Int J Public Health (2016) 61:1069–1077
DOI 10.1007/s00038-016-0863-3

ORIGINAL ARTICLE

Socioeconomic predictors of dietary patterns among Guatemalan adults

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Received: 25 April 2016 / Revised: 4 July 2016 / Accepted: 8 July 2016 / Published online: 15 July 2016

Abstract
Objectives We aimed to assess the associations of socioeconomic factors with dietary patterns in a Guatemalan population.
Methods Cross-sectional data of 1076 participants (42 % men, mean age 32.6 ± 4.2 years) collected between 2002 and 2004 in four rural villages in Guatemala. Dietary patterns were derived using principal component analysis. Chi-square and Poisson regression models were used to assess associations between socioeconomic factors and dietary patterns.
Results Three dietary patterns were identified: "Western" (high in processed foods), "traditional" (high in traditional foods) and "coffee and sugar", explaining 11, 7 and 6 % of the variance, respectively. Annual expenditures were associated with a higher adherence to the "Western" pattern: prevalence ratios [(PR) (95 % confidence interval)] 1.92 (1.17–3.15) for the highest vs. lowest expenditure group in men and 8.99 (3.57–22.64) in women. A borderline significant ($p = 0.06$) negative association was found between the "traditional" pattern and higher household expenditures [0.71 (0.49–1.02) in men] and with schooling [0.23 (0.05–1.02)] in women ($p = 0.05$).
Conclusions Dietary patterns in Guatemala are predicted by socioeconomic factors. In particular, high annual expenditures are associated with a more westernized, less traditional diet.

Keywords Socioeconomic · Diet patterns · Guatemala · Expenditures

Introduction

Socioeconomic status (SES) is one of the major determinants of health (Di Cesare et al. 2013). In high income countries (HICs), high SES is associated with healthier dietary patterns, including higher intake of whole grains,

Electronic supplementary material The online version of this article (doi:10.1007/s00038-016-0863-3) contains supplementary material, which is available to authorized users.

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lean meats, vegetables, fish and low-fat foods (Darmon and Drewnowski 2008). It is hypothesized that the social patterning of diet contributes to explaining, at least in part, these socioeconomic differences in health (Di Cesare et al. 2013).

While the associations between SES, dietary intake, and health have been extensively explored in HICs, less is known regarding social differences in dietary patterns in low and middle income countries (LMICs). In a recent review, it was suggested that the association between SES and consumption of a 'healthy' dietary pattern depends on the socioeconomic and nutrition transition stage of the country (Mayén et al. 2014). This review was mostly based on studies from upper middle income countries (e.g.: Brazil, China, and Iran), while limited data exist for a large number of LMICs such as Guatemala.

Guatemala has a per capita gross national income approximately half the average of the Latin America and the Caribbean region; 54 % of the population lives below the poverty line (The World Bank 2014) and half of all children are stunted (Public Health Ministry et al. 2009). Although evidence regarding social differences in health outcomes in Guatemala is scarce, a higher prevalence of hypertension, high blood cholesterol, and triglycerides have been shown in low vs. high educated men (Ministerio de Salud Pública y Asistencia Social et al. 2011). Few data exist on the social patterning of diet in the Guatemalan population. Thus, the aim of this study was to identify dietary patterns in an adult Guatemalan population and their associations with socioeconomic indicators.

Methods

Study population and design

This cross-sectional study included individuals who had participated in a nutritional supplement trial conducted in four rural villages (1969–1977), and who have been followed prospectively. Briefly, villages were selected according to the following criteria: (1) population size; (2) easy access; and (3) homogeneity among villages. Data on socioeconomic characteristics, diet and physical activity, and medical and reproductive histories were collected by interviews between 2002 and 2004 and adults living in the selected villages represented the target population. Data from the 2002 census was used. Of 2392 participants in the original study, 272 had died, 102 were untraceable, and 163 had migrated to another country, leaving 1855 (77 %) eligible for enrolment (Grajeda et al. 2005), of whom 1076 were included in the analysis for this study.

Socioeconomic status

Information on three SES indicators were obtained: annual expenditures, schooling, and the wealth index. Annual expenditures were included as a measure of individual economic well-being (Maluccio et al. 2005a). It was calculated by adding durable assets (i.e.: ownership of a refrigerator), food, non-food, and housing expenditures divided by the number of persons in each household. All values were adjusted to real values at a common date (March 2004; 1US$ = 8.1 Quetzales) (Central Bank of Guatemala 2014). Sex-specific quartiles were created for the wealth index and annual expenditures. We opted for quartiles as there are no official cut-offs to evaluate expenditure or wealth categories in Guatemala. Cut-points are shown in Supplementary Table 1.

Schooling was included as an individual measure of SES. Because of the low number of individuals attending upper secondary school and university (9 %), schooling was divided into two groups: "low": primary (grades one through six) or lower and "high": higher than primary. The wealth index is an asset-based approach to measure household socioeconomic position (Howe et al. 2008) and was categorized in quartiles. It was derived from the wealth linear index approach used by Filmer and Pritchett (2001). Assets or household characteristics were taken into account, such as owning a radio, a bicycle, and the number of rooms in the house, among others. A principal component analysis (PCA) was applied to this set of assets or household characteristics dichotomized as yes/no variables (Maluccio et al. 2005b). The first principal component was selected to derive a score for each participant, and individual scores were then categorized in quartiles.

Dietary intake

A validated 52-item semi-quantitative food frequency questionnaire was used to assess the average dietary intake for the previous 3 months. Items included local foods such as black beans (Supplementary Table 2), processed foods such as pizza, and open-ended questions to account for seasonality of fruit and vegetables consumption. For each item, consumption frequencies ranged from "never or rarely consumed" to number of units per day. A standard serving size was presented (with photographs) and participants indicated whether their serving sizes were bigger, equal, or smaller. The food intake registered by the food frequency questionnaire was converted into energy and nutrients using the INCAP food composition table (Menchú et al. 2000) and data from the US Department of Agriculture Nutrient Database. The daily intake

frequency was calculated. These values, multiplied by the concentration of nutrients in the food, resulted in the daily intake value (i.e., g/day), which were used for the PCA.

Covariates

Urbanity was categorized as urban (residential zones, city neighborhood, or peri-urban marginal areas) or rural (neighborhood inside the village, village marginal areas, country houses, farms, settlements).

Statistical analysis

Participants were excluded if (1) no data were available for the study variables, (2) more than 90 % of the individual dietary items were missing, or (3) energy intake was higher than three standard deviations of the mean energy intake. To decide whether analysis should be performed separately by gender, an interaction term between SES and sex was fitted. A significant interaction was found with the "Western" pattern and annual expenditures ($p = 0.005$). Thus, analyses were performed separately by sex. Statistical analyses were conducted using Stata version 13.1 (Stata Corp., College Station, TX, USA).

Dietary patterns were obtained using PCA with varimax orthogonal rotation (Kline 1994). Before running the PCA analysis, the Kaiser–Meyer–Olkin (KMO) test was used to assess the appropriateness of the data for PCA. We used the same criteria as described by others (Fernandez-Alvira et al. 2014; Kesse-Guyot et al. 2009) to retain dietary patterns, namely (1) eigenvalues greater than one, and (2) interpretability of the dietary patterns. As there is no established agreement for selecting the factor loading threshold of a pattern, food items with absolute factor loading >0.24 were considered to characterize the dietary pattern, which is similar or even higher than the ones used in other studies (de Castro et al. 2016; Luger et al. 2016). Dietary patterns were interpreted based on the foods with highest absolute loadings; food items with positive loadings were positively associated with the patterns and vice versa.

Dietary patterns were extracted from the whole sample, as conducted in similar studies (Dekker et al. 2015; Olinto et al. 2011). After PCA, participants were assigned a score for each dietary pattern, which indicated the agreement

Table 1 Baseline characteristics of the study participants, overall and by sex (Guatemala, 2002–2004)

	All ($n = 1076$)	SD	Men ($n = 457$)	SD	Women ($n = 619$)	SD	p value
Age (years)	32.6	4.2	32.4	4.0	32.7	4.3	0.326
Urbanity							
Rural	71.3		71.8		70.9		0.760
Urban	28.7		28.2		29.1		
Annual expenditure quartiles[a]							
First	23.1		23.2		22.9		N/A
Second	24.7		24.1		25.2		
Third	26.4		26.5		26.3		
Fourth	25.8		26.3		25.5		
Schooling (%)[b]							
Primary or less	83.6		79.4		86.6		0.002
More than primary	16.5		20.6		13.4		
Wealth index quartiles[c]							
First	30.0		24.1		34.4		N/A
Second	22.1		25.0		20.0		
Third	22.5		25.6		20.2		
Fourth	25.4		25.4		25.4		

Results expressed as mean or as percentage. Statistical analysis comparing between sex by t test or Chi-square. Wealth index quartiles and annual expenditures quartiles were sex-specific

SD standard deviation, *N/A* not available

* $p < 0.05$

[a] First quartile of annual expenditures represents the lowest expenditures and fourth quartile of annual expenditures represents the highest expenditures

[b] Schooling: highest formal grade attained

[c] First quartile of wealth index quartiles represents the poorest people and fourth quartile of wealth index represents the wealthiest people

between the participant's food intake and the dietary patterns. Dietary patterns were further dichotomized to compare the highest quartile to the other three (i.e., highest quartile vs. others) (Arruda et al. 2014).

Continuous variables were expressed as mean (standard deviation) and categorical variables as percentages. Bivariate between-group comparisons were performed using Student's *t* test for continuous variables and Chi-square test for categorical variables. Multivariate analyses of the associations of socioeconomic and demographic variables with dietary patterns were performed using Poisson regression, using age, urbanity, annual expenditure quartiles, schooling and wealth index quartiles as included variables in the model. As high adherence to dietary patterns was defined by the highest quartile (i.e., 25 % of the sample), Poisson regression was preferred to logistic regression to avoid the overestimation of the associations (Barros and Hirakata 2003). Results were expressed as prevalence ratios (PR) and (95 % confidence intervals). Tests for trend were performed using the *contrast p* command of STATA. We also used a simple multivariate imputation model to replace missing values on urbanity. Missing values on main exposures (annual expenditures, schooling, and wealth index) and outcomes (dietary intake) were not imputed.

A sensitivity analysis was conducted excluding participants without data for urbanity (no imputation). All analyses were two-tailed and statistical significance was assessed for $p < 0.05$.

Results

Exclusion criteria and sample characteristics

Of the initial sample of 2392 participants, 904 (38 %) were excluded for having no dietary intake, 20 (1 %) for over reporting energy intakes or missing >90 % of dietary data (reporting <9 foods), and 392 (17 %) for having no SES indicator information (Supplementary Fig. 1). The main characteristics of the 1076 remaining participants (457 men and 619 women) overall and by sex are shown in Table 1. The majority of the population lived in a rural area and women completed fewer years of school than men ($p = 0.002$). No significant differences between sexes were found for age ($p = 0.326$) or urbanity ($p = 0.977$).

Dietary patterns

Food items used to perform the PCA and their correlation to each dietary pattern are shown in Table 2. Since all food items had a KMO coefficient ≥0.5 (i.e., overall KMO coefficient = 0.7), none was excluded from the PCA analysis. Three components (patterns) were identified: "Western", "traditional" and "coffee and sugar", which explained 11, 7, and 6 % of the total variance, respectively.

The "Western" pattern was characterized by a high consumption of processed foods, ham, cheese, carrots, bread, boiled potatoes, and milk. The "traditional" pattern was characterized by a high consumption of *tortillas*, black beans, *tamales*, eggs, and fish. The "coffee and sugar" pattern included coffee and sugar only.

Associations of socioeconomic and demographic factors with dietary patterns

Bivariate associations of socioeconomic and demographic variables with the dietary patterns are summarized in Table 3 for men and women. A high adherence to the "Western" pattern was positively associated with annual expenditures in both sexes and with urbanity, and schooling in women only. A high adherence to the "traditional" pattern was negatively associated with urbanity and schooling in both sexes and with annual expenditures in men only. Annual expenditures were associated with the "coffee and sugar" pattern in women.

Multivariate associations of socioeconomic and demographic variables with the dietary patterns are summarized

Table 2 Factor loadings of the principal dietary patterns identified (Guatemala, 2002–2004)

	Dietary pattern		
	Western	Traditional	Coffee and sugar
Processed foods	0.3140		
Ham	0.2810		
Cheese	0.2646		
Carrot	0.2580		
Bread	0.2508		
Boiled potatoes	0.2447		
Milk	0.2415		
Tortillas		0.4977	
Black beans "parados o colados"		0.3274	
Tamal		0.2964	
Egg		0.2860	
Black beans "volteados"		0.2705	
Fish		0.2561	
Sugar			0.6652
Coffee			0.6632
Variance explained (%)	11	7	6

Only foods with factor loadings >0.24 or <−0.24 are shown. Total explained variance = 24 %

TEI total energy intake

Table 3 Bivariate associations of socioeconomic and demographic variables with the dietary patterns, by sex (Guatemala, 2002–2004)

	Men ($n = 457$)			Women ($n = 619$)		
	Western pattern	Traditional pattern	Coffee and sugar pattern	Western pattern	Traditional pattern	Coffee and sugar pattern
Age (years) (%)						
24–30	28.6	44.4	19.6	17.2	14.1	24.0
31–35	33.8	43.9	23.7	20.1	12.7	23.1
36–40	34.5	41.6	30.1	23.2	9.0	32.2
40+	15.4	23.1	7.7	14.3	4.8	23.8
p value	0.391	0.500	0.129	0.477	0.333	0.173
Urbanity (%)						
Rural	30.2	46.3	25.3	15.5	13.4	27.8
Urban	36.4	34.1	19.4	30.6	7.8	21.7
p value	0.197	0.017	0.180	<0.001	0.047	0.115
Annual expenditure quartiles (%)						
First	20.8	52.8	27.4	3.5	14.8	35.2
Second	32.7	45.5	24.6	13.5	14.7	27.6
Third	31.4	43.0	24.8	23.9	10.4	17.8
Fourth	41.7	31.7	18.3	36.7	7.6	24.7
p value	0.010	0.013	0.420	<0.001	0.139	0.006
Schooling (%)						
Primary or less	30.0	46.0	24.0	17.9	13.3	26.9
More than primary	39.4	30.9	22.3	32.5	2.4	20.5
p value	0.084	0.008	0.741	0.002	0.004	0.217
Wealth index quartiles (%)						
First	25.5	42.7	26.4	14.6	13.2	29.1
Second	31.6	42.1	22.8	22.6	16.1	21.8
Third	30.8	47.9	23.1	19.2	10.4	21.6
Fourth	39.7	38.8	22.4	25.5	7.6	28.7
p value	0.146	0.571	0.893	0.058	0.142	0.256

Results are expressed as the percentage of individuals within each stratum who are in the top quartile of each dietary pattern

* $p < 0.05$. Statistical analysis by Chi-square

in Table 4 for men and Table 5 for women. For both sexes, participants with the highest annual expenditures were more likely to have diets in the highest quartile of adherence to the "Western" pattern. When the four quartiles of annual expenditures were considered, a positive linear association with the "Western" pattern was found (p for trend ≤ 0.017). High schooling tended to be associated with a low adherence to the "traditional" pattern in men and women. The third quartile of annual expenditures was associated with a lower "coffee and sugar" intake in women, and a negative linear association with this pattern was found (p for trend 0.039). Finally, significant associations between urbanity and the dietary patterns in bivariate analyses were no longer significant after adjustment for socioeconomic factors in multivariate analyses.

Sensitivity analyses

A sensitivity analysis was performed without imputing the variable urbanity. Similar findings were found as the ones reported in main analysis (Supplementary Tables 3, 4 and 5).

Discussion

We assessed dietary patterns in a Guatemalan population as well as their association with socioeconomic and demographic variables. Three dietary patterns were identified: "Western", "coffee and sugar", and "traditional". These patterns were shown to be influenced by socioeconomic

Table 4 Multivariate association of socioeconomic and demographic variables with the dietary patterns in men ($n = 457$) (Guatemala, 2002–2004)

Variable	Western pattern	Traditional pattern	Coffee and sugar
Age (years)			
24–30	Reference	Reference	Reference
31–35	1.21 (0.86–1.69)	1.00 (0.78–1.28)	1.22 (0.79–1.89)
36–40	1.25 (0.86–1.80)	0.93 (0.70–1.24)	1.55 (0.98–2.44)
40+	0.57 (0.15–2.10)	0.53 (0.18–1.55)	0.43 (0.06–3.04)
p for linear trend	0.408	0.232	0.442
Urbanity			
Rural	Reference	Reference	Reference
Urban	1.02 (0.73–1.42)	0.89 (0.66–1.20)	0.83 (0.53–1.30)
p for linear trend	0.920	0.460	0.413
Annual expenditures quartiles			
First	Reference	Reference	Reference
Second	1.59 (1.00–2.52)	0.88 (0.67–1.16)	0.91 (0.58–1.43)
Third	1.49 (0.94–2.37)	0.84 (0.64–1.12)	0.93 (0.59–1.46)
Fourth	1.92 (1.17–3.15)	0.71 (0.49–1.02)	0.70 (0.39–1.25)
p for linear trend	0.017	0.062	0.263
Schooling			
Primary or less	Reference	Reference	Reference
More than primary	1.03 (0.73–1.47)	0.80 (0.55–1.16)	1.19 (0.74–1.90)
p value	0.859	0.236	0.469
Wealth index quartiles			
First	Reference	Reference	Reference
Second	1.21 (0.80–1.82)	1.01 (0.74–1.37)	0.86 (0.55–1.36)
Third	1.19 (0.78–1.81)	1.12 (0.84–1.50)	0.91 (0.58–1.43)
Fourth	1.45 (0.98–2.14)	0.93 (0.68–1.28)	0.86 (0.54–1.36)
p for linear trend	0.082	0.849	0.586

Results are expressed as prevalence ratio and (95 % confidence interval) and show the likelihood of being in the highest quartile of the dietary pattern compared to the lowest three quartiles

$p < 0.05$. Statistical analysis by Poisson regression adjusting for all variables presented

factors, with a particularly strong relationship between household annual expenditures and adherence to the "Western" pattern.

Dietary patterns

The "Western" pattern included several processed foods (e.g., pizza, cake, ice cream, chocolates, French fries) which have also been found in a Western-like pattern in Brazil (Olinto et al. 2011). This pattern might have appeared as part of the nutrition transition, encompassing access to supermarket foods, changes in food distribution and marketing, and regulatory environments which allow a freer flow of goods and services (Popkin 2006). Indeed, greater access to cheap, fat-rich foods might play a role in the development of obesity and NCDs (Popkin et al. 2012). However, this pattern may not be fully deleterious, since it includes dairy products high in calcium and protein which increase diet diversity (Cardoso et al. 2013).

The "traditional" pattern included most traditional Guatemalan staple foods such as black beans, rice, tortillas and derived items. Contrary to popular belief, the "traditional" pattern may not be a healthy one. Butter and cooking oils are frequently required for the preparation of cereals and cereal-derived traditional foods (Lako and Nguyen 2001) (e.g., *frijoles volteados* and *tamales*), increasing fat intake. Also, only the right amounts of grains and legumes (e.g., rice and beans) provide an optimized protein quality (Noel et al. 2009). Thus, by including animal source protein or vitamin-rich foods, some changes in dietary intake as occurring in the nutrition transition might actually be beneficial rather than deleterious (Popkin 2006). Although coffee may be defined as a traditional food, the "coffee and sugar" pattern has also been

Table 5 Multivariate associations of socioeconomic and demographic variables with the dietary patterns in women ($n = 619$) (Guatemala, 2002–2004)

Variable	Western pattern	Traditional pattern	Coffee and sugar
Age (years)			
24–30	Reference	Reference	Reference
31–35	1.13 (0.76–1.68)	0.95 (0.59–1.53)	0.94 (0.66–1.32)
36–40	1.38 (0.93–2.03)	0.63 (0.35–1.11)	1.29 (0.93–1.78)
40+	0.85 (0.31–2.34)	0.32 (0.05–2.11)	0.98 (0.44–2.19)
p for linear trend	0.859	0.185	0.825
Urbanity			
Rural	Reference	Reference	Reference
Urban	1.32 (0.95–1.82)	0.77 (0.44–1.34)	0.90 (0.64–1.27)
p for linear trend	0.096	0.347	0.555
Annual expenditure quartiles			
First	Reference	Reference	Reference
Second	3.79 (1.48–9.72)	0.98 (0.57–1.71)	0.77 (0.54–1.09)
Third	6.36 (2.55–15.87)	0.77 (0.40–1.50)	0.52 (0.34–0.78)
Fourth	8.99 (3.57–22.64)	0.73 (0.36–1.49)	0.72 (0.47–1.08)
p for linear trend	<0.001	0.314	0.039
Schooling			
Primary or less	Reference	Reference	Reference
More than primary	1.12 (0.76–1.64)	0.23 (0.05–1.02)	0.84 (0.52–1.37)
p value	0.560	0.053	0.488
Wealth index quartiles			
First	Reference	Reference	Reference
Second	1.11 (0.72–1.72)	1.42 (0.82–2.46)	0.85 (0.57–1.26)
Third	0.93 (0.57–1.50)	1.00 (0.53–1.86)	0.83 (0.56–1.24)
Fourth	0.99 (0.65–1.52)	0.82 (0.42–1.61)	1.23 (0.86–1.74)
p for linear trend	0.766	0.384	0.321

Results are expressed as prevalence ratio and (95 % confidence interval) and show the likelihood of being in the highest quartile of the dietary pattern compared to the lowest three quartiles

$p < 0.05$. Statistical analysis by Poisson regression adjusting for all variables presented

identified in a Mexican–American population (Sofianou et al. 2011).

Associations of socioeconomic and demographic factors with dietary patterns

The results of our bivariate analysis indicate differences between the SES indicators and urbanity with the dietary patterns. They are in line with what is hypothesized by the nutrition transition theory: a higher consumption of high-fat and sugary foods and a lower consumption of traditional "less trendy" foods among high SES groups at the first stages of the transition (Mayén et al. 2014).

After multivariate adjustment, only annual expenditures were significantly associated with the "Western" pattern in both sexes. This finding supports the few available studies regarding the association between annual expenditures and dietary patterns in LMICs, which showed a high adherence to a western-like dietary pattern among participants with higher income (Mayén et al. 2014). This may also be related to the fact that individuals in the lowest quartile of annual expenditures (reference group) may not buy foods but consume what is locally grown.

Conversely, the association of schooling with the "Western" and "traditional" patterns was no longer significant in multivariate analyses. This finding is in contrast with a previous study conducted in Brazil which showed that both higher schooling and income were associated with excessive intake of saturated fat (Araujo et al. 2014). A probable explanation is the low number of participants with schooling higher than primary, which might have reduced the statistical power in our analyses. Moreover, SES indicators may be strongly correlated and multivariate adjustment for the three indicators may result in over-adjustment. On the other hand, our results are in line with those from two randomized controlled trials

conducted in HICs, where education alone does not suffice to promote healthy eating patterns (Ni Mhurchu et al. 2010; Waterlander et al. 2013). Similarly, the association of urbanity with the "Western" and "traditional" patterns became non-significant in multivariate analyses. This finding also contrasts with previous evidence where urban individuals had a higher intake of calories, cholesterol and saturated fats (Mayén et al. 2014), probably due to the fact that the majority of our participants lived in rural settings.

In addition, the associations between annual expenditures and the "Western" pattern were much higher for women than men. These results are in line with other studies in middle income countries, showing higher obesity rates in high SES women (Neuman et al. 2011) before a reversal along with socioeconomic development (Monteiro et al. 2004) and the nutrition transition. The lower adherence to the "coffee and sugar" pattern in women is also in line with the nutrition transition theory. Coffee and sugar could be considered as traditional items as they have been produced in Guatemala and Mexico since many years (Campos-Ortiz and Oviedo-Pacheco 2013; USDA Foreign Agricultural Service, GAIN 2013; Pérez-Grovas et al. 2001). Thus, participants with higher annual expenditures might be tempted to consume more expensive, trendy and "high status" beverages available in supermarkets (Winham 2009).

Our results suggested that socioeconomic differences in dietary intake exist in Guatemala, with high SES individuals having a higher intake of processed foods rich in fat and sodium. Simultaneously, as economic growth increases, high SES individuals have a higher access to more nutrients and diet variety. Moreover, the population could be driven towards healthy eating with an improvement of their purchasing power and increased access to healthy food items (Blouin et al. 2009) while there is an increased cost of unhealthy foods (Barquera et al. 2013). Also, some of the components in the western pattern could be promoted while negotiating their composition (e.g., low salt bread and cheese) (Ferrante et al. 2011).

Study limitations

Our study has some limitations. First, the study sample is not representative for the general population of Guatemala as a convenience sample was used. Second, the variance explained by all three patterns was 24 %. However, it was higher than other studies conducted in LMICs or even HICs and likely due to the large number of food items included in the PCA. Third, annual expenditures were estimated using the number of persons in each household and might not represent "true" individual annual expenditures. Fourth, a possible lack of power may explain the lack of statistical significance for associations between dietary patterns and urbanity, schooling or wealth. Still, this is the first study to assess socioeconomic differences in dietary patterns in Guatemala, using a novel analytic approach and focusing on implications for adult health. Fifth, the wealth index was constructed based on the literature. However, it was not formally validated in the population and might explain the lack of significant associations. Finally, the database is from 2002 to 2004 and dietary patterns may have changed since then, especially in a country with a transitioning economy such as Guatemala. These are, however, the most recent data available for Guatemala and provide important reference information for future monitoring studies.

We conclude that in Guatemala, dietary patterns are significantly associated with socioeconomic factors and in particular by annual expenditures. Increased annual expenditures are associated with a more Westernized, less traditional diet.

Compliance with ethical standards

Ethical approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Procedures were approved by the institutional review boards at INCAP, Emory University, and the International Food Policy Research Institute. An informed consent was obtained from all individual participants included in the study.

Conflict of interest None.

Funding Data were collected using funding provided by the US National Institutes of Health (R01 TW-05598: PI Martorell). Ana-Lucia Mayén-Chacón is a recipient of a Swiss Excellence Government scholarship. Silvia Stringhini is supported by an Ambizione Grant (No. PZ00P3_147998) from the Swiss National Science Foundation (SNSF). Funders had no role in the design, analysis or writing of this article.

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