical analysis

Analyses were performed taking into account the multi-stage complex sampling design and after the application of weighting factors to allow for population inference. Intercooled Stata v. 7 software (StataCorp LP, College Station, TX, USA) was used to perform the analysis. Mean values were compared using ANOVA. $P<0{\cdot}05$ was considered as statistically significant.

Results

Table 1 shows the distribution of the 19 483 participating households, by demographic and socio-economic characteristics. Distributions are balanced in the four surveys. In all the datasets, in more than half of the households, residences are located in urban areas, their heads are either illiterate or of elementary education and more than 50 % of the household's expenses relate to food acquisition.

In Table 2, the mean daily availability of main food groups is presented, by survey year. The preferred food groups were, in order of consumption: cereals, fruits, tubers (including potatoes), vegetables, meat and meat products, milk and dairy products. The availability values of the first four food groups, as well as the

Table 1. Frequency distribution of households participating in the Household Surveys of 1999, 2000, 2001 and 2002 by demographic and socio-economic variables

Survey year...	1999		2000		2001		2002	
	n	%	*n*	%	*n*	%	*n*	%
Residence area								
Urban	1681	55	2749	57	2953	51	3299	57
Rural	1354	45	2108	43	2892	49	2447	43
Region of residence								
High plateau	1149	38	1957	40	2228	38	2387	42
Valleys	1019	34	1588	33	2064	35	1864	32
Low lands	867	29	1312	27	1553	27	1495	26
Educational level of the household head								
Illiterate or elementary education not completed	1782	59	2861	59	3576	61	3363	59
Elementary education completed	165	5	274	6	313	5	332	6
Secondary education not completed	291	10	485	10	624	11	655	11
Secondary education completed	284	9	537	11	539	9	567	10
Higher education	513	17	699	14	793	14	829	14
Household food expenditure ratio								
Quintile 1 (mean 0·22)	554	18	759	16	837	14	1009	18
Quintile 2 (mean 0·43)	572	19	919	19	998	17	1088	19
Quintile 3 (mean 0·56)	603	20	949	19	1171	20	1153	20
Quintile 4 (mean 0·68)	631	21	1091	23	1392	24	1291	22
Quintile 5 (mean 0·83)	675	22	1139	23	1446	25	1205	21
Total number	3035		4857		5845		5746	

Table 2. Availability of selected food groups among Bolivian households by survey year (g/person per d)*
(Mean values and standard deviations)

Survey year...	1999		2000		2001		2002	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Households (*n*)	3035		4857		5845		5746	
Cereals and cereal products	338	197	282	169	303	252	317	211
Meat and meat products	141	155	128	127	133	129	130	142
Fish and seafood	17	45	15	44	16	50	15	52
Milk and milk products	105	189	94	166	88	179	84	150
Eggs	22	30	20	25	21	27	20	23
Added lipids	26	17	23	16	28	24	34	31
Potatoes and starchy roots	215	169	217	219	225	201	236	213
Pulses	40	67	39	56	47	64	45	67
Vegetables	154	126	137	106	155	128	150	131
Fruits	261	316	228	290	266	292	245	228
Sugar and sugar products	65	44	60	45	69	209	66	67

* All $P \leq 0{\cdot}05$ (ANOVA).

noteworthy availability values for pulses (legumes), suggest a dietary profile based on plant foods. Taking 1999 as reference, a decrease in the daily household availability of milk, meat, fish and seafood, fruits, sugar products and cereals was generally observed, while the daily availability of tubers and added lipids increased. The daily availability of the remaining food groups (vegetables, pulses, eggs and beverages) either slightly changed or remained steady during the period under study.

Table 3 presents the mean daily individual availability of energy and selected macro- and micronutrients, by survey year. The observed trend is rather irregular, although the daily availability of energy and macronutrients generally decreased in 2000, increased in 2001 (but not reaching the 1999 values) and decreased again in 2002. Comparisons of the 1999 values with those of 2002 indicate a decrease in the daily availability of the energy-providing macronutrients, resulting in a subsequent decrease in the daily energy availability. Thus, when intakes are expressed as nutrient densities (that is, percentage contribution of each macronutrient to the total energy intake), values remain constant in all survey years (data not shown). On average, proteins provide 12 %, carbohydrates 68 % and fat 20 % of the total energy available at household level.

Table 4 shows the mean daily availability of selected food groups and nutrients according to the locality of the residence, classified as urban *v.* rural. Bolivian urban households reported significantly higher availability of meat, milk, eggs, pulses, vegetables, fruits, and sugar and sugar products available than their rural counterparts. Rural households seemed to prefer tubers (mainly potatoes and cassava). These differences were also reflected in comparisons between the nutrients. Taking 1999 as reference, urban households recorded a constant decline in the available energy, while energy availability in rural households did not change significantly.

Table 3. Daily individual availability of energy and selected nutrients among Bolivian households, by survey year*
(Mean values and standard deviations)

Survey year...	1999		2000		2001		2002	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Households (*n*)	3035		4857		5845		5746	
Energy (kJ)	11074	5624	9761	5176	10 486	7109	10 323	6799
Protein (g)	83	59	73	45	79	51	74	54
Fat (g)	57	36	50	32	58	50	55	41
Carbohydrates (g)	452	231	387	225	428	338	414	298
Fibre (g)	9·15	6·34	8·20	7·91	8·92	13·10	8·32	6·56
Ca (mg)	566	541	493	452	539	496	458	412
P (mg)	1199	765	1060	654	1151	771	1075	741
Fe (mg)	33	21	28	16	30	22	29	19
Vitamin A (μg)	1380	1177	1218	1067	1385	1185	1267	1207
Thiamin (mg)	0·97	0·59	0·87	0·54	0·96	0·66	0·93	0·66
Riboflavin (mg)	1·75	1·18	1·54	1·05	1·56	1·22	1·46	1·00
Vitamin C (mg)	120	110	106	102	117	115	100	88
Niacin (mg)	21	14	19	12	20	14	19	13

* All $P \leq 0{\cdot}05$ (ANOVA).

With respect to socio-economic disparities in food habits, Table 5 displays the mean daily availability of selected food groups and nutrients in Bolivian households classified by quintiles of their food expenditure ratio. Households in the lower quintiles (1 and 2), hence the wealthier ones, have more of all food groups available with exception of cereals and tubers. This is also reflected in the increase in the daily availability of carbohydrates, which increased only among deprived households (mean value of the food expenditure ratio was 0·83).

In Table 6 the availability of selected food groups and nutrients is presented according to the educational attainment of the household head. The more educated the household, the higher the availability of all food groups, with exception of potatoes and added lipids. The substantially higher daily availability of fat and protein among the trend-leading educated households should also be noted.

Discussion

We have used regularly collected and nation-representative data to estimate the daily food availability in Bolivian households and to identify food disparities within the country. Since in Bolivia the only data on food intake were collected in 1995 in the rural area of the capital city of La Paz (National Institute of Statistics, 1995) and no other dietary surveys have been undertaken since, the exploitation of the household surveys provide, for the time being, the only realistic alternative for monitoring the food habits of the population. The Bolivian dietary pattern is largely based on plant foods. Meat, milk and their products appear to be the important sources of animal fat and protein in the diet. This dietary pattern remains over the 4 years under study. Lower food availability values were recorded for all food items in the 2000 household survey, reflecting the lower agricultural yield and lower production of this year (National Institute of Statistics, 2004).

With respect to socio-economic disparities in food habits, the educational level of the household head has been used as a proxy indicator of social welfare (Liberatos *et al.* 1988). Households of highly educated individuals preferred food products considered as ‘healthy’ such as fruits and vegetables, but their higher purchasing capacity also allows access to meat and meat products, milk and dairy products, i.e. foods associated with wealth and higher social status.

Socio-economic differences in household food availability were also studied in terms of the households’ expenditure ratio (Table 5) (Trichopoulou *et al.* 2002). The dietary choices of the less advantaged households suggested that they acquired higher quantities of tubers, cereals and added lipids, probably reflecting their tendency to obtain energy from cheaper and energy-dense sources. In the overall population, the energy composition of the diet seems to be balanced. Significant differences ($P < 0{\cdot}001$) were, however, observed in the daily nutrient availability between quintiles of the ratio, showing that deprived households obtain more energy from carbohydrates (71 % of the daily energy in 2002) than the wealthier ones (65 % of the daily energy in 2002). The nutritional transition that is taking place in the country can also be observed, when rural and urban areas are compared. In 2002, rural households obtained 71 % of their daily energy from carbohydrates and 11 % from protein, whereas urban households obtained 67 % of energy from carbohydrates and 16 % from protein. A similar reduction in the contribution of carbohydrates to the daily energy is also observed as one moves from households of elementary to those of higher education. In this case, however, the reduction is mainly compensated by an increase in the energy contribution of fat (in 2002, fat contributed 20 % of energy among households of low education and 24 % among households of high education).

In general, individuals with low educational level, living in rural areas and in the higher quintiles of the expenditure ratio are the most vulnerable to food insecurity. The risk is higher in the rural areas of the highlands, which are the poorest of the country. These findings support previous reports associating socio-economically advantaged areas with healthier food choices (Turrell *et al.* 2004) and low education with an unhealthy diet (Krokstad *et al.* 2002; Shohaimi *et al.* 2004) and a higher risk for chronic diseases (Strand & Tverdal, 2004).

The estimated values for the daily availability of foods and macronutrients (Tables 2 and 3) are of the same magnitude as those previously published by the Bolivian National Institute of Statistics (National Institute of Statistics, 1995, 2000).

Table 4. Availability of selected foods and nutrients in Bolivian households by year and locality of the residence (person/d)
(Mean values and standard deviations)

	Urban								Rural							
	1999		2000		2001		2002		1999		2000		2001		2002	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Foods																
Cereals and cereal products (g)†‡	348	180	286	135	310	191	304	184	327	216	276	205	296	302	334	243
Meat and meat products (g)*†	188	159	163	133	162	136	160	140	89	132	81	101	83	109	97	135
Fish and seafood (g)*†	17	36	13	31	13	30	11	29	20	53	17	57	19	64	20	72
Milk and milk products (g)*†	137	194	117	173	106	162	102	156	65	174	62	153	71	193	60	138
Eggs (g)*	26	28	23	24	24	27	22	24	18	32	16	25	18	26	16	21
Added lipids (g)*†‡	29	16	25	15	30	20	32	30	25	18	22	18	28	28	31	33
Tubers (potatoes and starchy roots) (g)*‡	188	146	183	153	195	157	196	178	247	189	262	277	256	234	291	244
Pulses (g)*‡	52	70	46	58	50	62	48	68	29	60	26	51	37	66	30	65
Vegetables (g)*‡	176	123	160	104	170	124	165	133	131	126	109	102	134	128	121	125
Fruits (g)*†‡	324	312	264	244	301	295	252	225	210	311	182	337	192	278	152	220
Sugar and sugar products (g)*	68	43	66	44	70	54	71	64	59	46	57	45	64	292	62	70
Nutrients																
Energy (kJ)*†	11722	5354	10 101	4450	10 892	5693	10 256	6455	10 272	5856	9318	5969	10 072	8292	10 423	7267
Protein (g)*†	97	61	83	45	86	50	80	54	70	52	62	43	67	51	69	53
Fat (g)*†‡	64	36	56	31	61	38	58	37	49	35	44	32	54	60	54	46
Carbohydrates (g)†	468	216	402	176	438	241	413	283	438	248	402	277	422	414	441	319
Fibre (g)†	9	6	8	6	9	14	8	86	9	96	9	10	9	12	9	97
Ca (mg)*†	673	573	572	443	569	483	498	410	461	474	415	449	456	504	397	408
P (mg)*†	1366	762	117	626	122	753	113	714	105	734	957	670	102	777	104	776
Fe (mg)*†	36	22	30	14	32	22	30	17	30	19	26	18	28	22	29	22
Vitamin A (μg)*‡	1560	1149	141	978	148	1175	141	1216	118	1182	101	1135	120	1178	107	1168
Thiamin (mg)*†	1·04	0·59	0·90	0·48	1·01	0·66	0·93	0·61	0·89	0·58	0·82	0·60	0·90	0·66	0·93	0·71
Riboflavin (mg)*†	2·01	1·16	1·74	1·01	1·79	1·25	1·60	1·00	1·42	1·12	1·29	1·05	1·34	1·15	1·25	0·96
Vitamin C (mg)*†‡	135	111	115	87	129	116	107	87	102	106	95	118	104	112	89	88
Niacin (mg)*†	24	14	21	12	22	13	20	12	18	13	16	12	17	14	17	13

* Mean values were significantly different between urban and rural households in each survey year ($P<0·05$).
† Mean values were significantly different between survey years among urban households ($P<0·05$).
‡ Mean values were significantly different between survey years among rural households ($P<0·05$).

Table 5. Availability of selected foods and nutrients in Bolivian households by year and quintile of the food expenditure ratio (person/d)*
(Mean values and standard deviations)

	Quintile 1†								Quintile 2‡							
	1999		2000		2001		2002		1999		2000		2001		2002	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Food groups																
Cereals and cereal products (g)	285	180	264	142	261	191	256	183	343	186	281	134	299	146	305	173
Meat and meat products (g)	148	147	157	133	144	145	147	149	161	142	147	130	155	135	158	137
Fish and seafood (g)	15	35	12	27	11	28	9	21	17	38	15	42	14	30	11	32
Milk and dairy products (g)	149	212	153	205	144	203	135	188	125	192	107	176	115	179	89	135
Eggs (g)	24	29	21	20	22	26	21	23	27	34	22	24	24	25	22	24
Added lipids (g)	24	18	24	15	25	21	26	26	29	15	25	15	31	20	32	27
Tubers (g)	153	143	150	122	159	166	149	159	201	149	184	149	200	157	215	175
Pulses (g)	40	57	44	60	41	59	41	63	49	68	44	58	50	60	49	67
Vegetables (g)	146	127	154	109	149	137	138	138	168	117	157	112	176	121	173	129
Fruits (g)	309	297	258	244	293	314	256	240	303	310	247	271	306	315	238	217
Sugar and sugar products (g)	61	40	63	42	64	49	67	66	68	48	64	39	71	60	68	61
Nutrients																
Energy (kJ)	9868	5529	9409	4720	9440	6018	8921	5920	11 477	5188	9806	4661	10 913	5598	10 351	4990
Protein (g)	80	53	79	47	77	55	71	53	90	50	78	46	85	49	80	44
Fat (g)	55	38	55	33	56	41	53	41	62	33	54	31	63	40	60	37
Carbohydrates (g)	393	217	366	181	372	238	351	235	463	214	393	187	435	238	412	206
Fibre (g)	7·70	5·59	7·09	4·73	7·25	5·92	6·72	5·21	9·13	5·90	7·85	8·69	9·37	22·21	8·26	6·53
Ca (mg)	628	510	614	483	598	534	534	466	626	487	544	468	596	550	489	392
P (mg)	1153	740	1129	665	1104	794	1022	735	1294	726	1123	659	1222	798	1139	612
Fe (mg)	29	18	27	15	27	18	25	18	34	17	29	16	32	26	30	16
Vitamin A (μg)	1287	1100	1295	962	1260	1123	1166	1144	1453	1021	1371	1011	1510	1233	1482	1319
Thiamin (mg)	0·88	0·56	0·85	0·50	0·90	0·67	0·83	0·60	1·01	0·56	0·88	0·52	1·03	0·71	0·96	0·61
Riboflavin (mg)	1·76	1·16	1·70	1·05	1·65	1·19	1·52	1·09	1·89	1·15	1·66	1·13	1·80	1·49	1·60	0·91
Vitamin C (mg)	123	110	114	90	123	121	100	93	130	110	110	91	133	131	110	81
Niacin (mg)	20	14	20	12	20	15	18	14	23	13	20	13	22	13	20	12

Table 5. *Continued*

	Quintile 3§								Quintile 4‖							
	1999		2000		2001		2002		1999		2000		2001		2002	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Food groups																
Cereals and cereal products (g)	357	182	284	140	300	147	317	191	339	199	287	170	321	360	332	216
Meat and meat products (g)	159	158	134	129	130	125	131	124	134	149	116	117	116	122	125	139
Fish and seafood (g)	18	47	13	38	14	35	10	23	20	45	14	36	17	55	19	64
Milk and dairy products (g)	109	197	88	153	76	140	76	131	75	152	72	141	65	139	71	147
Eggs (g)	24	28	20	25	21	24	20	23	20	27	20	26	20	26	19	24
Added lipids (g)	29	16	25	15	30	20	32	27	27	18	25	17	31	30	33	34
Tubers (g)	228	161	198	174	214	167	224	197	234	175	236	223	245	206	254	217
Pulses (g)	52	73	39	54	50	66	43	72	38	63	37	55	43	65	37	60
Vegetables (g)	183	130	142	100	168	130	159	138	149	122	135	103	155	130	139	114
Fruits (g)	293	298	220	233	244	260	211	216	267	362	231	283	238	293	200	230
Sugar and sugar products (g)	66	35	66	48	66	44	67	61	66	51	61	45	63	54	67	65
Nutrients																
Energy (kJ)	11 759	5439	9719	4533	10 348	4889	10 324	6440	11 072	5708	9868	5263	10 776	7258	10 457	6041
Protein (g)	92	56	74	43	77	45	75	51	83	69	71	42	77	56	74	50
Fat (g)	61	36	51	31	57	34	57	40	55	34	50	32	58	44	56	41
Carbohydrates (g)	481	219	397	186	422	199	421	279	463	249	413	232	447	328	435	255
Fibre (g)	9·75	6·06	7·49	5·06	8·54	7·17	8·13	6·45	9·36	7·03	8·51	6·93	9·58	15·79	8·53	6·33
Ca (mg)	607	526	491	431	484	427	433	361	529	635	461	405	481	491	426	427
P (mg)	1319	780	1066	599	1116	657	1076	698	1186	724	1054	611	1133	858	1085	751
Fe (mg)	35	18	28	14	30	16	30	22	34	26	28	15	32	26	30	18
Vitamin A (μg)	1582	1159	1246	1012	1434	1171	1293	1134	1369	1292	1233	1108	1399	1206	1246	1036
Thiamin (mg)	1·05	0·60	0·84	0·46	0·95	0·59	0·91	0·61	0·95	0·58	0·87	0·52	0·97	0·73	0·92	0·63
Riboflavin (mg)	1·88	1·20	1·53	0·96	1·58	1·04	1·44	0·95	1·66	1·14	1·49	0·97	1·55	1·37	1·40	1·05
Vitamin C (mg)	132	110	101	86	116	98	98	88	117	120	107	102	116	119	94	82
Niacin (mg)	23	15	19	12	20	12	19	12	21	14	18	12	20	16	19	13

Table 5. *Continued*

	Quintile 5¶							
	1999		2000		2001		2002	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Food groups								
Cereals and cereal products (g)	361	226	288	223	314	280	361	262
Meat and meat products (g)	120	174	96	119	89	117	108	153
Fish and seafood (g)	20	55	18	63	21	70	23	82
Milk and dairy products (g)	76	183	66	152	70	214	60	137
Eggs (g)	20	31	17	26	19	31	16	22
Added lipids (g)	26	19	21	18	28	25	32	39
Tubers (g)	246	191	286	309	269	249	323	259
Pulses (g)	30	71	26	51	36	68	35	73
Vegetables (g)	135	130	112	103	124	116	124	134
Fruits (g)	206	301	200	372	193	275	152	225
Sugar and sugar products (g)	62	46	58	46	72	410	67	78
Nutrients								
Energy (kJ)	11 116	6072	9894	6203	10 639	9544	11 515	9645
Protein (g)	80	62	67	47	71	50	76	70
Fat (g)	54	39	46	33	55	72	55	47
Carbohydrates (g)	466	245	426	292	450	502	497	447
Fibre (g)	9·62	6·78	9·51	11·01	9·24	7·10	9·81	7·68
Ca (mg)	518	526	449	465	461	481	409	400
P (mg)	1185	839	1043	725	1069	731	1158	884
Fe (mg)	33	22	28	20	29	21	32	21
Vitamin A (μg)	1280	1260	1116	1168	1167	1155	1158	1370
Thiamin (mg)	0·96	0·62	0·89	0·65	0·92	0·61	1·02	0·81
Riboflavin (mg)	1·58	1·23	1·40	1·11	1·36	0·97	1·33	0·98
Vitamin C (mg)	102	98	103	127	103	106	96	95
Niacin (mg)	20	16	18	13	18	13	19	13

* Significant differences between quintiles of food expenditure in each survey year, with the exception of sugar and sugar products and P ($P<0·05$; ANOVA).
† All differences between survey years within quintile 1 were NS ($P>0·05$; ANOVA).
‡ Significant differences between years in quintile 2 for cereals and cereal products ($P=0·016$), added lipids ($P<0·001$), fruits ($P=0·006$), energy ($P=0·023$), fat ($P=0·023$), carbohydrates ($P=0·028$), Ca ($P=0·025$), thiamin ($P=0·039$) and vitamin C ($P=0·019$) (ANOVA).
§ Significant differences between years in quintile 3 for cereals and cereal products ($P=0·002$), added lipids ($P=0·001$), vegetables ($P=0·025$), fruits ($P=0·02$), and for all macro- and micronutrients except fat (ANOVA).
|| All differences between survey years within quintile 4 were NS ($P>0·05$), except for vitamin C ($P>0·05$; ANOVA).
¶ All differences between survey years within quintile 5 were NS ($P>0·05$), except for cereals ($P=0·002$), tubers ($P=0·012$) and added lipids ($P<0·001$) (ANOVA).

Table 6. Availability of selected foods and nutrients in Bolivian households by year and educational level of the household head (person/d)*

(Mean values and standard deviations)

	Illiterate or incomplete elementary†								Elementary education‡							
	1999		2000		2001		2002		1999		2000		2001		2002	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Food items																
Cereals and cereal products (g)	335	207	280	177	302	279	324	225	332	202	301	224	287	168	310	175
Meat and meat products (g)	114	139	105	118	99	116	111	129	138	174	143	134	118	116	131	116
Fish and seafood (g)	18	49	15	51	15	49	15	58	19	40	15	36	20	59	19	58
Milk and dairy products (g)	77	173	67	147	68	175	61	130	104	180	95	143	75	131	76	134
Eggs (g)	20	30	18	25	18	27	17	21	21	26	21	21	19	23	19	25
Added lipids (g)	26	18	23	17	28	26	30	30	25	17	25	16	28	24	33	37
Tubers (g)	232	177	246	251	246	222	265	231	217	191	197	177	193	162	228	198
Pulses (g)	36	65	34	55	41	66	38	69	37	56	34	46	40	55	38	53
Vegetables (g)	145	129	127	106	144	130	135	130	138	112	140	102	141	100	153	140
Fruits (g)	227	291	190	294	208	274	171	215	309	412	248	265	214	225	229	236
Sugar and sugar products (g)	61	44	60	44	66	264	63	64	69	39	60	37	58	37	70	79
Nutrients																
Energy (kJ)	10 584	5618	9467	5394	10 180	7764	10 169	6646	11 050	6276	10 127	5206	9728	4901	10 048	5227
Protein (g)	76	53	67	44	70	50	71	51	82	60	77	48	72	44	72	43
Fat (g)	52	34	47	32	54	55	52	41	54	38	53	30	55	37	52	32
Carbohydrates (g)	445	236	399	243	426	383	427	292	462	266	415	226	394	200	418	221
Fibre (g)	9·08	6·17	8·29	7·32	8·92	11·14	8·48	6·83	9·11	8·49	8·17	6·12	8·22	10·06	7·93	6·06
Ca (mg)	495	473	434	429	447	467	395	352	567	491	495	381	472	404	409	301
P (mg)	1125	730	1007	646	1049	755	1046	729	1193	860	1118	696	1049	643	1038	620
Fe (mg)	31	19	27	16	29	21	30	21	33	20	30	16	29	17	29	16
Vitamin A (μg)	1298	1180	1163	1118	1283	1200	1216	1236	1283	945	1193	874	1230	1027	1245	1099
Thiamin (mg)	0·92	0·57	0·84	0·56	0·91	0·65	0·91	0·66	0·94	0·65	0·87	0·54	0·86	0·54	0·86	0·53
Riboflavin (mg)	1·55	1·12	1·38	0·99	1·40	1·14	1·32	0·93	1·74	1·28	1·60	1·01	1·45	1·01	1·38	0·85
Vitamin C (mg)	107	101	98	105	109	109	92	86	126	130	103	89	102	92	91	65
Niacin (mg)	19	13	18	12	18	13	18	12	21	17	20	14	18	12	18	11

Table 6. *Continued*

	Secondary not completed§								Secondary completed‖							
	1999		2000		2001		2002		1999		2000		2001		2002	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Food items																
Cereals and cereal products (g)	339	177	283	167	314	290	305	191	356	176	278	123	311	172	300	200
Meat and meat products (g)	152	127	149	137	151	132	157	165	200	173	150	115	156	133	158	138
Fish and seafood (g)	20	51	14	32	17	41	14	43	20	36	12	24	14	29	14	34
Milk and dairy products (g)	100	146	108	177	96	158	100	170	152	211	121	182	116	189	107	154
Eggs (g)	25	32	22	26	24	27	21	27	29	32	22	21	25	28	24	24
Added lipids (g)	29	17	25	15	31	20	34	40	30	17	26	15	28	21	32	29
Tubers (g)	181	145	187	180	212	186	205	195	185	137	170	136	177	141	191	180
Pulses (g)	46	69	41	59	48	65	40	54	46	62	39	48	44	60	40	59
Vegetables (g)	160	115	152	108	166	125	151	128	183	123	152	101	163	123	152	118
Fruits (g)	314	299	267	294	294	309	225	211	323	293	287	287	296	288	253	224
Sugar and sugar products (g)	70	50	66	51	68	46	68	64	71	40	64	41	71	54	73	76
Nutrients																
Energy (kJ)	11 224	4869	10 048	5221	11 060	6845	10 411	9874	12 047	5092	9899	4343	10 878	5931	9980	4876
Protein (g)	90	81	79	47	84	55	78	79	99	55	78	40	85	49	76	42
Fat (g)	59	33	53	32	62	36	57	41	67	33	56	30	60	38	59	36
Carbohydrates (g)	459	206	408	219	447	305	427	457	476	200	395	178	440	262	399	203
Fibre (g)	8·91	5·65	8·00	5·58	8·92	6·88	8·01	6·67	9·02	5·23	7·91	10·41	9·53	29·75	7·51	4·96
Ca (mg)	615	794	548	470	551	463	486	579	692	469	569	443	592	563	492	330
P (mg)	1238	622	1121	646	1199	784	1110	907	1399	736	1131	594	1227	898	1096	585
Fe (mg)	35	33	30	15	32	23	30	19	36	17	29	15	32	32	29	14
Vitamin A (μg)	1461	1389	1410	1057	1431	1132	1291	1383	1578	1096	1336	966	1431	1302	1264	969
Thiamin (mg)	0·96	0·51	0·87	0·50	1·01	0·69	0·91	0·76	1·04	0·55	0·87	0·48	1·01	0·79	0·90	0·60
Riboflavin (mg)	1·81	0·97	1·67	1·07	1·73	1·14	1·54	1·23	2·08	1·15	1·71	1·04	1·80	1·74	1·55	0·82
Vitamin C (mg)	126	110	113	104	125	116	100	85	132	99	116	99	126	141	105	90
Niacin (mg)	22	12	20	13	21	15	19	15	25	15	20	11	21	13	19	11

Table 6. *Continued*

	Higher education¶							
	1999		2000		2001		2002	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Food items								
Cereals and cereal products (g)	341	186	286	143	297	149	310	189
Meat and meat products (g)	211	179	179	139	188	154	189	161
Fish and seafood (g)	16	27	16	33	22	63	14	43
Milk and dairy products (g)	179	229	166	201	160	198	153	185
Eggs (g)	28	27	25	25	28	27	26	26
Added lipids (g)	29	16	25	15	31	21	33	28
Tubers (g)	189	153	164	136	184	143	180	156
Pulses (g)	58	78	50	63	52	63	55	78
Vegetables (g)	179	126	160	108	178	126	178	139
Fruits (g)	373	361	309	258	366	339	315	252
Sugar and sugar products (g)	70	45	70	46	76	58	77	67
Nutrients								
Energy (kJ)	12 165	6001	10 529	4743	11 451	5389	11 193	6236
Protein (g)	104	61	90	47	96	53	90	55
Fat (g)	71	42	62	33	71	42	70	45
Carbohydrates (g)	472	236	407	187	439	210	432	250
Fibre (g)	9·63	7·18	8·21	9·85	8·76	5·54	8·62	6·52
Ca (mg)	787	583	713	491	743	558	669	488
P (mg)	1489	872	1289	675	1366	726	1300	756
Fe (mg)	37	21	31	17	32	16	31	18
Vitamin A (μg)	1613	1130	1410	969	1561	1102	1471	1121
Thiamin (mg)	1·12	0·67	0·96	0·51	1·10	0·61	1·06	0·63
Riboflavin (mg)	2·23	1·30	1·97	1·14	2·03	1·14	1·89	1·09
Vitamin C (mg)	154	132	128	92	145	120	126	99
Niacin (mg)	26	16	23	13	24	14	23	14

* Differences between educational categories were significant in each survey year ($P<0·05$; ANOVA).
† Significant differences between years in the educational category: cereals and cereal products ($P<0·001$), added lipids ($P<0·001$), vegetables ($P=0·027$), fruits ($P=0·002$), fat ($P=0·009$), Ca ($P=0·004$), Fe ($P=0·025$), riboflavin ($P=0·018$) and vitamin C ($P=0·002$) (ANOVA).
‡ Differences between years in the educational category 'elementary education' were NS ($P>0·05$) for all food groups and nutrients (ANOVA).
§ Differences between years in the educational category 'secondary not completed' were NS ($P>·05$), with the exception of added lipids ($P=0·039$) (ANOVA).
|| Differences between years in the educational category 'secondary completed' were NS ($P>0·05$), with the exception of energy ($P=0·045$), protein ($P=0·018$) and niacin ($P=0·021$) (ANOVA).
¶ Differences between years in the educational category 'higher education' were NS ($P>0·05$), with exception of added lipids ($P=0·001$) (ANOVA).

The increase in the availability of added lipids (butter, vegetable fat and oils) and potatoes (including all starchy tubers) may partly be responsible for the observed 10 % increase in the prevalence of overweight among Bolivian women in childbearing age, during a period of 4 years (Perez-Cueto & Kolsteren, 2004). Further research is, however, needed in order to evaluate associations between eating patterns and the nutritional status of the population, adequately controlling for potential confounders (for example, physical activity). In general, findings agree with previous observations that the country is undergoing a nutritional transition (Perez-Cueto & Kolsteren, 2004). In fact, development and sustained economic growth in some of the wealthier regions of the country (the low lands) is translated to changes in physical activity and diet. The traditional diets, based on foods of plant origin, low meat, and moderate milk consumption, that are still common in rural areas, have been replaced by energy dense foods mainly in the large cities. Bolivian urban households have more food available than rural ones do ($P<0{\cdot}05$), with the exception of tubers and starchy roots ($P<0{\cdot}05$). In rural Bolivia, the availability of most of the food groups remained steady in the period; however, in contrast to the national trend, rural households increased significantly their availability of cereals, tubers and meat. It is also important to highlight that in 2002, 52 % of the households who had less than 8372 kJ (2000 kcal)/person per d available were living in the rural areas.

To assure comparability, data were managed and analysed according to DAFNE methodology, which has been developed and validated in Europe (Naska *et al.* 2001). This post-harmonisation of the Bolivian household survey data further allows comparisons of the Bolivian food habits with those of other countries, bearing, however, in mind that the methods used for data collection are not directly comparable. Food data in the Bolivian household surveys of the MECOVI programme were collected using quantitative frequency questionnaires, while the European HBS make use of records on food acquisition kept by the household members during the reference period. In comparison with the dietary patterns observed in European countries, the Bolivian diet combines Northern and Southern patterns. In fact, the meat availability is of the same magnitude of Italy, the UK, Germany and Norway. The availability of added lipids was lower in Bolivia than in all European countries, although in 2002 the levels reached those of the UK, Germany, Finland and Norway, suggesting a step further into the nutritional transition. The availability of fruits was similar to the availability in the southern European countries (Spain, Italy and Greece).

The present study shows that DAFNE methodology is also applicable to data collected in developing countries and the use of the cost-efficient and regularly collected household surveys may constitute an important tool for nutritional surveillance and policy making at national and sub-national level (Trichopoulou, 2001), provided that the standardised DAFNE methods are applied to assure the comparability of the data (Friel *et al.* 2001; Lagiou & Trichopoulou, 2001; Naska *et al.* 2001).

Strengths of our investigation are the use of regularly collected and nationally representative data. The present study may, however, be limited by estimating the intra-household food allocation without considering the age and sex of the household members, and by missing information on meals taken outside the household premises. The lack of quantitative information on eating out and the need to individualise the data are well-known shortcomings of household surveys. Stochastic statistical models to individualise the data taking into account the members' age and sex have been applied and validated in the context of the DAFNE project and pointed in favour of the nutritional information available in such surveys (Naska *et al.* 2001). The present study may also be limited by the incomplete capture of seasonal variation in the diet, since the data were collected during 2 months (November–December). The questionnaire applied intended to cover the seasonal variations, and hence we believe that the results fairly reflect the daily availability. The use of a pre-defined list of food items may also introduce problems, although frequency questionnaires are commonly used for depicting food consumption, due to their lower relative cost, and the reduced burden imposed on participants (Bonifacj *et al.* 1997; Subar *et al.* 2001). The design of a food-frequency questionnaire may carry bias to over- or underestimation of food acquisition depending on the pre-defined list of food items (Bonifacj *et al.* 1997). Since, however, the questionnaires used in all four surveys were the same, systematic errors introduced by the design of the questionnaires will not limit the potential for monitoring changes over time.

The Bolivian diet is predominantly based on foods of plant origin such as potatoes, cereals, fruits and vegetables. Meat, milk and their products follow in the preference of Bolivians. In the period 1999–2002 an overall decrease in the availability at household level of most food groups was observed, while the availability of potatoes, pulses and added lipids increased. The present study allowed identifying disparities within the country. Poorer households choose significantly more potatoes and cereals as their source of energy than wealthier ones. Urban households systematically reported having more food available than rural households.

The present study evaluates an alternative for assessing and monitoring food availability and security in developing countries. To date, the only data available are the regularly published food balance sheets (Food and Agriculture Organization, 2004),which allow following changes at the country level over time, but they do not allow depicting disparities among sub-population groups.

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