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Exploring dietary patterns in a Mexican adolescent population: A mixed methods approach

Erica C. Jansen[a,*], Hannah Marcovitch[b], Julia A. Wolfson[a,c], Mary Leighton[b], Karen E. Peterson[a], Martha Maria Téllez-Rojo[d], Alejandra Cantoral[e], Elizabeth F.S. Roberts[b]

[a] Nutritional Sciences, University of Michigan School of Public Health, Ann Arbor, MI, USA
[b] Department of Anthropology, University of Michigan, Ann Arbor, MI, USA
[c] Health Management and Policy, University of Michigan School of Public Health, Ann Arbor, MI, USA
[d] Instituto Nacional de Salud Publica, Cuernavaca, Mexico
[e] CONACYT, National Institute of Public Health, Cuernavaca, Mexico

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ABSTRACT

To explore dietary patterns within the context of the nutrition transition among Mexican adolescents, we employed a mixed-methodology that included survey data from a cohort of 550 adolescents and direct ethnographic observations of six families. From the cohort study, we found that diet tended to cluster into 3 patterns. Interpreting the patterns using the ethnographic observations showed that the dietary clustering likely reflected differences in meal organization driven by socioeconomic status (SES). In particular, families of higher SES could afford to prepare larger home-cooked meals on a regular basis while lower SES households had less-stable patterns and greater reliance on processed food. These findings provide a more nuanced interpretation of dietary patterns observed in the Mexico population than is afforded by the food items alone (i.e. a "healthy" or "prudent" pattern versus "unhealthy" or "Westernized").

1. Introduction

Over the last several decades, Mexico has been in the midst of a nutrition transition, a process by which diets shift from more "traditional" fruit, vegetable, and whole grain-based diets to more "Westernized" diets that are high in animal products, processed and energy-dense foods, and saturated fat (Popkin). The changing diet patterns in Mexico are accompanied by rising obesity and chronic disease (Popkin, Adair, & Ng, 2012). The climbing rates of childhood and adolescent obesity are particularly concerning; in Mexico it is estimated that > 30% of Mexican children and adolescents are overweight or obese (Shamah-Levi, Cuevas-Nasu, Dommarco-Rivera, & Hernandez-Avila, 2016). While there are likely multiple causes, a Western diet has been identified as a key predictor of obesity and chronic disease morbidity in Mexican youth (Gutiérrez-Pliego, Del Socorro Camarillo-Romero, Montenegro-Morales, & De Jesus Garduño-García, 2016; Perng et al., 2017; Romero-Polvo et al., 2012).

To more fully understand the role of the nutrition transition on health in Mexican adolescents and whether these changing dietary patterns are modifiable, it is necessary to consider what "traditional" or "Western" dietary patterns actually represent, and if thesee classifications are useful and accurate distinctions. To understand diet at the population-level, dietary patterns are often created using a data-driven approach that takes into account how closely different foods cluster in the diet. The drawback is that this approach is unable to ascertain the reasons behind the clustering, or the actual difference among diets (apart from the food items) within a given population. The nutrition transition framework is one way to understand this distinction; e.g. a diet pattern high in fruits and vegetables may be in line with a "traditional" way of eating. Nonetheless, without additional information, it is impossible to determine if the food is actually consumed in a traditional way in terms of food preparation, meal arrangements, etc. In contrast, direct observations of the diets of adolescents and their households within the population can provide insight into how the food is purchased, prepared, and consumed, and thus is pivotal for understanding the dietary patterns that emerge from these data-driven approaches.

Another reason to explore dietary patterns in greater depth is to gain insights into the social contexts from which they arise, which is ultimately important for designing appropriate intervention frameworks. At the population level, the dietary changes related to the nutrition transition occur at different rates according to socioeconomic

* Corresponding author. 3863 SPHI, 1415 Washington Heights, Ann Arbor, MI, 48109, USA.
E-mail address: janerica@umich.edu (E.C. Jansen).

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status (SES), such that higher SES households tend to incorporate "Westernized" food products into their diet first due to the initial higher cost of these items. As the food environment changes and the products become more available, the pattern reverses; and lower SES households begin to incorporate a greater array of processed foods into their diets (Popkin). Currently, the Mexican population appears to be further along in the nutrition transition spectrum, with lower SES populations consuming higher proportions of processed and refined foods and higher SES populations with greater consumption of fresh fruits and vegetables. Nonetheless, the precise nature of the SES and dietary pattern relationships are not well-described in Mexican adolescents. For example, do the differences in dietary patterns between youth from lower versus higher SES households depend mostly on food availability and price, or are they more fully explained by other factors such as time allocated to preparing food, shopping practices, knowledge of healthful eating, parental education levels, etc.?

A few epidemiological studies in Mexican pediatric populations have explored the socioeconomic, household, or individual-level factors that are related to dietary patterns, yet with inconsistent findings. One recent study examined a host of socioeconomic and household factors in relation to diet, but after adjustment, only maternal occupation (administrative assistant or home compared to professional occupation) and child's screen time were associated with high fat and high sugar diet patterns (Galvan-Portillo et al., 2018). Other studies that have explored dietary patterns among Mexican youth have noted associations between lower quality diet patterns and individual-level characteristics including smoking (Gutiérrez-Pliego et al., 2016), younger ages (Romero-Polvo et al., 2012), and male sex (Romero-Polvo et al., 2012).

In contrast to the previous epidemiological analyses, which are typically heavily-reliant on surveys to assess diet and other lifestyle characteristics, ethnographic observations involve direct observations of diet and daily life in the population of interest over long periods of time (Roberts, & Sanz, 2018). Thus, these observations can be an invaluable source to understand dietary patterns within their social context. In the present analysis, we used a cohort study of adolescents from Mexico City and an ethnographic study of several households from the same cohort to explore socioeconomic and lifestyle predictors of diet in Mexican adolescents. First, we identified dietary patterns and statistically evaluated their sociodemographic predictors in the cohort of 550 adolescents. Second, we used ethnographic data to characterize dietary patterns, with a focus on two households of varying socioeconomic conditions. Finally, we incorporated both data sources to explore three questions:

1. Do dietary patterns that emerged in the epidemiological data match those observed in the ethnography and if so, how?
2. Can the ethnographic observations offer insights into the associations (or lack of associations) between diet and socioeconomic characteristics reported from the larger cohort study?
3. How are processed and "Western" foods incorporated into the diet, as reflected in the clustering of these foods in the cohort study as well as the observation of their consumption in the ethnographic analysis? Does this differ with respect to socioeconomic status?

2. Methods

2.1. Cohort study population

Our study population includes adolescent participants from sequentially-enrolled cohorts of the Early Life Exposure in Mexico to ENvironmental Toxicants (ELEMENT) study (Hu et al., 2006; Surkan et al., 2008). Between 1994 and 2004, 1079 mother/child dyads were recruited from prenatal clinics of the Mexican Social Security Institute in Mexico City. Data for the present study was taken from an adolescent follow-up visit that occurred from 2015 to 2016 in a subset of 550 participants from the original birth cohorts (cohorts two and three). The institutional review boards at the Mexico National Institute of Public Health and the University of Michigan approved research protocols, and informed consent was obtained for all participants.

2.2. Dietary, sociodemographic, and health behavior assessment

During the adolescent follow-up visit, trained interviewers administered a 112- item semi-quantitative food frequency questionnaire to the adolescents to obtain information on typical consumption habits. The questionnaire asked adolescents to recall how often they had consumed one serving of a standard portion size of each food item over the previous week. Photographs of food items were provided as a visual aid. Response options ranged from never to ≥ 6 times per day. We converted the raw response values (1–9) into servings/day.

Sociodemographic and lifestyle factors that prior studies have examined as predictors of dietary patterns in other Latin American settings (Galvan-Portillo et al., 2018; Gutiérrez-Pliego et al., 2016; Mayén et al., 2016; Romero-Polvo et al., 2012) were included in the present study, and include all the variables listed in Table 2. Information was collected 1) from mothers at the initial enrollment visit (maternal age, parity, and education) and 2) during the adolescent follow-up visit (current socioeconomic status, diet, and other health behaviors). At the adolescent follow-up visit, adolescents (with input from mothers when available) answered questions regarding socioeconomic status. This questionnaire was created by the *Asociación Mexicana de Agencias de Investigación de Mercados y Opinión Pública* (Mexican Association of Marketing Research and Public Opinion Agencies) to evaluate household resources, including education of the household head, number of rooms in the house, number of vehicles owned, ownership of particular appliances (e.g. microwave and washing machine), and access to internet. The index consists of 7 categories ranging from A/B (highest SES) to E (lowest SES).

Participants also completed questionnaires concerning daily activities. To calculate average hours of physical activity per week, we added the self-reported time in hours spent in all potential physical activities (e.g. soccer, volleyball, running). The education status of the adolescent was based on current self-report: attending primary school, attending secondary school, attending post-secondary education, or not attending any educational program. Sleep duration was measured with actigraph watches for up to 7 days following the visit. It was averaged over the 7 days and categorized, based on the American Academy of Sleep Medicine age-specific guidelines (Paruthi et al., 2016), as meeting sleep duration recommendation or not meeting sleep duration recommendations.

2.3. Ethnographic study and observations

Since 2012, we have conducted ethnographic observation of a subset of ELEMENT participants in ELEMENT study settings and in their homes. Nine families with children in the ELEMENT cohort who lived in one of two focal neighborhoods were invited to participate, and six agreed. From August 2014 through July 2015, we conducted an intensive ethnographic observation of these six ELEMENT families that involved participant-observation and iterative unstructured interviews. Specifically, the ethnographer (LFS) spent time in each family home for 3–6 h at a time, returning multiple days each week for a six-month period in each neighborhood (August 2014–January 2015 and February 2015–July 2015) to observe and participate in the families' daily routines, including larger neighborhood activities such as festivals and political events. The ethnographer also spent time with other neighbor families in both neighborhoods to obtain a sense of how typical the focal households were. We have continued intermittent ethnographic observations with these same six families and neighborhoods, and in February 2018 we conducted a few supplemental interviews with household members of the six families that focused specifically on

typical individual and family eating patterns.

All observations were documented through extensive field notes and photographs, and interviews were recorded and then transcribed. The ethnography was coded in Atlas TI by members of our ethnographic coding lab, meaning that tags were applied to the fieldnotes to highlight different aspects of life, including eating events. This included references to eating, cooking, shopping, discussing food, etc.

For this paper, we describe in detail the diets and eating habits of two families in the ethnographic study. While we drew from all of our ethnographic data (including the six households and neighbors), we decided to write specifically about these two households because they had the clearest contrasts with regards to diet and household financial stability. Nonetheless, the overall eating patterns and observations about determinants of these eating patterns were informed by the broader data from the six households and neighborhoods (who represented a wide range of economic circumstances). To protect the identities of the families, each household member was given a pseudonym.

3. Data analysis

3.1. Part 1

To identify dietary patterns, we first used principal component analysis (PCA), a data-reduction method that groups foods together based on how correlated they are with one another. Each pattern is characterized by the foods that have the highest factor loadings; for example, a pattern with high factor loadings on rice and beans means that those foods are likely to be consumed together often (they may be as a part of the same meals but not necessarily). The methodology for dietary pattern identification is described in detail elsewhere (Perng et al., 2017). Briefly, we grouped similar food items into categories based on nutritional similarity (Supplemental Table 1 for the complete list), and computed total-energy adjusted food group intakes using the residual method (Willett, Howe, & Kushi, 1997). We next performed principal component analysis of the food groups, and rotated with orthogonal transformation to obtain uncorrelated factors. We determined the number of factors to retain based on visual inspection of the Scree plot, eigenvalues > 1, and interpretability. We considered food groups with factor loadings > 0.25 or < -0.25 to provide meaningful interpretation of the pattern, although all food groups contributed to the computation of the dietary pattern score. Dietary pattern scores for each participant were computed by multiplying the factor loadings of each food (see Table 1) by the frequency of consumption of that food group. Finally, we summed the food group loadings for each factor to obtain the dietary pattern scores for each pattern. In sensitivity analyses, we also performed principal component analysis of the food groups stratified by socioeconomic status (upper two categories versus lower two categories).

To evaluate associations between sociodemographic characteristics and dietary patterns, we examined mean ± SD dietary pattern factor scores according to categories of maternal and adolescent characteristics. For ordinal characteristics, we conducted a test for linear trend by including in the model a continuous variable representing the ordinal levels of the characteristic. For nominal characteristics, we utilized a type-III Wald test. Finally, we conducted multivariable linear regression analysis in which each dietary pattern score was the outcome, and predictors were mutually adjusted for one another. All analyses were conducted in Stata 14.0, and statistical significance was considered at $p < 0.05$.

3.2. Part 2

In order to describe the daily dietary patterns and food habits of the two focal families, headed by women we call Alma and Renata, we reviewed all ethnographic notes that were coded as a "food event" (related to food purchase, preparation, or consumption) during visits with these households of interest. These included descriptions of foods events (meals, shopping trips, etc.) from the ethnographer as well as direct quotes from the participants during interviews. Similarly, we reviewed all photographs from these families to identify food events, many of which included photographs of plates of food. In addition to describing the overall food habits in the two households, we constructed a timeline of a typical day's eating for the households of Alma and Renata. For the timeline, we selected relevant photographs to portray both individual food items and the context of the food environment.

Table 1
Factor loadings of food groups for three dietary patterns.

Foods	Pattern 1	Pattern 2	Pattern 3
	Plant-based & lean proteins	Meat & starchy	Eggs, milk & refined grain
other vegetables	0.71	0.04	0.02
cruciferous vegetables	0.68	−0.08	−0.06
fruit	0.58	0.09	0.13
dark yellow vegetables	0.58	−0.04	0.05
leafy vegetables	0.56	0.01	−0.06
tomatoes	0.56	−0.09	−0.06
chicken	0.41	0.19	−0.11
fish	0.40	0.05	0.04
avocado	0.39	0.11	−0.01
soup	0.35	0.28	−0.11
high-fat dairy	0.32	0.36	0.14
water & unsweetened drinks	0.27	−0.21	0.19
chips	−0.16	0.54	−0.16
refined grains	0.04	0.46	0.42
sugar-sweetened beverages	−0.13	0.40	−0.20
processed meat	−0.08	0.40	0.07
Mexican foods	0.06	0.40	−0.03
potato & fried plantains	0.16	0.39	−0.05
sweets/dessert	0.23	0.34	0.01
pork	0.03	0.33	−0.24
legumes	0.08	0.32	0.18
corn tortillas	−0.01	0.26	0.20
milk	0.03	−0.13	0.70
sweetened milk	−0.14	0.06	0.56
mayonnaise or margarine	0.02	0.20	0.37
egg	0.09	0.14	0.30
fast food	0.11	0.17	0.18
natural juice	0.15	0.17	0.17
corn on the cob	0.18	0.22	−0.09
whole grains	0.21	−0.08	0.09
yogurt	0.19	0.04	0.03
beef	0.17	0.17	−0.03
butter	0.01	0.23	0.00
% variance explained	10.3%	6.5%	4.8%

3.3. Part 3

Finally, we considered our three mixed-methodology research questions. As a research team, which included a mixture of nutritional researchers and anthropologists, we compared/contrasted the findings from Part 1 and Part 2 to answer each of the three specific questions.

The data analysis approach draws from a "concurrent nested design" mixed-methods design typology (Creswell, Clark, & Gutmann,). It was "concurrent" in that the data collection of the quantitative and qualitative studies occurred approximately simultaneously, and it was "nested" since the analysis of the quantitative data (part 1) drove a deeper investigation using the qualitative data (part 3). It can also be understood from the "following a thread" data integration method (O'Cathain, Murphy, & Nicholl, 2010), since the quantitative findings were extended and explored in the qualitative data.

Table 2
Associations of maternal and child characteristics with adherence to dietary patterns among 550 Mexican children age 9–17 years.

		Pattern 1	Pattern 2	Pattern 3
	N	*Plant-based & lean proteins*	*Meat & starchy*	*Eggs, milk & refined grain*
Maternal characteristics				
Mother's age at baseline, y				
< 25	222	0.11 ± 1.04	0.07 ± 1.07	−0.08 ± 0.99
25 to < 30	183	−0.10 ± 0.85	0.00 ± 0.97	0.10 ± 0.94
30 to < 35	86	0.01 ± 1.19	−0.11 ± 0.91	−0.11 ± 1.04
≥35	53	−0.16 ± 0.91	−0.12 ± 0.99	0.16 ± 1.12
P, trend		0.07	0.10	0.27
Mother's number of previous pregnancies				
0 or 1	208	0.11 ± 1.11	0.01 ± 1.03	0.00 ± 1.03
2	194	−0.05 ± 0.98	−0.02 ± 1.00	0.03 ± 0.98
≥3	148	−0.09 ± 0.84	0.02 ± 0.97	−0.04 ± 0.99
P, trend		0.05	0.96	0.76
Mother's education, y				
Did not complete secondary (< 9)	64	−0.17 ± 0.92	0.15 ± 1.01	0.04 ± 0.93
Completed some high school (9 to < 12)	217	−0.09 ± 0.89	−0.03 ± 1.01	0.02 ± 0.97
Completed high school (12)	186	0.12 ± 1.11	0.00 ± 1.00	−0.06 ± 1.00
Higher education (> 12)	78	0.11 ± 1.04	−0.03 ± 0.99	0.09 ± 1.11
P, trend		0.02	0.45	0.93
Mother's marital status, %				
Married or civil union	387	−0.02 ± 1.00	−0.01 ± 0.99	0.02 ± 1.01
Single, separated, divorced, or widowed	54	0.13 ± 0.99	0.02 ± 1.16	−0.22 ± 0.82
P value		0.29	0.87	0.10
SES Level				
A/B, C+ or C (higher SES index)	137	0.10 ± 0.96	−0.05 ± 0.94	−0.08 ± 0.93
C-	135	0.00 ± 0.96	−0.04 ± 1.00	−0.08 ± 0.93
D+	130	−0.03 ± 1.06	0.10 ± 1.02	0.00 ± 0.96
D or E	148	−0.07 ± 1.02	−0.01 ± 1.04	0.15 ± 1.06
P value		0.14	0.48	0.04
Child characteristics				
Sex				
Male	264	0.02 ± 1.09	0.03 ± 0.97	0.02 ± 0.96
Female	284	−0.01 ± 0.91	−0.03 ± 1.03	−0.02 ± 1.03
P value		0.67	0.42	0.63
Age group				
9.5 to < 12 y	93	−0.11 ± 0.94	0.04 ± 1.09	0.05 ± 1.00
12 to < 14 y	160	0.03 ± 1.05	0.07 ± 1.01	0.02 ± 0.93
14 to < 16 y	103	0.05 ± 1.07	0.06 ± 1.10	−0.09 ± 1.05
16 to 18 y	193	0.00 ± 0.95	−0.11 ± 0.88	0.01 ± 1.03
P value		0.54	0.11	0.64
Current school status				
Attending primary	110	0.08 ± 0.99	0.05 ± 1.12	−0.03 ± 1.05
Attending secondary	207	−0.02 ± 0.96	0.08 ± 0.98	−0.05 ± 0.93
Attending post-secondary education	197	−0.02 ± 1.05	−0.07 ± 0.94	0.09 ± 1.04
Not attending school	36	0.00 ± 1.03	−0.22 ± 1.05	−0.11 ± 0.98
P value		0.50	0.24	0.85
Hours of screen time, quartiles				
Q1, 1–22.5 h/wk	139	−0.06 ± 0.95	−0.03 ± 1.00	0.02 ± 0.94
Q2, 23–32.5 h/wk	136	0.05 ± 1.13	0.12 ± 1.00	−0.04 ± 0.92
Q3, 33–48 h/wk	139	0.10 ± 1.03	−0.06 ± 0.97	0.06 ± 1.05
Q4, 48.5–116 h/wk	136	−0.09 ± 0.87	−0.03 ± 1.03	−0.04 ± 1.09
P value		0.91	0.65	0.85
Hours of physical activity, quartiles				
Q1, 0–5.5 h/wk	142	−0.10 ± 0.91	−0.12 ± 0.97	0.01 ± 1.01
Q2, 5.8–9 h/wk	134	−0.04 ± 0.95	0.04 ± 0.96	0.02 ± 1.03
Q3, 9.3–14 h/wk	145	0.08 ± 1.105	0.04 ± 1.03	0.01 ± 1.04
Q4, 14.3–29 h/wk	129	0.06 ± 1.08	0.04 ± 1.04	−0.04 ± 0.92
P value		0.11	0.21	0.72
Meets sleep duration recommendations				
Yes	320	0.04 ± 1.05	−0.05 ± 0.98	0.00 ± 1.03
No	215	−0.06 ± 0.88	0.06 ± 1.01	−0.02 ± 0.97
P value		0.25	0.24	0.86

4. Results- part 1

Supplemental Table 1 displays the foods that comprise each food group used in the dietary pattern analysis. Using principal components analysis, we identified 3 dietary patterns (Table 1). The first, which we describe as the *Plant-based & lean proteins* pattern, was characterized by high intake frequency of vegetables, fruit, soup, fish, water and unsweetened drinks, and high fat dairy. The second pattern, which we call *Meat & starchy,* was marked by high intake frequency of "Western" processed foods including chips, refined grains, sugar-sweetened beverages, processed meat, and high-fat dairy, as well as foods more in line with "traditional" foods such as the Mexican food group (e.g. tacos and quesadillas), potatoes and fried plantains, soup, legumes, and corn tortillas. The third pattern was characterized by high intake frequency of refined grains, milk, sweetened milk, mayonnaise or margarine, and eggs; this was called the *Eggs, milk & refined grain* pattern. In sensitivity analyses, we replicated the above process separately for lower and higher SES groups. In this SES stratified analysis, the first pattern (*Plant-based & lean proteins pattern)* appeared with very little variation in both SES groups. The second and third patterns differed according to some food items (e.g. fast food loaded highly in the second pattern for low SES but highly in the third pattern for high SES) but were not substantially different. Due to the robustness of the dietary patterns when stratified by SES, the below results are based on the dietary patterns identified in the full sample.

Table 2 presents the characteristics of the study sample and their associations with each dietary pattern. The average ± SD age of the participants was 14.5 ± 2.1 years old, and 51.8% were female. The average total energy intake of the study population was 2297 ± 922 Calories. In unadjusted analyses, adolescents whose mothers had fewer prior pregnancies (proxy for fewer siblings) and higher levels of education had higher scores in the *Plant-based & lean proteins* dietary pattern. In contrast, higher household SES was related to lower scores in the *Eggs, milk & refined grain* pattern. Scores in the *Meat & starchy* pattern did not differ with respect to any of the measured maternal or child characteristics. In adjusted analysis, the associations with maternal education and SES persisted in the *Plant-based & lean proteins* and *Eggs, milk & refined grain* patterns, respectively, albeit slightly attenuated (Table 3). To illustrate, children whose mothers did not complete secondary school had 0.28 units lower scores in the *Plant-based & lean proteins* dietary pattern compared to those whose mothers had completed higher education (95% CI -0.59 to 0.03; P, trend = 0.06). Children from households in the lowest SES category had 0.31 units (95% CI 0.04 to 0.57; P, trend = 0.02) higher adjusted *Eggs, milk & refined grain* dietary pattern scores than those in the highest SES households.

5. Results- part 2

5.1. Ethnographic households-mothers Alma and Renata

Although both Alma and Renata's households were categorized in the lower quartiles of SES based on responses to the epidemiological questionnaire, there were economic differences between the two. Alma had two daughters (aged 9 and 5 at the start of the study) and lived with her husband Raúl in an extended family compound that was home to nine people in total. Raúl had stable, formal-sector employment, which meant they had access to state-sponsored health care. They also had running water seven days a week. Renata also lived in a family compound that included three other units in addition to the two rooms she occupied with her husband and children (two girls and a boy, all 12 or older at the start of the study). But, unlike Alma, Renata's family had greater economic insecurity. While Renata's husband regularly worked low-paid construction jobs and she had occasional informal work such as selling home-made food through street-vending, no one in the immediate household maintained formal-sector employment. Additionally, Renata's household only had access to running water three days a week, which affected meal preparation and clean up.

Alma's and Renata's routines were both filled with the daily work of food: shopping for food, preparing food, selling food (Renata), serving and eating food with their families, and cleaning up afterwards. This was typical of women from their neighborhoods: although women in these neighborhoods often engaged in informal sector work, such as selling beauty products to each other or preparing food-items like sandwiches to sell from a basket, they were primarily occupied with domestic work in their homes.

5.2. Meal structure

Both families loosely followed the typical meal pattern structure in Mexico, where the later afternoon meal, called *comida* was the largest. *Comida* (translated as both "meal" and "food") is typically a home-cooked meal, and most often occurred between 1 and 4 PM in their households. It was the most social and elaborate meal of the day. Other meals included breakfast, a small mid-morning meal called *almuerzo* (translated as "lunch"), an afternoon snack, and a small-to-medium sized meal in the evening for dinner (Fig. 1).

In Alma's family, the day started around 7:45 a.m. with a breakfast of corn flakes and milk for her and her daughters. The girls took a packed lunch to school, which often consisted of a ham sandwich on white bread and a bottle of water. School regulations specified that only water could be sent with children in their lunch. For a time after this rule was instated, Alma would fill her daughter's water bottles with clear soda (Roberts, & Sanz, 2018). Alma made *comida* every day, and on a typical day Alma might prepare fresh tomato soup with pasta, homemade green salsa (comprised of tomatillos, chilis, potatoes, carrots, and onions) a dish of fried pork bellies or fat called chicharron, rice or fried pasta, and a sausage called *longaniza*. When Alma picked her younger daughter up from school, she usually bought her snacks—such as sugary yogurt, Cheetos, candy, or churros—which her daughter ate before they arrived home.. Alma and her younger daughter would then eat *comida* when they arrived home. Alma's older daughter ate a packed lunch during her day at school, and then ate *comida* around 5 PM when she got home. When Alma's husband got home at 8 PM he would eat the food from *comida* that everyone had eaten earlier in the day. The rest of the family ate a light meal or snack around this time, like pan dulce (sweet bread) or tacos brought from a street stall near their house. They might also have leftovers from *comida.*

In Renata's family the meal times were more likely to vary. Breakfast was around the same time, 7:45 or 8 a.m., and typically consisted of coffee and tamales (steamed corn cakes). Around mid-morning, they would have a snack such as a gordita (a pastry stuffed with meat, cheese, or other savory fillings). Similarly to Alma's family, *comida* was made at home most days from fresh ingredients and included a vegetable-heavy soup followed by a meat dish. The meat dish could be chicken with green chili sauce, accompanied by tortillas and soda or fruit-flavored water. The timing of *comida* was anywhere between 1 and 3 p.m. Renata's children were not always able to attend school because of fears of violence in their neighborhood. They often bought snack foods on the street throughout the afternoon, such as cup-of-noodles or chicharron. The evening meal often consisted of foods Renata prepared that day to sell from her basket, such as tacos.

5.3. Shopping

Alma shopped for food at both the open-air market (*tianguis*) in her neighborhood and the nearest *Bodega Aurera*, a supermarket chain owned by Wal-Mart. Her husband's secure formal sector job was a large factor in their dietary stability, and enabled their day-to-day food options to encompass a greater variety. As a result, her pantry was well stocked for substantial *comidas,* large enough that there were typically

Table 3
Mutually-adjusted associations of maternal and child characteristics with adherence to dietary patterns among 550 Mexican children age 9–17 years.

	Adjusted differences (95% Confidence Intervals)[a]		
	Plant-based & lean proteins	Meat & starchy	Eggs, milk & refined grain
Maternal characteristics			
Mother's age at baseline, y			
< 25	Reference	Reference	Reference
25 to < 30	−0.24 (-0.44, −0.03)	−0.04 (-0.25, 0.17)	0.21 (0.00, 0.41)
30 to < 35	−0.16 (-0.43, 0.11)	−0.23 (-0.50, 0.04)	−0.03 (-0.29, 0.24)
≥35	−0.24 (-0.57, 0.10)	−0.21 (-0.54, 0.13)	0.31 (-0.02, 0.64)
P, trend	0.10	0.09	0.19
Mother's number of previous pregnancies			
0 or 1	Reference	Reference	Reference
2	−0.05 (-0.26, 0.16)	0.03 (-0.18, 0.25)	−0.03 (-0.24, 0.18)
≥3	−0.02 (-0.27, 0.23)	0.07 (-0.19, 0.32)	−0.1 (-0.35, 0.15)
P, trend	0.83	0.61	0.45
Mother's education, y			
Did not complete secondary (< 9)	−0.28 (-0.59, 0.03)	0.22 (-0.10, 0.53)	0.13 (-0.18, 0.43)
Completed some high school (9 to < 12)	−0.23 (-0.45, −0.02)	−0.07 (-0.29, 0.14)	0.12 (-0.09, 0.33)
Completed high school (12)	Reference	Reference	Reference
Higher education (> 12)	−0.07 (-0.36, 0.22)	0.01 (-0.28, 0.31)	0.21 (-0.08, 0.50)
P, trend	0.06	0.59	0.92
Mother's marital status, %			
Married or civil union	Reference	Reference	Reference
Single, separated, divorced, or widowed	0.18 (-0.13, 0.48)	−0.02 (-0.33, 0.28)	−0.22 (-0.52, 0.08)
P value	0.25	0.88	0.14
SES Level			
A/B, C+ or C (higher SES index)	Reference	Reference	Reference
C-	−0.11 (-0.36, 0.15)	0.06 (-0.20, 0.31)	0.10 (-0.15, 0.35)
D+	−0.19 (-0.46, 0.07)	0.18 (-0.09, 0.45)	0.18 (-0.08, 0.44)
D or E	−0.18 (-0.45, 0.09)	0.08 (-0.19, 0.35)	0.31 (0.04, 0.57)
P value	0.15	0.41	0.02
Child characteristics			
Sex			
Male	Reference	Reference	Reference
Female	0 (-0.18, 0.18)	−0.07 (-0.26, 0.11)	−0.13 (-0.30, 0.05)
P value	0.98	0.42	0.16
Age group			
9.5 to < 12 y	Reference	Reference	Reference
12 to < 14 y	0.28 (-0.14, 0.70)	−0.04 (-0.47, 0.39)	0.03 (-0.39, 0.45)
14 to < 16 y	0.19 (-0.32, 0.70)	0.02 (-0.50, 0.53)	−0.04 (-0.04, 0.46)
16 to 18 y	−0.07 (-0.66, 0.52)	−0.19 (-0.78, 0.41)	0 (-0.58, 0.58)
P value	0.42	0.55	0.92
Current school status			
Attending primary	Reference	Reference	Reference
Attending secondary	−0.2 (-0.61, 0.21)	0.02 (-0.40, 0.43)	−0.1 (-0.50, 0.31)
Attending post-secondary education	0.19 (-0.36, 0.74)	0.04 (-0.51, 0.60)	−0.14 (-0.68, 0.40)
Not attending school	0.17 (-0.46, 0.80)	−0.11 (-0.75, 0.53)	−0.22 (-0.85, 0.40)
P value	0.15	0.90	0.92
Hours of screen time, quartiles			
Q1, 1–22.5 h/wk	Reference	Reference	Reference
Q2, 23–32.5 h/wk	0.05 (-0.20, 0.30)	0.09 (-0.16, 0.35)	−0.02 (-0.27, 0.22)
Q3, 33–48 h/wk	0.08 (-0.17, 0.33)	−0.06 (-0.31, 0.20)	0.04 (-0.21, 0.29)
Q4, 48.5–116 h/wk	−0.11 (-0.36, 0.15)	0.04 (-0.22, 0.30)	−0.08 (-0.33, 0.17)
P value	0.48	0.93	0.67
Hours of physical activity, quartiles			
Q1, 0–5.5 h/wk	Reference	Reference	Reference
Q2, 5.8–9 h/wk	0.06 (-0.18, 0.31)	0.14 (-0.11, 0.38)	0.02 (-0.23, 0.26)
Q3, 9.3–14 h/wk	0.18 (-0.06, 0.43)	0.11 (-0.14, 0.36)	−0.03 (-0.27, 0.21)
Q4, 14.3–29 h/wk	0.2 (-0.05, 0.45)	0.08 (-0.17, 0.34)	−0.08 (-0.33, 0.17)
P value	0.07	0.58	0.49
Meets sleep duration recommendations			
Yes	Reference	Reference	Reference
No	−0.01 (-0.20, 0.17)	0.09 (-0.10, 0.27)	−0.13 (-0.31, 0.06)

(*continued on next page*)

Table 3 (*continued*)

	Adjusted differences (95% Confidence Intervals)[a]		
	Plant-based & lean proteins	Meat & starchy	Eggs, milk & refined grain
P value	0.89	0.36	0.17

[a] From separate linear regression models with each dietary pattern as a continuous outcome, and all the variables listed in the table as categorical predictors.

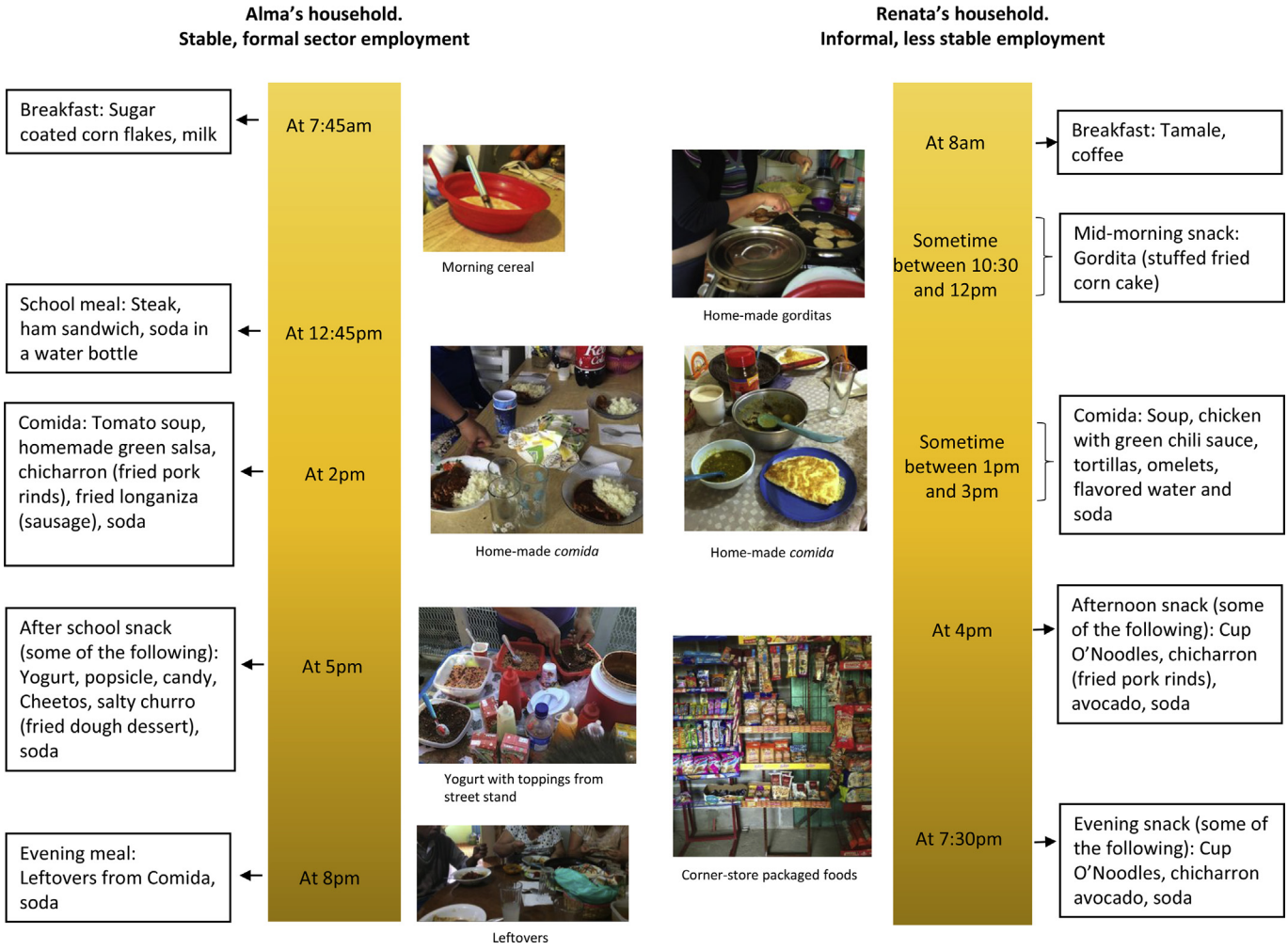

Fig. 1. A typical timeline of eating events in Alma's and Renata's households.

leftovers to store for future meals. There was also money for the snack foods that the children requested throughout the day.

Renata shopped for fresh fruits and vegetables about once a week at the central food market in Mexico City, *La Merced*. The whole trip took most of the day including public transport time but was worth it to her because prices at *La Merced* were significantly lower. She also planned her trips to the supermarket chain in order to get her non-produce staples based on when the store offered discounts. Otherwise, the family shopped meal-to-meal, with family members often instructed to purchase items as needed (sometimes on credit) at corner stores near their house. As a result, home meals were often planned around what was cheapest at the store, for example beans and rice from the supermarket with a green salsa made from tomatillos from *La Merced*. These *comida* meals also tended to be smaller than Alma's, meaning there was rarely food left over. Breakfast food, as well as food for mid-morning and afternoon snacks, usually came from food Renata sold through her own street-vending that day, or items bartered for or purchased inexpensively from other street-vendors. Notably, the foods Renata's family ate outside of their daily *comida* were often inexpensive and convenient packaged foods, and family members tended to eat a higher proportion of their total calories from street food and from smaller meals with cheaper sources of protein (e.g. eggs or cup-o-noodles) than members in Alma's household. As a whole, it was more difficult to identify consistent dietary patterns in Renata's family, which reflected their lack of steady income.

5.4. Summary of main similarities and differences between households

Overall, the main differences observed in the families were Alma's ability to buy produce ahead of time and to plan meals that included leftovers, versus relying on purchasing items ad hoc from local stores; Alma's greater disposable income for purchasing extra snacks; and the regularity of meal times. The similarities in meal content, however, were striking between the two families. Both families ate a large, home-cooked meal (*comida*) which included a protein, a starch, and a large quantity of cooked vegetables in the soup and/or salsa. They also both

drank soda and ate processed snacks (cup-of-noodles, sugary yogurt, candy) throughout the day. Nonetheless, Alma more often purchased these snacks as extra treats, consumed in addition to regular meals, while Renata's household more often ate these food items as meals. Thus, even though there were clear differences in diet, the differences were not apparent in the actual foods themselves as they were in the daily patterns of consumption (see Supplemental Table 2 for examples of food consumed at each meal from the fieldnotes).

5.5. Adolescent eating behaviors

Although a main focus in the ethnography was on the mothers in the households, the eating behaviors of the adolescents deserves a special note. Adolescents, especially the older adolescents, in these households had freedom to make their own food choices, and spent some time away from the house with friends when they might have a snack or a soda. However, the eating patterns away from home were not much different from what they would consume at home. For example, Renata's adolescents would be just as likely to eat a microwaveable noodle cup at home with their mother as on their own or with friends. Furthermore, all the adolescents in both households (and across the other four families not reported in detail here) routinely came home for the daily *comida*.

6. Results part 3

Question 1: Do dietary patterns that emerged in the epidemiological data match those observed in the ethnography and if so, how?

Answer: The dietary patterns derived from the epidemiological study-namely the *Plant-based & lean proteins*, *Meat & starchy*, and *Eggs, milk & refined grain* could also be observed in the ethnographic observations, although differently than expected. Whereas the epidemiological interpretation of these dietary patterns might suggest that *Plant-based & lean proteins* pattern was more reflective of an adolescent following a "traditional" or "prudent" overall diet whereas the *Meat & starchy*, and *Eggs, milk & refined grain* patterns were more in line with a "Western" or "transitioning" pattern, the ethnographic observations suggested a more nuanced interpretation. In particular, the ethnographic observations indicated that each dietary pattern may be indicative of different meals or eating events that take place over the course of a day. The *Plant-based & lean proteins* pattern was most consistent with a specific meal, *comida*, that usually contained grains, vegetables, proteins and starches. Across all households observed in the ethnographic study, *comida* almost universally contained a high variety of vegetables, often in the form of salsas and soups, as well as some type of meat like chicken or beef. The *Eggs, milk & refined grain* pattern was also associated with particular meals, notably with smaller meals including breakfast and the mid-morning snack. In contrast, the *Meat & starchy* pattern was not necessarily indicative of a particular meal, but was made up of foods that were frequently purchased and consumed outside the home from street vendors (e.g. tortillas, meat, sugar-sweetened beverages, fried tortilla foods).

These findings suggest that a child with a higher score on the *Plant-based & lean proteins* pattern may come from a household more similar to Alma's, with regular *comida* meals consumed at mid-day as well as for leftovers for dinner or lunch the next day. In contrast, a child with higher scores on the *Eggs, milk & refined grain* or *Meat & starchy* pattern may indicate a child more aligned with Renata's family, where a higher caloric content comes from smaller meals and/or snacks purchased outside the home.

Question 2: Can the ethnographic observations offer insights into the associations (or lack of associations) between diet and socioeconomic or lifestyle characteristics reported from the larger cohort study?

Answer: In the epidemiological data analysis, household socioeconomic factors, including maternal education and household SES, were the most strongly associated predictors of dietary patterns. Interpreted from a nutrition transition framework, the associations were generally in line with a population in the latter stages of the nutrition transition, in that the higher SES households (proxied by maternal education) had higher consumption of fruits and vegetables. The ethnographic observations suggested a more specific interpretation, in that the differences in diet according to SES may have to do with differences in the structure of eating throughout the day and the economic ability to plan ahead for meals. Alma's family (the family with greater economic stability) had a predictable and regular eating schedule, which was largely structured by her two daughters' school schedules and her husband's work schedule. Her family had very regular *comida* meals, which she planned and purchased food for several days in advance. In addition, her family's day often included pre-packed lunches. In contrast, Renata's family—which could not rely on a steady income and whose children could not attend school regularly because of school violence—had an irregular eating schedule, with timing of eating events varying day-to-day. Of note, variations in diets in the more stable household versus lower-stability households did not rely on differences in time allocation or cooking knowledge between the mothers.

Question 3: How are processed and "Western" foods incorporated into the diet, as reflected in the clustering of these foods in the cohort study as well as the observation of their consumption in the ethnographic analysis? Does this differ with respect to socioeconomic status?

Answer: Processed and westernized foods were noted in all three of the epidemiological dietary patterns, to varying degrees. In the *Plant-based & lean proteins* pattern, only one food group that could be considered westernized, which was high fat dairy, loaded positively. The other two patterns had a greater number of processed or westernized food items; for example, *Meat & starchy* had high fat dairy, refined grains, processed meat, and sugar-sweetened beverages, and *Eggs, milk & refined grain* had western products such as refined grain and spreads like margarine and mayonnaise.

The ethnographic notes revealed even less separation between consumption of "traditional" and westernized foods. Processed and westernized foods were widely incorporated into practically all meals throughout the day, with processed foods often inserted into traditional dishes or meals. For example, in one day's *comida* Renata's family ate frozen French fries ("Western") with their main course of homemade meat ("traditional"). Alma's family had tacos ("traditional") with canned tuna ("Western") in them for their *comida* one day. The starkest difference we noted in the consumption of processed foods was that Renata's family more often consumed processed foods as part of their main meals, while Alma's family ate processed snacks and desserts in addition to their fruit and vegetable-rich home-cooked meals.

7. Discussion

In this paper, we evaluated patterns of eating among adolescents in Mexico City in two distinct but complementary ways. First, using epidemiological data from 550 participants in the longitudinal ELEMENT study, we identified three dietary patterns: *Plant-based & lean proteins*, *Meat & starchy*, and *Eggs, milk & refined grain.* Interpreted in light of the nutrition transition, the first fruit and vegetable-based pattern appears in line with a more "traditional" or "prudent" diet while the latter two are more in line with a "Western" pattern. Further, the quantitative analysis revealed that higher maternal education (considered a proxy for higher SES) was associated with higher *Plant-based & lean proteins* scores, and that lower SES was associated with higher *Eggs, milk & refined grain* pattern scores; these associations are consistent with a population in the latter stages of the nutrition transition. Incorporating ethnographic information from households within the cohort sheds a more nuanced perspective of the diet patterns and their SES correlates. Specifically, we found that the empirically-derived dietary patterns may be more fully understood as particular eating events, with scores on the dietary patterns representing the type of meal patterning in the household (e.g. the pattern high in fruits and vegetables may indicate a

household with a consistent *comida* and substantial leftovers consumed later in the day). Further, the associations between SES indicators and diet could have to do with differences in the economic ability to plan and prepare large home-cooked meals (i.e. higher SES households could afford to buy a wide variety food in advance). Instead, lower SES families may have less structured meal times and may be more likely to rely on cheaper and heavily-processed food for meals than those from higher SES households.

The dietary patterns we identified using factor analysis mirror those of dietary patterns previously described in the ELEMENT cohort (Perng et al., 2017) as well as other studies conducted in Mexico (Gutiérrez-Pliego et al., 2016; Monge et al., 2018; Rodriguez-Ramirez, Mundo-Rosas, García-Guerra, & Shamah-Levy, 2011; Romero-Polvo et al., 2012). In general, these prior studies identified one healthier pattern (often called "Prudent") that is characterized by fruits, vegetables, whole grain, and lean proteins, and other less healthy patterns (often called "Western" or "transitioning") that are characterized by energy-dense and meat-based foods as well as vegetable oils and sugar-sweetened beverages, patterns that align with our *Plant-based & lean proteins* and *Meat & starchy* patterns. In addition, our *Eggs, milk & refined* grain pattern was similar to the "egg" and "milk and sweetened breads" patterns reported in an analysis of breakfast habits in the Mexican pediatric population (Afeiche et al., 2397). The similarities in dietary patterns between previous studies and ours is salient because it means that our ethnographic insights may extend beyond this particular cohort of Mexican adolescents.

One of our main findings was that the dietary patterns we identified may reflect meal patterns within households rather than overall dietary patterns. For example, having a higher *Plant-based & lean proteins* dietary pattern may not reflect an individual participant following an overall healthy diet or traditional lifestyle, but rather it may reveal the stability of *comida* consumption in his or her household. Furthermore, it was evident that there were few real distinctions between adolescents who followed more "traditional" diets versus "Western" diets in terms of food, as elements of "Westernized" and "traditional" were present in both households' diets, and during all meals and eating events throughout the day. This co-occurrence suggests that instead of adopting a more "Westernized" pattern of eating and living, households may simply be incorporating certain "Western" foods into their typical meals and lifestyles. The fact that the differences in diet may have more to do with differences in meal patterning implies that previous relationships between similar dietary patterns and health outcomes could potentially be explained by characteristics of meal patterns-such as timing, stability, or social connections during meals-rather than the individual foods in the dietary patterns. To explore these potential associations, future surveys should include questions about timing of the meals, where meals are taken (at home versus restaurant or street), as well as how particular foods are linked to specific meals. More broadly, our findings illustrate that simply naming dietary patterns as "Western" or "traditional" may lead to oversimplified interpretations of how diet appears in everyday life. For example, "Western" and "traditional" terms may be used (whether explicitly or implicitly) as a proxy for "unhealthy" versus "healthy" diet patterns, which could ignore the fact that the diet patterns with "Western" food could also have positive correlations with foods that are associated with better health (e.g. fruits and vegetables) or vice versa. For example, within the *Meat & Starchy* pattern, we showed positive factor loadings for multiple processed foods (refined grain, chips, and sugar-sweetened beverages) as well as soup (a vegetable-rich food item). Furthermore, this labeling may lead to a false sense of comparability between countries, when in fact a "Western" diet likely looks very different in the US compared to Mexico, or in Mexico compared to other countries in the midst of nutrition transitions (e.g. China or Brazil). In a similar vein, a "traditional" pattern may not necessarily be clear either, as it can depend on the time period and region of interest. Thus, we recommend that data-driven dietary patterns should be named for their food components and not for their subjective classification as "traditional", "transitioning" or "Westernized."

The second overarching theme highlighted from this mixed-methods analysis was that, as expected, household socioeconomic status was one of the most important predictors of diet in Mexico City adolescents. Indeed, although we examined a host of individual-level factors in the epidemiological analyses, only maternal education (which we considered a proxy of SES) and SES (based on an index of household resources) were associated with two of the dietary patterns after adjustment for confounding factors. These associations were mirrored in the ethnographic observations, where we found that there were differences in dietary patterns in the household with lower versus higher economic stability. Specifically, there were differences in the organization of shopping, food storage, and meal preparation in the household of lower versus higher economic stability. There were also differences where families shopped; more stable households tended to do more of the shopping at local outdoor markets and large supermarkets while less-stable households more heavily relied on local corner stores where they could purchase cheap food on credit. Interestingly, we found that economic stability associated with diet in ways that may both benefit and detract from health. On one hand, economic stability allowed for greater organization and planning of the mid-day meal, which often contains the healthiest and freshest food items. Many of the foods typically consumed for *comida*, such as fish, leafy greens, fresh vegetables, and fruit, are among the foods with the highest per calorie prices in Mexico (Mendoza, Pérez, Aggarwal, & Drewnowski, 2017). At the same time, we found that economic stability also enabled greater ability to purchase extra meals and snacks that were typically high in calories, fat, and added sugar; and available at nearly every street corner (Bridle-Fitzpatrick, 2015). It should be noted that economic stability was not a part of the SES questionnaire administered in the broader cohort (based on household possessions), and thus we posit that a questionnaire incorporating this aspect of life would have been a stronger indicator of economic situation and more strongly associated with the diet patterns.

There are multiple strengths of this study. The epidemiologic sample included a large sample size and used the same food frequency questionnaire as the national nutrition surveys in Mexico, making the results directly comparable to other estimates of dietary intake/patterns in Mexico. We were able to examine a number of different factors that are potentially important determinants of dietary habits. One of the limitations was the small sample size of the ethnographic observations. Nonetheless, ethnography has been shown to be a valid approach to gathering data because the intensive and repetitive nature of the research provides a more detailed and complex portrait of daily activities, and of the economic and social constraints on food-consumption, than can be gained from surveys or interviews alone. Given the extensive time period of observation and the nature of ethnography (e.g. reservation of comments about eating or other lifestyle behaviors), it is very unlikely families would change their eating habits during the ethnographic observation (i.e. social desirability bias). In addition, although we focused on two specific families, we also drew insights from at least 6 other households where we spent substantial time and from larger neighborhood events. The generalizability of the findings may also be somewhat limited, particularly in populations outside of Mexico. In addition, the cohort was considered representative of mid-to lower-SES in Mexico; thus it does not generalize to higher-income populations where mothers are more likely to have formal-sector employment, or to very low-income households. Another limitation is the potential bias due to self-reported diet in the FFQ, which could be due to social desirability biases as well as random error in recall. Further, we did not collect information in the epidemiological sample concerning individual eating occasions or meal timing.

In summary, we identified three dietary patterns in a population of Mexico City adolescents and found that they were associated with socioeconomic indicators in an expected manner. Yet, the ethnographic observations offered a more specific interpretation, which was that

families with greater economic resources may be more likely to have organized shopping trips and consistent home-cooked meals and eating schedules, while lower SES households were more likely to shop and eat meal-to-meal. Further, while all participants consumed calorie-dense, highly processed food, there may be different reasons behind the consumption of these items across SES levels (hunger-satiating versus the ability to consume of "extras"). Overall, this work contributes to our understanding of dietary patterns in Mexico and encourages a more nuanced view on how families may perceive the feasibility of dietary interventions or advice. More broadly, this paper serves to encourage and inform further mixed-methods research, with the aim of augmenting epidemiological findings on nutrition with rich contextual data about diet in daily life.

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Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2019.104542.

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