



## Association of the duration of residence with obesity-related eating habits and dietary patterns among Latin-American immigrants in Spain

A. C. Marín-Guerrero<sup>1\*</sup>, Fernando Rodríguez-Artalejo<sup>1,2</sup>, P. Guallar-Castillón<sup>1,2</sup>, Esther López-García<sup>1,2</sup> and Juan L. Gutiérrez-Fisac<sup>1,2</sup>

<sup>1</sup>Department of Preventive Medicine and Public Health, School of Medicine, Universidad Autónoma de Madrid, Madrid, Spain

<sup>2</sup>CIBER de Epidemiología y Salud Pública (CIBERSP), Madrid, Spain

(Submitted 9 April 2014 – Final revision received 20 August 2014 – Accepted 16 October 2014 – First published online 24 November 2014)

### Abstract

The dietary patterns of immigrants usually change with the duration of residence and progressively resemble those of the host country. However, very few studies have investigated individuals migrating to countries with a high-quality diet, such as the Mediterranean diet (MD), and none has yet focused on Latin-American immigrants. The present study examined the association of the duration of residence with obesity-related eating habits and dietary patterns among Latin-American immigrants residing in Spain. A cross-sectional study was conducted in 2008–10 in a representative sample of the adult population residing in Spain. Adherence to the MD was defined as a MD Adherence Screener score  $\geq 9$ . Analyses were conducted by including 419 individuals aged 18–64 years born in Latin-American countries. Compared with immigrants residing in Spain for  $< 5$  years, those residing for  $\geq 10$  years accounted for a lower percentage of individuals who habitually ate at fast-food restaurants and never trimmed visible fat from meat. Moreover, these immigrants were found to have a lower intake of sugary beverages and a higher intake of Na, saturated fat, fibre, olive oil, vegetables and fish and to more frequently strictly adhere to the MD. A longer duration of residence in Spain was found to be associated with both healthy and unhealthy changes in some eating habits and dietary patterns among Latin-American immigrants. Some of the healthy changes observed contrasted the ‘Westernisation’ of the diet reported in studies conducted in other Western countries. The results of the present study support the role of the food environment of the host country in the modification of the dietary patterns of immigrants.

**Key words:** Immigrants: Duration of residence: Eating habits: Dietary patterns

Numerous studies have shown that the dietary patterns and eating behaviours of immigrants residing in Western countries change according to the duration of residence and degree of acculturation in the host country<sup>(1–3)</sup>. Studies on Latino immigrants residing in the USA have shown an association between various measures of acculturation and increased consumption of both healthy and unhealthy foods. More acculturated individuals have been found to consume more fast foods, fatty snacks and sugary beverages and also more fibre and low-fat foods and to more likely engage in fat-avoidance behaviours<sup>(4–8)</sup>. Studies on Chinese and South Asian immigrants residing in North America have also generally found a progressive ‘Westernisation’ of the diet with the duration of residence in the host country and also increased consumption of fibre and vegetables<sup>(9–11)</sup>. Moreover, a review of studies on changes in dietary patterns after the migration of South Asians to Europe has shown an increased intake of fat and

energy and a reduced intake of fibre, fruits and vegetables<sup>(12)</sup>. Lastly, two reviews of studies on the dietary patterns of the major ethnic groups of immigrants residing in European countries found diverse changes in dietary patterns after migration, which were generally characterised by an increased intake of processed and energy-rich foods and a reduced intake of fibre, as well as preservation of dietary habits characterised by a higher intake of fruits and other elements of their traditional diets<sup>(13,14)</sup>.

To date, most of the studies have been conducted among immigrants from countries in nutritional transition who had moved to countries with Westernised diets. However, very few studies have investigated individuals migrating to countries with a high-quality, healthy diet, such as the Mediterranean diet (MD)<sup>(15–19)</sup>, and none has yet examined this phenomenon in Latin-American immigrants. This type of investigation would be able to help directly assess whether

**Abbreviations:** MD, Mediterranean diet; MEDAS, Mediterranean Diet Adherence Screener; OREH, obesity-related eating habit.

\* **Corresponding author:** A. C. Marín-Guerrero, email [anac\\_1975@hotmail.com](mailto:anac_1975@hotmail.com)

the food environment of the host country can improve the dietary patterns of immigrants.

Thus, the objective of the present study was to examine the association of the duration of residence with obesity-related eating habits (OREH) and dietary patterns among Latin-American immigrants residing in Spain.

## Methods

### Study design and participants

Data from the ENRICA study (study on nutrition and cardiovascular risk in Spain) were used in the present study; details regarding the ENRICA study have been reported elsewhere<sup>(20)</sup>. Briefly, ENRICA is a cross-sectional study conducted between June 2008 and October 2010 among 12 948 individuals representative of the non-institutionalised population of Spain aged  $\geq 18$  years. The study participants were selected by stratified cluster sampling. The sample was first stratified by province and size of municipality. Then, clusters were randomly selected in two stages: municipalities and census sections. Finally, the households within each section were selected by random telephone dialling using the directory of telephone landlines as the sampling frame. Individuals within the households were selected proportionally to the distribution of the population of Spain by sex and age group. The sample size of the ENRICA study allows estimation of the prevalence of a risk factor with 95% CI of  $\pm 1\%$  assuming a risk factor prevalence of 50% (worst case) and a sampling design effect of 1.3<sup>(20,21)</sup>. The study included structured interviews, physical examination and collection of biological samples. Specifically, information on sociodemographic variables was collected by telephone interviews and that on eating habits and dietary patterns by face-to-face interviews using a diet history<sup>(22)</sup>. The response rate was 51%, which is similar to or even higher than that in comparable studies carried out in Europe<sup>(23)</sup>. A total of 419 Latin-American immigrants residing in Spain were included in the present study.

The participants gave written informed consent. The study protocol was approved by the ethics committees of 'La Paz' University Hospital in Madrid and the Hospital Clinic in Barcelona.

### Study variables

#### Duration of residence in Spain

The main independent variable was the duration of residence in Spain, calculated as the difference between the date of arrival to Spain and the date of the interview. The duration of residence was classified into the following categories:  $< 5$ ; 5–9;  $\geq 10$  years.

#### Obesity-related eating habits

The study participants were questioned about the following eight variables, associated with excess weight<sup>(24)</sup> and a poor quality of diet<sup>(25,26)</sup>: (1) eating at fast-food restaurants; (2) purchasing chocolates, candy bars and other snacks from

vending machines; (3) eating lunch away from home; (4) consuming pre-cooked foods (for these four variables, a frequency  $\geq 1$  time/week was considered to represent a risk behaviour); (5) trimming visible fat from meat before eating; (6) removing the skin from chicken before eating; (7) choosing low-energy foods (for these three variables, a frequency of never or almost never was deemed to be a risk behaviour); (8) the time spent having breakfast (for this variable, a risk behaviour was defined as  $\leq 5$  min). Finally, a risk score was developed using all these variables, which ranged from 0 (optimum) to 8 (highest risk).

#### Habitual food consumption

Habitual food consumption during the previous year was assessed using a computerised diet history developed from that used in the European Prospective Investigation into Cancer and Nutrition (EPIC) cohort study carried out in Spain<sup>(22)</sup>. The diet history comprised questions on foods consumed in a typical week; only foods that were consumed relatively frequently were taken into account, so information on foods consumed less than once every 2 weeks was not collected. The diet history automatically converts the foods into nutrients using the Spanish food composition tables<sup>(27,28)</sup>. In this analysis, information on the intake of energy (kJ/d), total sugars (g/d), Na (mg/d), saturated fat (g/d) and fibre (g/d) as well as on the consumption of olive oil (g/d), vegetables (g/d), fruits (g/d), fish (g/d) and sugary beverages (g/d) was used.

Adherence to the MD was evaluated using the MD Adherence Screener (MEDAS)<sup>(29)</sup>, which was developed to measure compliance with the dietary intervention in the PREvención con DIeta MEDiterránea (PREDIMED) trial<sup>(30)</sup>. The MEDAS consists of fourteen questions about the achievement of targets of consuming twelve foods and two eating habits that are part of the typical Spanish diet. One point is given for each target achieved, and a score is calculated by summing the points across all targets (range 0–14); a higher score indicates greater adherence to the MD. A score  $\geq 7$  was considered to indicate good adherence to the MD and a score  $\geq 9$  strict adherence<sup>(31)</sup>.

Furthermore, a factor analysis was conducted to group the foods according to their similarities in nutrient profile and culinary preferences. A total of 900 foods were categorised into thirty-six different groups. Factor loadings were obtained for each food group, making it possible to identify the groups most highly correlated with the dietary pattern; in this way, two *a posteriori* dietary patterns were identified<sup>(32)</sup>. The factors were rotated by orthogonal transformation (Varimax rotation) to facilitate their interpretation. The first of these two *a posteriori* dietary patterns was named the 'Mediterranean pattern' because it was characterised by a high intake of olive oil, vegetables, fish, and legumes; the second was named the 'Westernised pattern' because it was characterised by a high intake of red and processed meat, French fries, refined bread products, whole-fat dairy products, pasta and sweetened beverages, as well as a low intake of fresh fruits and fruit juice, low-fat dairy products and whole-grain products. For each pattern, each participant

received a score that was calculated as the sum of intakes of items in each food group weighted by the corresponding factor loading. A higher score indicated greater adherence to the respective dietary pattern. Finally, scores equal to or greater than the sex-specific sample median were deemed to represent adherence to these dietary patterns.

### Other variables

The following variables were considered to possibly act as potential confounders of the association under investigation: sex; age; educational level (primary or less, secondary, or university).

### Statistical analyses

Data obtained from 419 Latin-American immigrants aged 18–64 years who had complete information on the country of origin, date of interview, date of arrival to Spain, eating habits and food consumption patterns were included in the analyses.

The association between the duration of residence in Spain and the frequency of each OREH, MEDAS-based MD adherence, and adherence to the *a posteriori* dietary patterns is summarised with the prevalence ratio and its 95% CI obtained from binomial regression. The association between the duration of residence and the number of OREH, nutrient and food intakes, and the MEDAS score was analysed by linear regression and summarised with the  $\beta$ -regression coefficient and its 95% CI.

Immigrants residing in Spain for <5 years were taken as the reference group in the regression models. The models were adjusted for age, sex and educational level. The *P* value for linear trend was calculated by modelling the duration of residence as a continuous variable. Given that no sex interactions were found, the results are presented for the entire sample.

Statistical significance was set at a two-sided *P* value <0.05. The analyses were performed using the survey procedure in Stata version 11 (Stata Corp LP) to account for the complex sampling design.

### Results

Among the 419 Latin-American immigrants, 85% were born in South America, mainly in Colombia, Ecuador and Argentina. With an increase in the duration of residence in Spain, the percentage of women decreased, but the percentage of individuals aged  $\geq 45$  years and of those with university education increased (Table 1).

In the crude analysis, the percentage of immigrants who habitually ate at fast-food restaurants and bought snacks from vending machines was found to decline with an increase in the duration of residence (Table 2). The number of most other OREH was also found to decrease, although the *P* value for linear trend did not reach statistical significance. As a result, the mean number of OREH decreased significantly with the duration of residence, from 1.9 in immigrants residing

**Table 1.** Characteristics of Latin-American immigrants according to the duration of residence in Spain (*n* 419)  
(Number of participants and percentages)

	Total		Duration of residence (years)			<i>P</i>
			<5	5–9	$\geq 10$	
	<i>n</i>	%	%	%	%	
Total	419		32.2	41.8	26.0	
Sex	419					
Women	239	57.0	63.7	56.0	50.2	0.171
Age (years)	419					
18–29	135	32.2	44.7	31.2	18.3	
30–44	192	45.8	45.9	47.8	42.7	
45–64	92	22.0	9.4	21.0	39.0	<0.001
Educational level	414					
$\leq$ Primary	45	10.8	13.9	8.7	10.3	
Secondary	246	59.8	55.3	68.8	51.0	
University	122	29.4	30.8	22.6	38.7	0.050

in Spain for <5 years to 1.5 in those residing for  $\geq 10$  years (*P* value for linear trend=0.05; Table 2).

In the multivariable regression analysis, habitually eating at fast-food restaurants was found to be inversely associated with the duration of residence: compared with immigrants residing in Spain for <5 years, those residing for  $\geq 10$  years had a prevalence ratio of 0.29 (95% CI 0.10, 0.85). Furthermore, the variables never or almost never trimming visible fat from meat, never or almost never removing the skin from chicken, and choosing low-energy foods were found to exhibit a similar association with the duration of residence, but the association did not reach statistical significance. Accordingly, the number of OREH also declined with an increase in the duration of residence, although it failed to achieve statistical significance (Table 2).

The intake of energy, Na, vegetables and fish exhibited a significant direct association with the duration of residence in both the crude and multivariable regression analyses. By contrast, the intake of sugary beverages was inversely associated with the duration of residence. The intake of saturated fat and fibre also exhibited a significant direct association with the duration of residence, but this association disappeared when these nutrients were considered in relation to energy intake (Table 3).

As regards dietary patterns, MEDAS-based MD adherence was found to increase significantly with the duration of residence in the crude analysis, so that the percentage of immigrants exhibiting good and strict MD adherence increased from 23.0 to 37.7% when the duration of residence was <5 years and from 2.9 to 13.9% when it was  $\geq 10$  years (Table 4). Adherence to the *a posteriori* Mediterranean pattern also increased with the duration of residence, from 29.3% among immigrants residing in Spain for <5 years to 44.5% among those residing for  $\geq 10$  years. In the multivariable regression analysis, the MEDAS mean score and strict adherence to the MD were found to exhibit a significant direct association with the duration of residence. Lastly, the frequency of adherence to the *a posteriori* Westernised pattern did not exhibit substantial variations with respect to the duration of residence (Table 4).

**Table 2.** Association between duration of residence in Spain and obesity-related eating habits among Latin-American immigrants (Number of participants and percentages; prevalence ratios (PR) and 95% confidence intervals)

Eating habits	Total		Duration of residence (years)			P for trend	Duration of residence (years)					P for trend
			<5	5-9	≥10		<5	5-9		≥10		
	n	%						%	%	%	PR*	
Eating at fast-food restaurants ≥ 1 time/week	414	14.1	20.4	14.7	5.3	0.009	Reference	0.81	0.45, 1.43	0.29	0.10, 0.85	0.021
Purchasing snacks from vending machines ≥ 1 time/week	376	2.8	5.2	0.8	3.0	0.049	Reference	0.19	0.04, 0.89	1.50	0.23, 9.55	0.882
Eating out ≥ 1 time/week	376	33.3	37.6	27.7	36.9	0.227	Reference	0.79	0.53, 1.19	0.98	0.67, 1.44	0.906
Consuming pre-cooked foods ≥ 1 time/week	376	47.5	48.3	47.5	46.6	0.970	Reference	0.99	0.74, 1.33	1.05	0.74, 1.49	0.818
Never or almost never trimming visible fat from meat	372	17.2	19.4	19.2	11.5	0.312	Reference	0.83	0.43, 1.60	0.49	0.21, 1.13	0.091
Never or almost never removing the skin from chicken	371	15.0	14.2	18.0	11.3	0.434	Reference	1.18	0.58, 2.38	0.71	0.27, 1.86	0.513
Never or almost never choosing low-energy foods	371	48.2	53.9	49.5	39.4	0.151	Reference	0.98	0.75, 1.28	0.14	0.54, 1.09	0.151
Having breakfast in ≤ 5 min	365	4.8	2.6	7.1	3.9	0.205	Reference	3.04	0.94, 9.79	1.97	0.50, 7.76	0.207
Number of obesity-related eating habits (mean)	358	1.7	1.9	1.8	1.5	0.050	Reference†	-0.08	-0.45, 0.29	-0.33	-0.76, 0.09	0.132

\* PR was obtained from binomial regression models adjusted for sex, age and educational level.

† For the number of eating habits, the  $\beta$ -coefficient reported was obtained by linear regression adjusted for sex, age and educational level.

**Table 3.** Association between duration of residence in Spain and nutrient and food intakes among Latin-American immigrants (Number of participants and mean values;  $\beta$ -coefficients and 95% confidence intervals)

	Total		Duration of residence (years)			P for trend	Duration of residence (years)					P for trend
			<5	5-9	≥10		<5	5-9		≥10		
	n	Mean						Mean	Mean	Mean	$\beta^*$	
Energy intake (kJ/d)	375	9099.8	8634.1	9216.9	9454.2	0.065	Reference	158.3	-22.7, 339.3	254.8	47.9, 461.6	0.015
Sugar intake (g/d)	375	102.0	98.0	102.8	105.4	0.190	Reference	5.21	-6.51, 16.9	10.1	-1.62, 21.8	0.092
Na intake (mg/d)	375	2637.4	2475.3	2567.5	2934.0	0.017	Reference	69.1	-278.3, 416.5	452.8	58.7, 846.9	0.030
Saturated fat intake (g/d)	375	30.1	28.0	31.1	31.2	0.093	Reference	3.75	0.31, 7.18	4.35	0.69, 8.01	0.016
Saturated fat intake/4184 kJ	375	13.4	13.2	13.6	13.6	0.431	Reference	0.55	-0.42, 1.53	0.66	-0.33, 1.64	0.183
Fibre intake (g/d)	375	20.7	19.3	20.2	22.9	0.008	Reference	0.69	-1.66, 3.05	3.31	0.35, 6.27	0.030
Fibre intake/4184 kJ	375	9.9	9.7	9.7	10.4	0.235	Reference	-0.22	-1.27, 0.81	0.19	-0.91, 1.29	0.769
Olive oil intake (g/d)	375	14.5	13.4	13.7	17.2	0.030	Reference	0.15	-2.96, 3.26	3.14	-0.32, 6.59	0.087
Vegetable intake (g/d)	375	185.3	163.5	180.2	218.4	0.006	Reference	12.3	-22.7, 47.3	41.3	4.2, 78.5	0.032
Fruit intake (g/d)	375	180.1	171.8	168.1	208.2	0.144	Reference	-18.9	-58.4, 20.7	9.3	-38.5, 57.1	0.300
Fish intake (g/d)	375	43.02	35.9	37.8	59.2	0.000	Reference	1.80	-6.61, 10.21	19.14	8.68, 29.6	0.000
Sugary beverage intake (g/d)	375	170.7	216.7	180.1	102.7	0.018	Reference	-39.9	-135.2, 55.5	-105.9	-194.6, -17.1	0.024

\* The  $\beta$ -coefficient was obtained by linear regression adjusted for sex, age and educational level.

**Table 4.** Association between duration of residence in Spain and dietary patterns among Latin-American immigrants (Number of participants and percentages; prevalence ratios (PR) and 95% confidence intervals)

	Duration of residence (years)						P for trend
	< 5		5-9		≥ 10		
	n	%	n	%	n	%	
MEDAS score (mean)	373	5.3	5.2	5.1	5.9	5.9	0.040
MEDAS score ≥ 7 (%)	373	28.1	23.0	25.7	37.7	37.7	0.075
MEDAS score ≥ 9 (%)	373	6.1	2.9	3.4	13.9	13.9	0.004
A <i>posteriori</i> Mediterranean pattern ≥ median (%)	373	35.7	29.3	34.9	44.5	44.5	0.099
A <i>posteriori</i> Westernised pattern ≥ median (%)	373	63.5	60.7	67.9	60.1	60.1	0.437

  

	Duration of residence (years)						P for trend
	< 5		5-9		≥ 10		
	PR*	95% CI	PR*	95% CI	PR*	95% CI	
Reference†	Reference	Reference	Reference	Reference	Reference	Reference	Reference
Reference	0.99	0.61, 1.59	0.99	0.61, 1.59	0.43†	0.26, 1.12	0.020
Reference	1.04	0.24, 4.54	1.04	0.24, 4.54	1.24	0.75, 2.05	0.156
Reference	1.15	0.77, 1.71	1.15	0.77, 1.71	3.17	0.92, 10.93	0.019
Reference	1.07	0.85, 1.35	1.07	0.85, 1.35	1.36	0.90, 2.05	0.101
					1.01	0.76, 1.32	0.324

MEDAS, Mediterranean Diet Adherence Screener.

\* PR was obtained from binomial regression models adjusted for sex, age and educational level.

† For the mean MEDAS score, the  $\beta$ -coefficient reported was obtained by linear regression adjusted for sex, age and educational level.

## Discussion

Compared with Latin-American immigrants residing in Spain for <5 years, those residing for ≥10 years reported less frequency of habitual eating at fast-food restaurants, as well as a lower intake of sugary drinks. Moreover, they reported a higher intake of fibre, olive oil, vegetables and fish and also a higher intake of Na and saturated fat. Furthermore, the percentage of immigrants who strictly adhered to the MD increased with the duration of residence, reaching 13.9% for those residing in Spain for ≥10 years, which is similar to the value for the whole Spanish population<sup>(32)</sup>.

Although these findings indicate both healthy and unhealthy changes in the dietary patterns of Latin-American immigrants residing in Spain, and given that comparisons with findings from other studies are difficult because of the heterogeneity in the measurement of dietary habits and eating habits, some of the healthy changes observed after migration to Spain were found to differ from the main results of many studies on this issue conducted in other Western countries in which a 'Westernisation' of the diet and an increased frequency of some OREH were observed.

Studies carried out on Hispanic immigrants residing in the USA have demonstrated some unfavourable changes in dietary patterns after migration, such as increased consumption of fast foods, fatty snacks and sugar, including sugary drinks<sup>(4)</sup>. In addition, among Mexican immigrants residing in the USA, Batis *et al.*<sup>(5)</sup> found a mixture of beneficial and harmful changes in dietary patterns, including increased consumption of saturated fat, sugar, salty snacks, pizza and French fries. Moreover, compared with Mexican-Americans born in the USA, those born in Mexico have been found to have a lower intake of fat and a higher intake of fibre and to exhibit greater adherence to nutritional guidelines<sup>(33)</sup>, and being born in Mexico or Central America and longer US residency have been found to be associated with higher odds of consuming ≥5 daily fruit/vegetable servings<sup>(7)</sup>. In Puerto Rican adults residing in Boston area, the association of acculturation with dietary quality was mixed, but tended towards better carbohydrate quality<sup>(8)</sup>. As regards other ethnic groups, Rosenmüller *et al.*<sup>(9)</sup> reported a direct association between the duration of residence of Chinese immigrants in Canada and the size of food portions, the frequency of eating out and the consumption of convenience foods. Another study on Chinese immigrants residing in the USA and Canada has also demonstrated an association between various indices of acculturation and higher frequency of eating at fast-food restaurants and between meals<sup>(10)</sup>. Lesser *et al.*<sup>(11)</sup> found that the majority of South Asians reported an improvement in dietary practices including an increase in the consumption of fruits and vegetables and a reduction in the consumption of high-fat/fried foods after immigration to Canada. Moreover, studies on Asian immigrants residing in European countries have also reported complex and varied changes after migration that, in general, resulted in a 'Westernisation' of the diet: reduced fibre intake; increased energy and fat intake; replacement of complex carbohydrates with refined carbohydrates<sup>(12)</sup>. Finally, the review by Gilbert & Khokhar<sup>(13)</sup>

on changes in dietary patterns in various ethnic groups that emigrated to European countries again demonstrated a common pattern characterised by the maintenance of certain aspects of their traditional diets and the incorporation of some processed foods, sugary drinks and fast foods.

Very few studies have investigated changes in food consumption patterns among individuals who migrated to Mediterranean countries. Méjean *et al.*<sup>(16)</sup> found an increase in the percentage of energy intake from sugar/sweets and meat in Tunisian immigrants residing in France; however, the fact that both the country of origin and the country of destination were in the Mediterranean basin may complicate the interpretation of the results of their study. Another study on adolescent immigrants in Croatia coming from nearby areas demonstrated that these adolescents quickly adapted their dietary patterns to the Mediterranean dietary pattern predominant in the region<sup>(15)</sup>. The results of some studies carried out in Spain are consistent with those of the present study. The acculturation of Moroccan immigrants has been found to be associated with better eating habits and dietary patterns, specifically greater food variety and increased consumption of vegetables, fish and legumes<sup>(18)</sup>. Favourable changes in dietary patterns have also been reported by two studies carried out among African immigrants residing in Madrid. In one study, the first generation of immigrant Bubis, the main ethnic group in the Bioko Island (Equatorial Guinea), had food and nutrient intakes similar to those derived from the prevalent diet in Madrid than to those derived from the diet of their native land<sup>(17)</sup>. A subsequent study demonstrated a direct association between the duration of residence of West-African immigrants in Madrid and a healthier dietary pattern, with higher consumption of dairy products, fish, vegetables, fruits and legumes<sup>(19)</sup>.

Several factors could influence the eating behaviours of immigrants, including the country of origin and ethnicity, knowledge of the language of the host country, beliefs and cultural factors as well as individual characteristics such as socio-economic status<sup>(5,13)</sup>. However, our findings support the role of the food environment of the host country. Given that the analyses carried out in the present study were adjusted for educational level, its influence on the results was reduced. Moreover, the fact that, regardless of the immigrant group investigated, the results of the studies carried out in Spain show a progressive adoption of the Mediterranean dietary pattern, while those of studies carried out in the USA and Northern Europe show a 'Westernisation' of the diet illustrates the importance of food availability and prevailing food habits in the host country.

The results of the present study could be partly explained by a period effect. Given that the process of immigration is quite recent in Spain<sup>(34)</sup> and that many Latin-American countries are experiencing rapid urbanisation and nutritional transition, immigrants from these countries may have already been exposed to many diet-related risk behaviours before reaching Spain<sup>(35,36)</sup>. Thus, the process of acculturation in Spain could lead to a certain improvement in eating patterns, as indicated by the results of the present study.

Among the limitations of the present study is the cross-sectional design, which did not allow for separating the

effect of the duration of residence of the immigrants from a cohort effect linked to their age at arrival to the host country<sup>(37)</sup>. However, there were no changes in the results after adjustment for or stratification by the immigrants' age at arrival to Spain. Another limitation is the relatively small sample size, which precluded the examination of changes in dietary patterns according to the specific country of origin. Finally, although the duration of residence in a country does not fully capture the acculturation process, and individuals may vary in their level of acculturation even though they have resided in Spain for the same number of years, this variable is considered a reasonable proxy and has been used in many studies<sup>(38,39)</sup>. The main strength of the present study is the variety and depth of information obtained on the eating habits and dietary patterns of immigrants residing in Spain.

Studies on immigrants groups are important because they offer an opportunity to witness the 'natural experiment' of the effect of a new environment on immigrants. This is the first study to investigate the changes in the eating habits and dietary patterns of the Latin-American population residing in Spain, which comprises the largest group of immigrants in this country. Although the culture of both the host country and country of origin surely influences eating behaviours and may determine the effect of environment on dietary patterns, the consistency of the results of the present study with those of other studies carried out in Spain and in the international literature on immigrants from different cultures supports the important role of the food environment of the host country in the modification of the dietary patterns of immigrants.

### Acknowledgements

The present study was supported by grant PI/12/1166 from the Instituto de Salud Carlos III.

The funding body had no role in data extraction and analysis, writing of the manuscript, or the decision to submit the article for publication.

The authors' contributions are as follows: J. L. G.-F. designed the study and coordinated the writing of the article; A. C. M.-G. contributed to the analysis of the data and to the drafting of the manuscript; P. G.-C., E. L.-G. and F. R.-A. contributed to the interpretation of the results and to the drafting of the manuscript. All authors contributed to the final version of the article.

None of the authors has any conflicts of interest to declare.

### References

1. Satia-About AJ, Patterson RE, Neuhouser ML, *et al.* (2002) Dietary acculturation: applications to nutrition research and dietetics. *J Am Diet Assoc* **102**, 1105–1118.
2. Satia JA (2010) Dietary acculturation and the nutrition transition: an overview. *Appl Physiol Nutr Metab* **35**, 219–223.
3. Redstone Akresh I (2007) Dietary assimilation and health among hispanic immigrants to the United States. *J Health Soc Behav* **48**, 404–417.



4. Ayala GX, Baquero B & Klinger S (2008) A systematic review of the relationship between acculturation and diet among Latinos in the United States: implications for future research. *J Am Diet Assoc* **108**, 1330–1344.
5. Batis C, Hernandez-Barrera L, Barquera S, *et al.* (2011) Food acculturation drives dietary differences among Mexicans, Mexican Americans, and Non-Hispanic Whites. *J Nutr* **141**, 1898–1906.
6. Lui JH, Chu YH, Frongillo EA, *et al.* (2012) Generation and acculturation status are associated with dietary intake and body weight in Mexican American adolescents. *J Nutr* **142**, 298–305.
7. Matias SL, Stoecklin-Marois MT, Tankredi DJ, *et al.* (2013) Adherence to dietary recommendations is associated with acculturation among Latino farm workers. *J Nutr* **143**, 1451–1458.
8. Van Rompay MI, McKeown N, Castaneda-Sceppa C, *et al.* (2012) Acculturation and sociocultural influences on dietary intake and health status among Puerto Rican adults in Massachusetts. *J Acad Nutr Diet* **112**, 64–74.
9. Rosenmöller DL, Gasevic D, Seidell J, *et al.* (2011) Determinants of changes in dietary patterns among Chinese immigrants: a cross-sectional analysis. *Int J Behav Nutr Phys Act* **18**, 8–42.
10. Sata JA, Patterson RE, Kristal AR, *et al.* (2001) Development of scales to measure dietary acculturation among Chinese-Americans and Chinese-Canadians. *J Am Diet Assoc* **101**, 548–553.
11. Lesser IA, Gasevic D & Lear SA (2014) The association between acculturation and dietary patterns of South Asian immigrants. *PLOS ONE* **9**, e88495.
12. Holmboe-Ottesen G & Wandel M (2012) Changes in dietary habits after migration and consequences for health: a focus on South Asians in Europe. *Food Nutr Res* **56** (Epub Nov 6).
13. Gilbert PA & Khokhar S (2008) Changing dietary habits of ethnic groups in Europe and implications for health. *Nutr Rev* **66**, 203–215.
14. Wandel PE (2013) Population groups in dietary transition. *Food Nutr Res* **57**, 21668.
15. Skreblin L & Sujoldzic A (2003) Acculturation process and its effects on dietary habits, nutritional behavior and body-image in adolescents. *Coll Antropol* **27**, 469–477.
16. Mèjean C, Traissac P, Eymard-Duvernay S, *et al.* (2008) Influence of acculturation among Tunisian migrants in France and their past/present exposure to the home country on diet and physical activity. *Public Health Nutr* **12**, 832–841.
17. Gil A, Vioque J & Torija E (2005) Usual diet in Bubis, a rural immigrant population of African origin in Madrid. *J Hum Nutr Diet* **18**, 25–32.
18. Montoya Sáez PP, Torres Cantero AM & Torija Isasa ME (2001) La alimentación de los inmigrantes marroquíes de la Comunidad de Madrid: factores que influyen en la selección de los alimentos (Nutrition among Moroccan immigrants in the community of Madrid: factors affecting the choice of food). *Aten Primaria* **27**, 264–270.
19. Delisle HF, Vioque J & Gil A (2009) Dietary patterns and quality in West-African immigrants in Madrid. *Nutr J* **8**, 3.
20. Rodríguez-Artalejo F, Graciani A, Guallar-Castillón P, *et al.* (2011) Rationale and methods of the Study on Nutrition and Cardiovascular Risk in Spain (ENRICA). *Rev Esp Cardiol* **64**, 876–882.
21. Johnson CL, Dohrmann SM & Burt VL, *et al.* (2014) National Health and Nutrition Examination Survey: sample design, 2011–2014. National Center for Health Statistics. *Vital Health Stat* **2**, 162.
22. Guallar-Castillón P, Sagardui-Villamor J, Balboa-Castillo T, *et al.* (2014) Validity and reproducibility of a Spanish dietary history. *PLOS ONE* **9**, e86074.
23. Aromaa A, Koponen P, Tafforeau J, *et al.* (2003) Evaluation of health interview surveys and health examination surveys in the European Union. *Eur J Public Health* **13**, 67–72.
24. Mesas AE, Muñoz-Pareja M, López-García E, *et al.* (2012) Selected eating behaviours and excess body weight: a systematic review. *Obes Rev* **13**, 106–135.
25. Mesas AE, Guallar-Castillón P, León-Muñoz L, *et al.* (2012) Obesity-related eating behaviors are associated with low physical activity and poor diet quality in Spain. *J Nutr* **142**, 1321–1328.
26. Muñoz-Pareja M, Guallar-Castillón P, Mesas AE, *et al.* (2013) Obesity-related eating behaviors are associated with higher food energy density and higher consumption of sugary and alcoholic beverages: a cross-sectional study. *PLOS ONE* **8**, e77137.
27. Ferrán A, Zamora R, Cervera P, *et al.* (2004) *Tablas de composición de alimentos del CESNID (Spanish Food Composition Database, CESNID)*. Barcelona: Edicions Universitat de Barcelona.
28. Moreiras O, Carvajal A, Cabrera L, *et al.* (2007) *Tablas de composición de alimentos (Food Composition Tables)*, 11th ed. Madrid: Ediciones Pirámide.
29. Schröder H, Fitó M, Estruch R, *et al.* (2011) A short screener is valid for assessing Mediterranean diet adherence among older Spanish men and women. *J Nutr* **141**, 1140–1145.
30. Estruch R, Martínez-González MA, Corella D, *et al.* (2006) Effects of a Mediterranean-style diet on cardiovascular risk factors: a randomized trial. *Ann Intern Med* **145**, 1–11.
31. Sánchez-Taínta A, Estruch R, Bulló M, *et al.* (2008) Adherence to a Mediterranean-type diet and reduced prevalence of clustered cardiovascular risk factors in a cohort of 3204 high-risk patients. *Eur J Cardiovasc Prev Rehabil* **15**, 589–593.
32. León-Muñoz LM, Guallar-Castillón P, Graciani A, *et al.* (2012) Adherence to the Mediterranean diet pattern has declined in Spanish adults. *J Nutr* **142**, 1843–1850.
33. Dixon LB, Sundquist J & Winkleby M (2000) Differences in energy, nutrient and food intakes in a US sample of Mexican-American women and men: findings from the Third National Health and Nutrition Examination Survey, 1988–1994. *Am J Epidemiol* **152**, 548–557.
34. Martínez Bujan R & Golías Pérez M (2005) La latinoamericanización de la inmigración en España (The latin-americanization of immigrants in Spain). *Cuadernos geográficos* **36**, 51–64.
35. Uauy R, Albala C & Kain J (2001) Obesity trends in Latin America: transiting from under- to overweight. *J Nutr* **131**, 893S–899S.
36. Rivera JA, Barquera Simón, González-Cossío T, *et al.* (2004) Nutrition transition in Mexico and in other Latin American countries. *Nutr Rev* **62**, S149–S157.
37. Lauderdale DS & Rathouz PJ (2000) Body mass index in a US national sample of Asian-Americans: effects of nativity, years since immigration and socioeconomic status. *Int J Obes Relat Metab Disord* **24**, 1188–1194.
38. Alegria M (2009) The challenge of acculturation measures: what are we missing? A commentary on Thomson & Hoffman-Goetz. *Soc Sci Med* **69**, 996–998.
39. Sanou D1, O'Reilly E, Ngnie-Teta I, *et al.* (2014) Acculturation and nutritional health of immigrants in Canada: a scoping review. *J Immigr Minor Health* **16**, 24–34.