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Energy intake and food sources of eight Latin American countries: results from the Latin American Study of Nutrition and Health (ELANS)

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Abstract

Objective: Few previous studies in Latin America (LA) have provided data on dietary intake composition with a standardized methodology. The present study aimed to characterize energy intake (EI) and to describe the main food sources of energy in representative samples of the urban population from eight LA countries from the Latin American Study in Nutrition and Health (ELANS).

Design: Cross-sectional study. Usual dietary intake was assessed with two non-consecutive 24 h dietary recalls.

Setting: Urban areas from eight countries (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru, Venezuela), September 2014 to July 2015.

Subjects: Adolescents and adults aged 15–65 years. Final sample comprised 9218 individuals, of whom 6648 (72·1 %) were considered plausible reporters.

Results: Overall, mean EI was 8196 kJ/d (1959 kcal/d), with a balanced distribution of macronutrients (54 % carbohydrate, 30 % fat, 16 % protein). Main food sources of energy were grains, pasta and bread (28 %), followed by meat and eggs (19 %), oils and fats (10 %), non-alcoholic homemade beverages (6 %) and ready-to-drink beverages (6 %). More than 25 % of EI was provided from food sources rich in sugar and fat, like sugary drinks, pastries, chips and candies. Meanwhile, only 18 % of EI was from food sources rich in fibre and micronutrients, such as whole grains, roots, fruits, vegetables, beans, fish and nuts. No critical differences were observed by gender or age.

Conclusions: Public health efforts oriented to diminish consumption of refined carbohydrates, meats, oils and sugar and to increase nutrient dense-foods are a priority in the region to drive to a healthier diet.

Keywords
Energy intake
Food sources
Latin America
Survey
Plausible reporters

† A full list of the ELANS Study Group members is available in the Appendix.

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Most surveys on dietary sources of energy, diet composition and food patterns have been performed in North American or European countries. Relatively little information is available on dietary intakes within the Latin American region, which is still distinctive in its culture, agriculture, and food sources and habits. Differences in geographical location, climate, food access and level of economic development are key determinants of the Latin American diet[1,2].

Latin American countries have been experiencing a nutrition transition during the last 40 years, moving from under- to overweight while still experiencing nutritional deficiencies[1,3]. As a result of this transition, alarming rates of overweight (32·0 %) and obesity (19·6 %) have been described in most of the countries of the region, and these rates are projected to increase to 38·1 and 43·6 %, respectively, by 2030[4]. Total energy intake (EI) has increased substantially in most Western countries and this increase in energy supply has been directly associated with the increase in overweight and obesity prevalence[5]. In the USA, however, average EI did not change significantly between 1988 and 2010[6].

It has been suggested that the excessive intake of energy is especially associated with the increased reliance on processed foods and high intakes of refined carbohydrates, added sugars, fats and animal-source foods[7]. Results from the National Health and Nutrition Examination Survey (NHANES) have shown that the percentage of energy from carbohydrate increased, whereas the percentage of energy from fat and protein decreased in the USA from 1971 to 2006[8,9].

Few previous studies have provided detailed data on Latin American dietary composition with standardized accurate methodology and examined differences across countries and among regions within the same country. Identification of food sources of EI in representative samples of the Latin American population is necessary to determine feasible and appropriate dietary recommendations. Moreover, identification of the main food sources of energy is particularly important for supporting public health efforts to oppose the epidemic of obesity and other non-communicable diseases.

The purpose of the current study was to provide updated data on EI and its food sources in representative samples of the urban population from eight Latin American countries, assessed with the same methodology, to provide better understanding of the dietary practices of these populations with a focus on the differences between regions, age groups and gender.

Methods

The Latin American Study of Nutrition and Health (Estudio Latinoamericano de Nutrición y Salud; ELANS) is a household-based multinational cross-sectional survey. ELANS aimed to describe the nutritional status in Latin America and to investigate food and nutrient intakes in representative samples from urban populations, where 80–90 % of the population is living. Eight Latin American countries (i.e. Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru and Venezuela) were involved. The fieldwork for ELANS was conducted from September 2014 to July 2015.

Sample

The sample consisted of 9218 adolescents and adults aged 15–65 years from the urban population of eight Latin American countries. It was a random complex multistage sample, stratified by geographical region, gender, age and socio-economic level, with a random selection of primary sampling units and secondary sampling units. For the selection of households within each secondary sampling unit, households were selected through systematic randomization. Selection of a respondent within a household was done using 50 % of the sample next birthday, 50 % last birthday, controlling quotas for gender, age and socio-economic level. The representative sample size was established with a confidence level of 95 % and a maximum error of 3·49 %. Sample weighting was applied at each country level.

Socio-economic level was evaluated by questionnaire using a country-dependent format and based on the legislative requirements or established local standard layouts. The standard study protocol was designed to evaluate the nutritional intakes, physical activity levels and anthropometric measurements. More details of this study can be found in a previous publication[10].

Dietary assessment

The dietary assessment was conducted face-to-face during two household visits on non-consecutive days, with an interval of up to 8 d between them. In both visits, a 24 h dietary recall was conducted by trained interviewers using the multiple-pass method[11] to assess all foods and beverages consumed over the prior day. A photographic album containing the most commonly used household utensils and portion sizes was used to improve accuracy in the estimation of food servings. These were specific to each country, including local food item pictures and common utensils, and standardized within the country. The 24 h recalls included both weekdays and weekend days, with a proportional distribution of days among the sample, to capture the day-to-day variation in intakes. The 24 h recalls were supervised by trained nutritionists who were also responsible for converting the measures obtained into grams and millilitres. Data consistency was made at each site and a randomized double check was made by telephone.

The food and beverage intakes recorded were converted into energy, macronutrient and micronutrient values using the Nutrition Data System for Research (NDS-R version 2013; University of Minnesota, Minneapolis, MN, USA). To use the NDS-R software which is based on the US Department of Agriculture composition table, a standardized procedure matching local foods to US Department of Agriculture foods was conducted by professional nutritionists in each country to minimize errors and verify quantities of key nutrients, which, for the purpose of the present article, are referred to as energy and its sources from consumed foods. The complete procedure for standardization of the food composition database has been described in detail elsewhere[12].

Regional foods without an exact equivalent available in the NDS-R database were broken down into ingredients and entered into the software as user recipes. Local teams were responsible for creating a recipe that represented the same nutritional value as the original version. They were obtained from national publications, recipe books and local culinary websites of each country and checked against actual data from 24 h recalls. Consistency checks were run to minimize errors and to verify results for key nutrients.

Food consumption was organized to characterize EI. A total of 3351 types of foods and beverages were reported in both 24 h recalls for all countries. They were grouped into ninety-three food items, according to nutritional similarities. In addition to the coding into ninety-three items, foods were further categorized into eighteen food groups, representing a larger and general group list. The list of the ninety-three food items and eighteen food groups is shown in Table 3. This categorization was based not only the nutritional value of each food, but also the food's preparation and eating time. The percentage contribution of each food item to EI was calculated using the weighted-proportions formula developed by Block *et al.*[13], in which the relative contribution (RC) of a given food item is defined as:

$$\text{RC} = \frac{\text{Total EI from a food item}}{\text{Total energy in all foods consumed}}.$$

The percentage contribution of each food item to EI was calculated for the overall population, as well as separately for each country.

Usual intake

Two 24 h recalls were used to estimate usual food consumption and to evaluate intra-individual variability in nutrient intakes. The web-based statistical modelling technique Multiple Source Method (MSM; https://msm.dife.de/tps/en), proposed by the European Prospective Investigation into Cancer and Nutrition (EPIC), was used to estimate energy and macronutrient intakes. This method was chosen because of its capability to improve estimates of usual dietary intake of energy, nutrients, foods and food groups by considering within-person variance in the intake, thereby improving the usual intake distribution for the population[14]. It has also been largely used in other Latin American studies for usual intake estimation[15–17]. To minimize errors derived from the method, the estimation of usual intakes was conducted individually for each country, thus taking differences in eating habits among the Latin American populations into account. The relative contribution of each macronutrient to total EI was subsequently calculated.

Anthropometry

The anthropometric measurements of body weight, height and waist, hip and neck circumferences were collected according to standardized procedures[10]. Categorization of nutritional status by BMI in adolescents (15–19 years old) was based on the gender-specific BMI-for-age cut-off points from the WHO[18] for underweight (BMI-for-age < -2 SD), normal weight (-2 SD $\geq$ BMI-for-age ≤ 1 SD), overweight (1 SD $\geq$ BMI-for-age ≤ 2 SD) and obesity (BMI-for-age > 2 SD) categories. For adults and elderly (older than 19 years), BMI was categorized as underweight ($<18{\cdot}5$ kg/m^2), normal weight (18·5–24·9 kg/m^2), overweight (25·0–29·9 kg/m^2) and obesity ($\geq 30{\cdot}0$ kg/m^2)[19].

Physical activity

Physical activity was assessed by the International Physical Activity Questionnaire (IPAQ) – Long Form, adapted from the Mexican (Spanish) version, allowing the determination of levels of physical activity as well as sedentary habit. More details are available in a previous publication[10]. In the present study, the information collected by the IPAQ was used to predict the total energy expenditure (TEE) on physical activities for each participant. The TEE was estimated from the participant's age, height, weight and overall activity level using a predictive equation developed by the Institute of Medicine[20]. Briefly, the level of each individual activity for each participant was calculated as a function of the participant's basal energy expenditure and body weight and the duration and metabolic equivalent of task score of each activity. The physical activity level (ΔPAL) for each participant was determined by summing up the PAL across all individual activities that were done by that participant. Finally, the TEE was predicted based on the Dietary Reference Intake equations and then used to identify the misreporters of EI, as described below.

Misreporting of energy intake

Misreporting of EI was calculated based on the methodology used by McCrory *et al.*[21], according to the following equation:

$$\text{SD} = \sqrt{(\text{CV}^2_{\text{wEI}} / d) + \text{CV}^2_{\text{wpTEE}} + \text{CV}^2_{\text{pTEE}}},$$

where CV_{wEI} is the within-subject CV in EI over the number of days of diet assessment (d), CV_{wpTEE} is the within-subject CV of measuring the TEE by the doubly labelled water method and CV_{pTEE} is the CV of predicting the TEE. In the present study, CV_{wEI} (31·2 %) was estimated based on both 24 h recalls from the overall ELANS population, so the number of days (*d*) was two. CV_{wpTEE} was set to 8·2 %, as estimated from doubly labelled water measurements[22] and CV_{pTEE} was 17·7 %, as estimated from prediction equations of TEE[21,23]. To identify the misreporting, the ±1·5 SD cut-off point was used to statistically compare reported EI with predicted TEE (EI:TEE). Under-reporting was defined as EI:TEE < −1·5 SD and over-reporting as EI:TEE > +1·5 SD. It should be highlighted that EI from the first 24 h recall was used in this approach[24,25].

Ethics

The ELANS protocol was approved by the Western Institutional Review Board (#20140605) and registered at clinicaltrials.gov (#NCT02226627). It was also approved by a local ethics committee in each country. All participants gave their informed consent/assent before participation in the survey. The complete design, protocol and methodology of ELANS have been described elsewhere[10].

Statistical analysis

Descriptive analyses of central tendency and dispersion were applied to estimate and describe the population according to gender, age group (adolescents (15–19 years old), younger adults (20–34 years), adults (35–49 years) and older adults (50–65 years)), socio-economic level (low, medium and high) and nutritional status (underweight, normal weight, overweight and obesity) by each country. Linear regression analysis was performed to identify the independent predictors of EI, considering a *P* value of <0·05 as statistically significant. All analyses were carried out using the statistical software package Intercooled Stata version 13.0.

Results

Of 10 134 eligible participants initially assessed in the first visit, 9680 participants had two complete visits and 9218 participants satisfied the analysis of inconsistencies or partially missing data (Fig. 1). Overall and country-level population sociodemographic characteristics are shown in Table 1. The largest sample was from Brazil (*n* 2000) and the smallest from Costa Rica (*n* 798). Overall, 52·2 % were women, 37·7 % were aged 20–34 years and 38·4 % were categorized as medium socio-economic level. Most of the sample had excess weight (59·6 %), with the highest proportion in Chile (68·6 %) and the lowest proportion in Colombia (50·7 %). After adjusting for misreporting, the plausible reporters were 6648 individuals (72·1 %), who were used for further analyses.

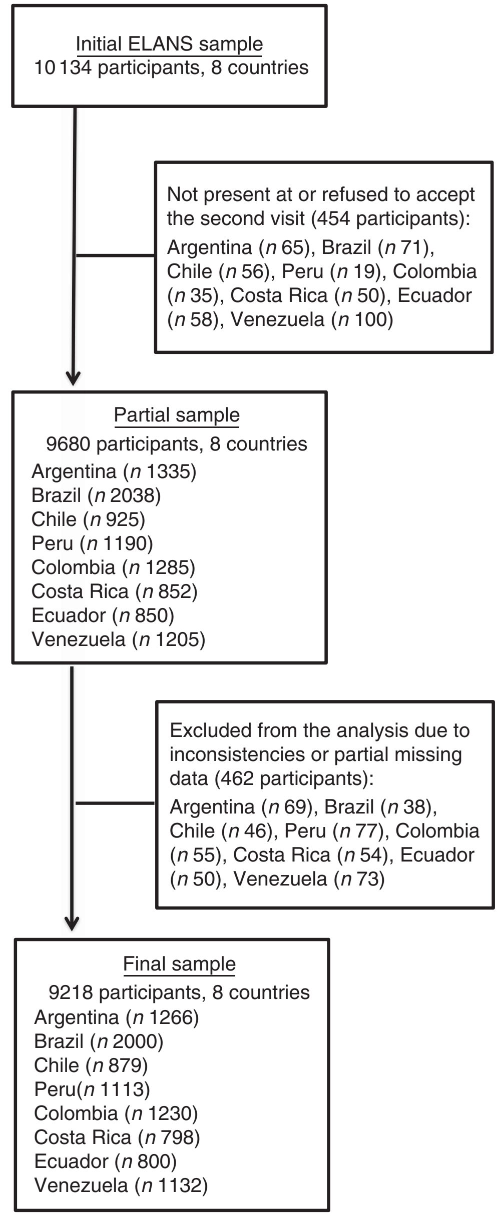

Fig. 1 Flow diagram of the study participants in the Latin American Study of Nutrition and Health (ELANS)

Energy intake and distribution

Usual EI and macronutrients as a percentage of EI by country, gender and age of the plausible reporters are shown in Table 2. Mean EI was 8196 (SD 1954) kJ/d (1959 (SD 467·1) kcal/d). Ecuador had the highest reported EI (8828 kJ/d (2110 kcal/d)) and Chile the lowest (7448 kJ/d (1780 kcal/d)). Men reported higher EI than women (*P* < 0·001), independent of age group and country. Adolescents reported consuming more energy than middle-aged and older groups (*P* < 0·001). In all countries, the highest EI was observed in young men and the lowest in older women, with a difference of approximately 2510 kJ/d (600 kcal/d). The mean contribution of macronutrients to EI was 54·4 (SD 6·9) % for carbohydrate, 29·6 (SD 5·7) % for fat and 16·0 (SD 2·9) % for protein. Peru had the highest percentage of energy derived

Table 1 Sociodemographic characteristics of adolescents and adults aged 15–65 years in the Latin American Study of Nutrition and Health (ELANS), September 2014–July 2015*

	ELANS		Argentina		Brazil		Chile		Colombia		Costa Rica		Ecuador		Peru		Venezuela	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Sample size	9218	100·0	1266	100·0	2000	100·0	879	100·0	1230	100·0	798	100·0	800	100·0	1113	100·0	1132	100·0
Gender																		
Men	4409	47·8	573	45·3	942	47·1	425	48·4	603	49·0	394	49·4	397	49·6	523	47·0	552	48·8
Women	4809	52·2	693	54·7	1058	52·9	454	51·6	627	51·0	404	50·6	403	50·4	590	53·0	580	51·2
Age (years)																		
15–19 years	1223	13·3	152	12·1	235	11·8	118	13·4	148	12·0	121	15·2	128	16·0	165	14·8	156	13·8
20–34 years	3479	37·7	446	35·2	745	37·2	307	34·9	445	36·2	301	37·7	316	39·5	460	41·3	459	40·5
35–49 years	2627	28·5	379	29·9	608	30·4	252	28·7	335	27·2	224	28·1	222	27·8	294	26·4	313	27·7
50–65 years	1889	20·5	289	22·8	412	20·6	202	23·0	302	24·6	152	19·0	134	16·8	194	17·4	204	18·0
Socio-economic level																		
High	880	9·6	65	5·1	169	8·4	80	9·1	67	5·4	108	13·5	104	13·0	225	20·2	62	5·5
Medium	3542	38·4	585	46·2	915	45·8	388	44·1	384	31·2	428	53·6	297	37·1	355	31·9	190	16·8
Low	4796	52·0	616	48·7	916	45·8	411	46·8	779	63·3	262	32·8	339	49·9	533	47·9	880	77·7
BMI																		
Underweight	306	3·3	37	2·9	87	4·3	5	0·6	59	4·8	27	3·4	28	3·5	24	2·2	39	3·5
Normal	3420	37·1	493	38·9	749	37·5	271	30·8	548	44·5	267	33·4	288	36·0	414	37·5	390	34·5
Overweight	3167	34·4	399	31·5	664	33·2	332	37·8	419	34·1	260	32·6	287	35·9	422	38·3	384	33·9
Obesity	2315	25·2	337	26·6	500	25·0	271	30·8	204	16·6	244	30·6	197	24·6	243	22·0	319	28·1

*Including the whole sample of the ELANS (plausible and non-plausible cases).

from carbohydrate (62·9 %) and Argentina and Brazil the lowest (51·3 and 51·5 %, respectively). Argentina had the highest percentage of energy derived from fat (32·6 %) and Brazil the highest from protein (17·8 %), while Peru had the lowest proportion of energy provided by both macronutrients (22·3 % for fat and 14·8 % for protein). Costa Rica also had a low percentage of energy from protein (14·5 %). Percentage of energy provided by different macronutrients was similar across age groups and gender.

Energy intake contribution from foods and beverages

Main food and beverage sources of energy at country level, ranked as a percentage of EI from high to low, are shown in Table 3. The grains, pasta and bread group was the main source of energy in all countries (27·8 % of EI), with the highest proportions observed in Peru and Chile (35·9 and 32·9 % of EI, respectively). Within the grains, pasta and bread group, rice was the major source of EI in Peru, Colombia, Costa Rica and Ecuador, while bread was the major source in Argentina, Brazil and Chile. Refined-grain products were the major sources only in Venezuela, especially due to corn flour used for homemade *arepas*.

Meat and eggs were the second main source of energy in all countries (18·9 % of EI). Within this group, non-processed beef and poultry represented the major sources for all countries (9·7 % of EI). Overall, fish was almost non-existent in terms of contribution to energy (0·9 % of EI). Exceptions were Peru and Ecuador, where the intake of processed meats was half that in the rest of the countries and had little influence on EI.

Oils and fats were the third major energy source in all countries (9·7 % of EI). Within this group, vegetable oil represented the major source (6·1 % of EI), followed by butter and margarine (only 1·6 % of EI). Interestingly, the intake of margarine was higher than that of butter in Brazil, Peru, Colombia, Costa Rica and Venezuela, while the opposite occurred in Argentina, Chile and Ecuador.

Non-alcoholic beverages were the fourth major source of energy in all countries (12·1 % of EI), with an extremely high contribution to total energy in Venezuela (14·6 % of EI). Soft drinks were the main source of total energy from beverages in all countries (3·9 % of EI), followed by natural fruit juices with added sugar (2·9 % of EI), except for Argentina and Chile where soft drinks were followed by ready-to-drink juices with sugar (2·3 and 2·2 % of EI, respectively). In Brazil, there were similar proportions of EI from natural fruit juices with added sugar and ready-to-drink juices with sugar (1·9 and 1·5 % of EI, respectively). Interestingly, Venezuela and Argentina were the countries with highest intake of energy from non-alcoholic beverages (above 14 % of EI), while the rest of the countries consumed between 10 and 12 % of EI, but not from equal sources.

Dietary sources of EI from foods and beverages were similar between genders (see online supplementary material, Supplemental Table 1), except for the alcoholic beverages group in which men had a higher energy percentage than women (4·1 *v.* 1·6 % of EI, respectively), and the sugars and sweets group in which women had a higher energy percentage than men (4·2 *v.* 2·9 % of EI, respectively).

Discussion

In this first characterization of the dietary intake of representative samples of the urban population of eight

Table 2 Energy and macronutrient intakes, by age group, gender and country, among adolescents and adults aged 15–65 years in the Latin American Study of Nutrition and Health (ELANS), September 2014–July 2015*

		Overall			15–19 years			20–34 years			35–49 years			50–65 years		
	n	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women	Total	Men	Women
Energy intake (kcal/d)†																
Argentina	879	2103·17	2383·26	1862·76	2232·79	2489·22	1838·75	2151·28	2410·08	1916·00	2092·57	2379·21	1888·62	1987·32	2274·74	1770·57
Brazil	1406	1865·53	2079·34	1677·45	1997·12	2201·16	1697·44	1953·72	2164·04	1757·47	1846·39	2038·76	1686·35	1665·87	1864·76	1536·65
Chile	625	1780·82	2005·08	1565·69	1860·42	2067·59	1627·35	1837·99	2101·67	1597·86	1768·89	2006·86	1544·13	1668·81	1831·90	1512·08
Peru	876	2031·15	2253·86	1818·39	2043·11	2232·57	1783·06	2093·74	2329·31	1874·72	2039·90	2283·34	1828·29	1863·96	2050·85	1697·57
Colombia	875	2035·83	2233·05	1846·98	2128·73	2313·31	1872·36	2123·81	2329·24	1906·45	2026·86	2208·26	1865·62	1878·76	2054·20	1742·46
Costa Rica	551	1892·68	2141·71	1640·92	1947·93	2100·30	1752·59	2007·17	2258·75	1735·67	1853·30	2100·86	1588·32	1671·99	1961·21	1479·17
Ecuador	574	2110·43	2313·41	1894·30	2152·20	2307·91	1955·52	2211·84	2380·24	2003·43	2067·86	2316·62	1809·78	1912·72	2104·54	1782·66
Venezuela	862	1887·39	2060·24	1727·66	1946·76	2102·30	1780·31	1940·04	2102·73	1781·10	1866·34	2054·78	1685·68	1763·89	1923·58	1652·45
ELANS	6648	1959·46	2178·87	1754·22	2035·83	2230·25	1780·32	2035·21	2253·68	1819·88	1943·66	2163·70	1749·27	1799·85	2005·90	1645·50
Carbohydrate (% of energy intake)																
Argentina	879	51·33	51·36	51·31	51·82	52·86	50·21	51·48	51·88	51·11	51·20	50·97	51·37	51·07	50·02	51·87
Brazil	1406	51·52	51·47	51·57	51·83	52·06	51·49	51·62	51·16	52·05	51·66	52·12	51·28	50·99	50·55	51·27
Chile	625	54·21	54·57	53·87	54·98	54·81	55·17	54·49	54·48	54·50	53·36	54·39	52·39	54·37	54·75	54·00
Peru	876	62·91	63·82	62·04	63·56	64·54	62·21	62·61	63·21	62·06	62·92	63·73	62·21	63·07	64·69	61·63
Colombia	875	53·87	53·60	54·13	53·53	53·59	53·44	53·02	52·39	53·70	54·33	54·22	54·42	54·71	54·91	54·56
Costa Rica	551	57·19	57·26	57·11	57·43	58·48	56·07	56·25	55·91	56·61	58·07	58·75	57·34	57·63	56·63	58·29
Ecuador	574	54·02	54·07	53·96	54·69	53·71	55·94	53·61	54·03	53·10	53·69	53·91	53·47	54·89	54·98	54·84
Venezuela	862	52·92	52·64	53·18	51·88	52·36	51·36	52·49	51·74	53·22	53·23	53·56	52·92	54·13	53·57	54·52
ELANS	6648	54·43	54·57	54·29	54·88	55·27	54·36	54·30	54·15	54·45	54·38	54·83	53·98	54·43	54·47	54·40
Total fat (% of energy intake)																
Argentina	879	32·59	32·44	32·72	32·38	31·48	33·75	32·80	32·35	33·20	32·56	32·58	32·55	32·44	33·05	31·98
Brazil	1406	30·66	30·50	30·81	31·05	30·76	31·48	30·76	30·80	30·73	30·52	29·99	30·96	30·49	30·52	30·47
Chile	625	30·17	30·03	30·30	30·41	30·96	29·79	29·97	30·16	29·81	30·85	30·12	31·53	29·51	29·18	29·84
Peru	876	22·32	21·49	23·12	22·06	21·08	23·41	22·61	22·07	23·11	22·25	21·37	23·01	21·97	20·67	23·13
Colombia	875	30·82	31·25	30·42	31·51	31·65	31·31	31·75	32·48	30·98	30·41	30·65	30·20	29·67	29·64	29·69
Costa Rica	551	28·36	28·17	28·55	28·74	27·95	29·75	29·15	29·10	29·20	27·56	26·94	28·21	27·58	28·24	27·14
Ecuador	574	30·11	30·08	30·15	29·93	30·69	28·98	30·48	30·16	30·87	30·41	30·18	30·64	28·96	28·91	29·00
Venezuela	862	30·63	30·87	30·40	32·08	31·54	32·66	30·95	31·57	30·34	30·31	30·00	30·61	29·34	29·98	28·90
ELANS	6648	29·55	29·41	29·68	29·70	29·36	30·15	29·75	29·82	29·69	29·51	29·09	29·88	29·15	29·07	29·21
Protein (% of energy intake)																
Argentina	879	16·08	16·20	15·97	15·81	15·66	16·03	15·73	15·77	15·69	16·24	16·45	16·09	16·48	16·93	16·15
Brazil	1406	17·81	18·03	17·62	17·12	17·18	17·03	17·62	18·05	17·22	17·82	17·89	17·76	18·52	18·93	18·25
Chile	625	15·62	15·41	15·83	14·61	14·23	15·04	15·54	15·37	15·70	15·79	15·49	16·08	16·11	16·07	16·16
Peru	876	14·77	14·70	14·84	14·38	14·37	14·38	14·78	14·72	14·83	14·84	14·90	14·78	14·96	14·65	15·24
Colombia	875	15·31	15·16	15·45	14·96	14·76	15·25	15·22	15·13	15·32	15·26	15·13	15·39	15·62	15·45	15·75
Costa Rica	551	14·45	14·57	14·34	13·84	13·57	14·18	14·61	14·99	14·19	14·38	14·31	14·45	14·79	15·12	14·56
Ecuador	574	15·87	15·85	15·89	15·37	15·60	15·09	15·91	15·81	16·04	15·90	15·91	15·89	16·14	16·11	16·16
Venezuela	862	16·45	16·49	16·42	16·04	16·10	15·98	16·56	16·69	16·43	16·45	16·44	16·47	16·53	16·45	16·58
ELANS	6648	16·02	16·02	16·02	15·42	15·38	15·49	15·94	16·03	15·86	16·11	16·07	16·13	16·42	16·46	16·39

*Values presented are means and include the plausible reporters only (*n* 6648).
†To convert to kJ/d, multiply kcal/d values by 4·184.

Table 3 Dietary sources of energy (percentage of energy intake) from food groups/subgroups, by country, among adolescents and adults aged 15–65 years in the Latin American Study of Nutrition and Health (ELANS), September 2014–July 2015*

Food group/subgroup	ELANS	Argentina	Brazil	Chile	Colombia	Costa Rica	Ecuador	Peru	Venezuela
Grains, pasta and bread	27·84	24·72	25·64	32·85	23·53	28·36	27·61	35·86	28·07
Refined-grain products	14·29	19·72	13·51	25·13	11·71	10·29	8·89	9·09	17·35
Rice (white or brown)	9·81	1·61	8·57	3·56	9·79	16·18	15·52	20·57	5·46
Pasta (white and whole flour)	2·94	2·83	3·27	3·57	1·30	1·41	2·04	4·13	4·50
Wholegrain products	0·81	0·56	0·29	0·60	0·73	0·49	1·15	2·07	0·77
Meat (not processed) and eggs	14·24	13·87	15·99	10·72	14·98	11·67	16·21	14·17	13·56
Beef (not processed)	5·12	6·40	7·77	3·03	5·57	2·34	5·60	2·07	4·86
Poultry (not processed)	4·59	3·97	4·34	3·02	4·05	3·66	5·36	6·84	5·04
Eggs	1·94	2·35	1·25	2·04	2·94	1·94	1·45	2·07	1·61
Pork (not processed)	1·20	0·54	1·15	0·99	1·46	2·70	1·70	0·76	1·03
Fish (not processed)	0·89	0·33	0·99	0·60	0·63	0·74	1·55	1·57	0·72
Liver and organ meats	0·26	0·25	0·37	0·05	0·28	0·14	0·31	0·29	0·21
Lamb, veal, game	0·17	0·03	0·02	0·95	0·01	0·02	0·07	0·48	0·07
Seafood	0·07	0·01	0·10	0·05	0·03	0·12	0·17	0·09	0·03
Oils, fats and dressings	9·74	9·41	10·66	9·23	10·09	9·43	11·22	7·64	9·86
Oils (vegetable)	6·10	5·92	5·74	4·47	5·32	6·62	8·81	6·20	6·34
Margarine or shortening, vegetable oil	1·60	0·24	3·28	0·86	1·95	1·32	0·65	0·52	2·73
Butter	1·04	1·71	1·19	2·53	1·16	0·46	1·09	0·22	0·06
Salad dressing	0·64	1·24	0·41	1·16	0·48	0·57	0·33	0·48	0·60
Animal fats and other fats	0·33	0·29	0·04	0·19	1·14	0·40	0·32	0·21	0·11
Dipping sauces (cream base)	0·02	0·00	0·01	0·03	0·04	0·06	0·01	0·01	0·01
Non-alcoholic beverages, homemade	6·13	5·50	3·47	3·32	7·06	6·32	8·06	8·31	8·14
Natural juice	2·93	0·21	1·95	0·30	3·45	3·07	5·21	4·20	5·85
Infusions (coffee, tea, herbal infusions)	1·71	1·12	1·07	2·56	1·95	2·79	1·59	2·09	1·57
Milk with fruit or cereal	0·70	0·33	0·46	0·05	0·73	0·40	1·15	1·67	0·73
Mate with sugar or artificially sweetened†	0·57	3·84	0·00	0·02	0·00	0·00	0·00	0·00	0·00
Water with cocoa, with sugar or artificially sweetened	0·17	0·00	0·00	0·03	0·80	0·00	0·12	0·33	0·00
Milk with tea or coffee	0·06	0·00	0·00	0·35	0·13	0·07	0·00	0·02	0·00
Non-alcoholic beverages, ready-to-drink	5·96	8·60	6·60	7·70	4·89	5·56	3·70	3·60	6·42
Soft drinks/soda, regular	3·86	6·06	4·56	4·20	2·45	2·81	2·87	2·81	4·07
Juice and nectar (with sugar)	1·26	2·30	1·51	2·21	0·97	1·32	0·34	0·51	0·79
Juice and nectar (unsweetened or artificially sweetened)	0·60	0·13	0·46	1·21	1·32	0·50	0·22	0·05	1·09
Tea, ready-to-drink	0·16	0·00	0·03	0·01	0·06	0·88	0·15	0·01	0·44
Other drinks‡	0·09	0·10	0·03	0·07	0·09	0·06	0·13	0·22	0·02
Processed meat	4·64	5·39	5·31	5·85	5·58	5·52	2·80	1·51	4·94
Processed meat (e.g. sausage and cold cuts)	2·46	2·73	2·84	3·94	2·88	2·96	1·77	0·88	1·88
Beef (processed)	1·69	2·41	2·21	1·51	2·28	1·36	0·30	0·15	2·40
Fish (processed)	0·32	0·12	0·13	0·32	0·25	0·80	0·48	0·29	0·51
Poultry (processed)	0·17	0·13	0·13	0·07	0·18	0·39	0·25	0·19	0·15
Cookies, crackers and breakfast cereal	3·99	5·94	4·55	3·56	3·41	5·80	2·70	2·62	2·89
Cookies	1·28	2·86	1·33	1·56	0·77	1·73	0·37	0·83	0·60
Crackers	1·13	2·09	1·91	0·37	0·71	0·94	0·47	0·89	0·61
Chips and other snacks	1·01	0·59	1·02	0·73	1·06	2·00	1·47	0·71	0·94
Cereal, ready-to-eat or hot	0·56	0·40	0·29	0·90	0·87	1·12	0·39	0·19	0·74

Table 3 *Continued*

Food group/subgroup	ELANS	Argentina	Brazil	Chile	Colombia	Costa Rica	Ecuador	Peru	Venezuela
Milk, yoghurt and soya drinks	3·95	3·24	5·51	3·24	6·17	2·84	3·04	2·96	2·65
Milk, whole and whole milk products	2·90	1·98	4·71	1·15	5·43	0·53	2·33	2·01	2·27
Milk, skimmed, 1 %, 2 % and products	0·50	0·49	0·30	1·13	0·36	2·09	0·17	0·14	0·17
Yoghurt, regular, low-fat and/or low-sugar	0·48	0·71	0·45	0·96	0·36	0·18	0·48	0·55	0·22
Soya drink and milk substitute	0·06	0·05	0·06	0·00	0·02	0·04	0·05	0·25	0·00
Fruits	3·70	2·07	2·26	4·45	5·41	3·40	5·88	4·66	2·94
Fruits	2·07	1·99	2·21	2·65	1·81	1·91	2·25	2·96	0·80
Plantains (including pasteles)	1·29	0·01	0·00	0·00	3·31	1·14	3·39	1·17	2·02
Avocado	0·32	0·04	0·04	1·73	0·28	0·33	0·23	0·48	0·11
Fruits, sweetened	0·02	0·03	0·00	0·07	0·01	0·02	0·01	0·05	0·01
Roots	3·53	1·97	2·12	3·16	6·02	2·37	4·52	5·42	3·02
Potatoes, white	2·54	1·88	1·37	3·10	4·05	1·57	3·64	4·16	1·11
Other root vegetables	0·99	0·09	0·75	0·05	1·98	0·80	0·88	1·26	1·91
Sugars and sweets	3·46	4·59	4·08	4·11	2·71	3·77	2·04	3·19	2·65
Candy (regular and low-calorie)	1·22	1·69	1·62	1·84	0·99	1·56	0·35	0·90	0·64
Cakes, pies and pudding	0·81	1·38	0·54	0·76	0·45	0·63	1·05	1·06	0·65
Sugar	0·69	0·51	0·84	0·69	0·72	0·62	0·33	0·65	1·02
Ice cream, sherbet, frozen yoghurt	0·62	0·97	0·81	0·76	0·46	0·87	0·21	0·39	0·32
Other candies (e.g. gelatin, peanut butter)	0·12	0·05	0·27	0·07	0·09	0·08	0·11	0·18	0·02
Dairy products	3·34	4·62	2·00	3·73	2·09	2·68	3·34	1·17	8·09
Cheese	3·16	4·36	1·81	3·56	1·97	2·03	3·28	1·11	8·06
Cream	0·18	0·26	0·19	0·16	0·12	0·65	0·06	0·06	0·03
Alcoholic beverages	2·94	3·44	5·13	2·73	2·03	2·16	1·80	1·73	2·66
Alcohol beverages (low-alcohol grade)	2·49	2·97	4·56	2·46	1·09	1·78	1·53	1·60	2·33
Alcohol beverages (high-alcohol grade)	0·45	0·48	0·57	0·27	0·94	0·38	0·27	0·13	0·32
Beans, legumes and soyabeans	2·46	0·23	3·97	1·38	2·56	6·61	2·21	1·54	1·69
Beans/legumes	2·44	0·18	3·97	1·34	2·55	6·61	2·21	1·51	1·67
Soyabeans and soyabean products	0·02	0·05	0·00	0·04	0·01	0·00	0·00	0·03	0·02
Vegetables	1·75	1·18	1·03	2·22	1·68	2·17	3·03	2·02	1·77
Vegetables (non-dark green leafy)	1·32	0·95	0·68	1·82	1·32	1·64	1·73	1·82	1·39
Tomatoes products	0·16	0·09	0·16	0·08	0·22	0·17	0·34	0·01	0·20
Dark green leafy vegetables	0·14	0·11	0·14	0·26	0·08	0·06	0·38	0·11	0·07
Spices and herbs	0·13	0·03	0·05	0·06	0·06	0·29	0·59	0·09	0·11
Pizza	1·06	4·83	1·16	1·25	0·04	0·00	0·02	0·02	0·01
Nuts and seeds	0·30	0·21	0·20	0·19	0·60	0·48	0·55	0·22	0·04
Others§	0·98	0·17	0·32	0·31	1·14	0·84	1·27	3·35	0·59

*Values presented are means and include the plausible reporters only (*n* 6648).
†Mate is an infusion prepared from leaves of yerba mate (*Ilex paraguariensis*) that is traditionally drunk in Latin America.
‡Sports drinks, isotonic drinks, energy drinks, diet sodas and flavoured waters.
§Condiments, soups, supplements, dry mix chocolate, sandwiches, baby food and sweeteners.

Latin American countries, based on a comprehensive and standardized dietary assessment, important differences in EI and food sources were observed between countries, genders and age groups. Overall, daily mean energy distribution from macronutrients was balanced (54, 30 and 16 % of EI from carbohydrate, fat and protein, respectively). However, the relative distribution of energy from macronutrients differed between countries and these differences seemed to be culturally influenced by the types of foods habitually consumed in each country and region (by comparison between northern countries (Colombia, Venezuela, Ecuador, Peru and Costa Rica) *v.* southern countries (Argentina, Chile and Brazil)). When food sources of EI were analysed, a large contribution from refined carbohydrates, fat- and sugar-rich foods and beverages, and a limited contribution from complex carbohydrates and fruits and vegetables, were found in all ELANS countries.

As expected, in all ELANS countries, EI decreased progressively at older ages and was higher among men than women. The finding might be partially explained by the higher energy requirements associated with gender-specific growth and development during adolescence. Similar results were observed in national surveys conducted in Brazil[26], the USA[6] and Europe[27,28]. The mean daily total EI for plausible reporters in most of the ELANS countries was higher than previously described in national surveys in Latin America[29–36], but lower than observed in the US adult population[37]. This difference could help explain the increased prevalence of overweight in the Latin American region, but also could be related to differences in the dietary assessment methodologies followed by other surveys.

Sociodemographic differences between populations living in the USA and Latin America can also help explain intake differences. Environmental exposures according to socio-economic status, such as living in a household with food insecurity, a situation frequently found in Latin America, can influence and determine the quantity and quality of food intake[38,39].

There was a difference of more than 1674 kJ/d (400 kcal/d) between the country with the highest EI (Ecuador) and the country with the lowest EI (Chile). Notably, the lower EI in Chile was followed by the highest prevalence of excess weight (68 %) in the ELANS countries. Since these data represent only the plausible eaters, it should be highlighted that the obesity epidemic has multifactorial risk factors that are independently associated with weight gain such as dietary patterns (fat, sugar and refined grain intakes), physical activity, sedentary time and screen time, and sleep[40].

Not only diet and rates of overweight and obesity show marked differences between countries, but also the whole umbrella of cardiometabolic risk factors. Recent studies revealed that CHD and stroke respectively cause 42·5 and 28·8 % of the CVD mortality in Latin America[41]. A study of the behavioural and metabolic risk factors for CVD in three South American countries (Argentina, Chile and Uruguay) indicated that 68·3 % of individuals have three or more risk factors, including low intake of fruit and vegetables, low physical activity, hypertension, dyslipidaemia and diabetes, among others[42]. Prevalence of diabetes together with prevalence of obesity are the best indicators of diet-related diseases. Among South American countries, diabetes mellitus prevalence was 14·0 % in Argentina[43], 10·8 % in Costa Rica, 9 % in Chile, 7 % in Brazil and 2·8 % in Ecuador[30,44–46].

The proportions of energy derived from macronutrients were similar across age groups and genders in all countries. According to the Acceptable Macronutrient Distribution Ranges, which establish the range of intake for a specific energy source (protein, fat and carbohydrate) that is associated with reduced risk of chronic disease while providing intakes of essential nutrients[47], ELANS countries reported a balanced and adequate distribution of macronutrients. However, a wide range of usual EI from carbohydrate was observed between countries, from 63 % in Peru to 51 % in Argentina and Brazil. Different forms of compensation were observed among these countries. In Peru, higher EI derived from carbohydrate was compensated by a decrease in fat intake. Argentina compensated the lower energy derived from carbohydrate by a higher intake of fat, while Brazil compensated with a higher intake of protein. Both compensation by fat and compensation by protein (separately), in combination with a Western diet, might contribute to a positive energy balance and exacerbate the development of metabolic diseases[48,49]. On the other hand, there is no consensus on whether the higher carbohydrate and lower fat intakes observed in Peru have an adverse effect on weight status or metabolic diseases. However, it is increasingly clear that both the amount and type of carbohydrate, protein and fat, and the interaction between them, are important variables in the development of obesity.

More than one-quarter of all EI in the ELANS countries came from the grains, pasta and bread group, regardless of gender and age group. Interestingly, in the southern countries bread (mainly wheat) was the main contributor to EI, while in the remaining countries rice was the main contributor. Different results were found in a previous study comparing Brazilian and North American food sources of energy in the adult population[50]. Although the consumption of bread was an important contributor to total EI in both countries (10·5 and 9·7 % of EI in the USA and Brazil, respectively), protein mixed dishes was the main source of EI in the USA, while rice and dishes with rice and other ingredients were the main sources in Brazil. Unfortunately, wholegrain products are almost inexistent (<2 % of EI) as part of the cereals source within the Latin American diet. According to the US Dietary Guidelines[51], a daily intake of whole grains of at least half of total grain consumption is recommended, which reinforces the low consumption of complex carbohydrates in Latin America.

It is of concern that energy derived from food sources typically rich in fibre and micronutrients, such as whole grains, roots, fruits, vegetables, beans, fish and nuts, represented only 17·7 % of EI. Although there is no single recommendation in terms of the percentage of energy expected from this group of foods, in recent years multiple diet–disease relationships have been established based on the insufficient consumption of these healthful food sources[52]. In addition, more than 25 % of total EI came from food groups that provide large quantities of sugar and fats, such as ready-to-eat foods, sugary drinks, pastries, chips and candies. Again, geographic distribution seems to have influenced the intake of non-alcoholic beverages, since in southern countries the main source of EI was industrialized/ready-to-drink beverages and in northern countries it was homemade beverages. These results are in accordance with the trends in dietary patterns of Latin American countries reported by Bermudez and Tucker[1] during an extensive review of consumption trends through household expenditure surveys available in FAO food country datasheets from 1990 and 1999. A reduced consumption of fruits and vegetables and increased fat and sugar intakes were found by the end of the 20th century. A more detailed description of total and added sugar intakes from ELANS is given elsewhere[53].

The present study has several strengths. To our knowledge, it is the first and the largest representative study to examine Latin Americans living in urban areas in relation to EI and its food sources. Another strength of our study was the simultaneous application of two individual non-consecutive days of dietary recall across countries following a standardized methodology. This allowed us to carefully examine the dietary intake. Also, the estimates of usual energy and macronutrient intakes were based on statistical methods performed to appropriately adjust for intra-individual variability; such procedure allowed removal of extreme unlikely values[54]. Further, the careful data quality control methods (described elsewhere[55]) may have reduced the misreports of dietary intake, allowing more appropriate comparison of dietary data among countries.

The present study also has some limitations. The ELANS Study Group is aware that with the cross-sectional design of the project, causal and temporal inference is limited. Also, as ELANS data represent the dietary intake of the urban population of eight countries of Latin America, caution should be used in extrapolating these findings to other countries of South and Central America. Although dietary data from the rural population were absent, it should be highlighted that many more people are currently living in the urban setting (64 to 92 %)[56]. Misreporting of EI, described as one of the main sources of error of the dietary assessment instruments based on self-report (24 h recalls), if not controlled for in the current study, could have altered the mean EI. Under-reporting occurs in most adult populations, especially in women and in those persons with a higher BMI. As pointed out by other authors[57], this could be attributable to participants' denial or poor ability to report dietary intake, or due to a tendency to provide socially desirable answers. Despite the limitations, these data are the best available to evaluate current dietary EI for the Latin American population.

Conclusion

In conclusion, daily mean EI was similar and the distribution of different macronutrients was balanced in eight Latin American countries participating in ELANS. The distribution of energy from macronutrients as well as the major food sources of EI differed between northern and southern countries. A large energy contribution from refined carbohydrates, high-fat and high-sugar foods and beverages, and limited intakes from complex carbohydrates, fruits and vegetables, was found in all ELANS countries. Findings from the present study can, at least partly, explain the role of dietary factors in the increased prevalence of overweight/obesity and other non-communicable chronic diseases in Latin America. The dietary profile observed in the present study can support initiatives aimed at improving the diet quality and reducing the incidence of metabolic disorders and CVD in our region.

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Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.1017/S1368980018001222

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Appendix

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