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Dietary patterns in Mexican children and adolescents: characterization and relation with socioeconomic and home environment factors

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Dietary patterns in Mexican children and adolescents: characterization and association with socioeconomic and home environmental factors

ABSTRACT

Background. Eating habits in **c**hildren and adolescents are influenced by multiple determinants, which include socioeconomic and home environmental factors.

Objective. To characterize the dietary patterns in Mexican children and adolescents and **to assess its association** with socioeconomic and home environmental factors.

Methods. A cross-sectional study was conducted in 878 children and adolescents aged 5 to 15 years, **unrelated, selected randomly from Morelos Sports Unit at north of Mexico City**. Dietary, anthropometric, family, and socioeconomic information was obtained from each participant. Dietary patterns were identified through cluster analysis. The association between dietary patterns with socioeconomic and home environmental factors was assessed by a multivariate multinomial logistic regression model.

Results. Three major dietary patterns were identified: diverse dietary pattern (D), high fat dietary pattern (HF), and high sugar dietary pattern (HS). 87% of the participants followed the HF or HS dietary patterns (36% & 51%, respectively). Mother's occupation and the child's screen time was associated with a significant likelihood of following a HF and HS dietary patterns.

Conclusion. A high percentage of children and adolescents reported following a HS or HF dietary pattern, which in turn were associated with socioeconomic and home environmental factors. These **results suggests priority groups for prevention and control actions**.

Key words: Socio-determinants; Dietary patterns; Mexico; Children; Adolescents.

Dietary patterns in Mexican children and adolescents: characterization and association with socioeconomic and home environmental factors

Abbreviations

IMSS: Mexican Social Security Institute

FFQ: Food frequency questionnaire

D: Diverse dietary pattern

HF: High fat dietary pattern

HS: High sugar dietary pattern

Introduction

Eating habits are developed at an early age and persist during adulthood. Several studies have shown that children and adolescents with high consumption of fruits and vegetables are twice as likely to meet the recommendations for adequate intake of fiber, saturated fatty acids or salt later in life (Mikkilä, Räsänen, Raitakari, Pietinen, & Viikari, 2004). Similarly, once the consumption of sugar-sweetened beverages has been established during childhood, it tends to increase in early adulthood (Demory-Luce et al., 2004). **In Mexican children and adolescents, Batis et al. showed that only seven to sixteen percent reach the recommended intake of fruits and vegetables, while only ten to twenty two percent and fourteen to nineteen percent, respectively, do not exceed the recommended upper limit intake for sugar-sweetened beverages and high saturated fat or added sugar products** (Batis, Aburto, Sánchez-Pimienta, Pedraza, & Rivera, 2016)**. Regarding dietary patterns, previous studies have shown that fifteen percent of the population aged five to eleven follow a Western dietary pattern, characterized by the consumption of cereals, soft drinks, cakes, dishes with fat and salty snacks** (Rodríguez-Ramírez, Mundo-Rosas, García-Guerra, & Shamah-Levy, 2011).

The theoretical framework supports that multiple determinants influence eating habits in children and adolescents, which include socioeconomic status expressed in indicators such as parents' education, income and employment, as well as home environment (Camara et al., 2015; Cameron et al., 2012; Cutler, Flood, Hannan, & Neumark-Sztainer, 2011; Datar, Nicosia, & Shier, 2014; Fernández-Alvira et al., 2015; Gwozdz et al., 2013; Liberona, Castillo, Engler, Villarroel, & Rozowski, 2011; Martin, Van Hook, & Quiros, 2015; Moreira et al., 2010;

Rasmussen et al., 2006; Sadeghirad, Duhaney, Motaghipisheh, Campbell, & Johnston, 2016; Zarnowiecki, Ball, Parletta, & Dollman, 2014). **Each of these conditions account for different explanatory processes in a given context** (Braveman et al., 2005; Lynch & Kaplan, 2000; Turrell, Hewitt, Patterson, & Oldenburg, 2003).

The role of parental education in food consumption of children and adolescents has been previously described (6,7). To date, results regarding the association between a higher educational level of the mother with better knowledge about food and its nutritional information, and therefore, with a high likelihood of preferring healthy and low-energy dense foods, are consistent (Camara et al., 2015; Cameron et al., 2012; Fernández-Alvira et al., 2015; Moreira et al., 2010; Rasmussen et al., 2006; Zarnowiecki et al., 2014). However, the educational level of the father and its role in the eating habits of children has been scarcely explored.

Concerning the employment and income of the parents, the **influence** of these on the development of food preferences in children and adolescents are complex. It has been suggested that a full-time job in the mother increases family income and makes it possible to buy fresh and better quality food items; however, it has also been described that employment in women decreases the time for family meals, home food preparation and time for accompanying the children at mealtime (Datar et al., 2014; Gwozdz et al., 2013; Zarnowiecki et al., 2014). Furthermore, better income has been associated with healthy eating patterns, since it allows a greater availability of foods with better nutritional value at home (Fernández-Alvira et al., 2015; García-Cardona, Jeannette, Fernández-García, & Arroyo-Acevedo, 2008; Martin et al., 2015). However, better income also increases the money given to children and adolescents, which can

be invested in unhealthy and nutrient-poor foods in contexts outside the home, such as school (Datar et al., 2014; Martin et al., 2015). In this regard, the results in terms of occupation, income and development of eating habits in children under 18 years are not yet conclusive.

The home environment has also been associated with eating habits, because the availability of food within the household delimits the family member's dietary choices, which allows the behaviors to be shared and in turn, could explain the fact of a higher obesity prevalence in children of obese mothers (McDonald, Baylin, Arsenault, Mora-Plazas, & Villamor, 2009). Additionally, time spent watching TV has been positively associated with increased consumption of fast foods and sugar-sweetened beverages, and negatively with the consumption of fruits and vegetables (Moreira et al., 2010; Rasmussen et al., 2006). The explanatory process suggested for the association between TV time and food consumption has been argued from the type and target population of food advertisement (Krølner et al., 2011; Sadeghirad et al., 2016).

Despite the explanatory processes pointed out for socioeconomic characteristics and home environment, it is important to recognize that these have been constructed from evidence in developed countries of Europe, North America and Australia; and that these may be different or exhibit other patterns of association in contexts such as developing countries. In Latin America, scientific literature evaluating the association between food consumption from a dietary pattern approach and these conditions in children and adolescents is scarce. **We hypothesized that in a Mexican context, worse socioeconomic conditions and home environment are associated with a worse dietary pattern**. Therefore, the aim of this paper was to characterize the dietary

patterns in Mexican children and adolescents and **to assess its association** with socioeconomic and home environmental factors.

Materials and methods

Study design and population

A cross-sectional study was conducted in Mexico City between June 2011 and July 2012 in a representative sample of **unrelated** children and adolescents, participating in a larger epidemiologic study of the Genetics of Obesity in Infants and Adolescents. In summary, the study sought to characterize and evaluate the association of the genetic and lifestyle factors with obesity in 2,066 participants aged from 5 to 17 years. **The participants were randomly selected from four Sports Units of the Mexican Social Security Institute (IMSS), located in different geographical areas of Mexico City; Unit Morelos at north; Unit Independencia at south; Unit Netzahualcoyotl at east and Unit Cuauhtémoc at west). Inclusion criteria included not having a previous diagnosis of diseases such as diabetes, hypertension or dyslipidemia**. **Participants who had infectious diseases or gastrointestinal disorders at the time of the interview and those in whom complete information was not obtained were excluded. In case of having more than one child or adolescent from the same family, only one of them was randomly selected.**

Because the information about socio-demographic and economic aspects was only collected in participants at the Morelos Unit, for the current study we selected a subsample of 878 children and adolescents aged 5 to 15 years. This study was approved by the Mexican Social Security Institutes' and the National Institute of Public Health committees for ethics and research. **Procedures for collecting information as well as the risks and benefits of**

participating in the study were explained to potential participants and their parents. In those who agreed to participate, the verbal and signed informed assent and the signed informed consent from their parents were obtained.

Information

Through a personal interview conducted by previously trained and standardized personnel, we obtained dietary, socioeconomic and home environmental information from each participant. Due to the age of the children, we used a proxy to collect the information –usually the adult who spent most time with the child, i.e the mother or caregiver. Additionally, basic anthropometric measurements were obtained from each participant

Dietary information. Dietary information was obtained with a semi-quantitative food frequency questionnaire (FFQ) of 107 items, which was developed according to the methodology proposed by Willett et al. (Willett, 1998), **and was answered by the participant in company of one of their parents.** The dietary information collected refers to the frequency of consumption of each food-item in the year prior to the interview. For each predetermined portion of 107 food items, the FFQ included 10 frequency response options of consumption ranging from "never" to "6 or more times a day". Consumption of fruits and vegetables was adjusted by seasonal availability during the year.

Frequency consumption data of each food item was converted to daily portions and grams or milliliters of intake. The conversions were performed using the standardized and validated measurements of the the National Nutrition Survey-1999 (Ramírez I, 2006). Also, the

macronutrient intake was assessed using the ESHA Food Processor Nutrition Analysis and Fitness Software (version 10.11.0, 2011, ESHA Research Inc., Salem, OR), which includes data on traditional Mexican food items. Total energy intake was calculated by summing the energy value of each food item.

Dietary patterns. Daily energy intake from each food item was transformed to percentage of total energy contribution by specific foods and standardized to a Z-score. In order to identify dietary patterns, standardized Z-scores of each food were classified into the following 32 sub-groups: 1) Low-fat dairy products; 2) Probiotic dairy products; 3) Whole milk; 4) Milk products w/ more fat or sugar; 5) Processed dairy products; 6) Berries; 7) Citrus fruits; 8) Melons; 9) Other fruits; 10) Dark-green leafy vegetables; 11) Dry beans and peas; 12) Orange vegetables; 13) Other vegetables; 14) Chili peppers; 15) Starchy vegetables; 16) Eggs; 17) Fish; 18) Meat; 19) Poultry; 20) Organ meats; 21) Processed meats;22) Rice; 23) Refined grains; 24) Grain products with more fat and sugar; 25) Whole grains; 26) Traditional Mexican dishes; 27) Fast food; 28) Sugar-sweetened beverages; 29) Fats; 30) Nuts and seeds; 31) Sweets; 32) Avocado.

The basis for placing a food item in a certain food subgroup was based mainly on the similarity of their nutrient profiles (e.g. lipid, sugar, dietary fiber and antioxidant content). Some subgroups were defined according to the amount of antioxidants (i.e. citrus fruits). Other subgroups were defined by their sugar content (i.e. sweetened beverages). Furthermore, some food items were considered individually as a food group because their nutrient profiles were unique or because those particular foods were consumed less frequently (i.e. rice, avocado, light milk). Dietary patterns were generated by K-means cluster analysis based on the standardized percentage of

161 total energy contribution for each food group per day. Two to four solutions were examined to
162 assess which set of clusters was more meaningful to define the dietary patterns.

163

164 **Socioeconomic and home environmental variables.** Information about monthly family
165 income, educational level, parental occupation as well as socioeconomic background was
166 obtained by personal interview. Based on Mexico's City minimum wage in 2012, the monthly
167 gross income was categorized as below minimum wage (≤$9,500 Mexican pesos) and above
168 minimum wage (>$9,500 Mexican pesos) (DOF - Diario Oficial de la Federación, 2012).
169 Educational level for both parents was defined as the highest level attained (middle school or
170 less, high school or technical education, and college or more). Parental occupation was
171 categorized as "Professional", "Administrative assistant", and "Home/unemployed" according to
172 the classifications of the 2011 National Classification System of Occupation, set by the National
173 Institute of Statistics and Geography (Instituto Nacional de Estadística y Geografía, n.d.).

174

175 As home environmental factors, we considered child and adolescent obesity, family history of
176 obesity and screen time of participants. Family history of obesity was self-reported and defined
177 in parents as: no history of obesity, one of the parents has it and both of the parents have it . The
178 same categorization was employed for history of obesity in the grandparents. Screen time was
179 expressed as minutes/week and assessed by asking the participants about the frequency of time
180 they spent watching TV, movies and/or videos (with 8 response options ranging from "never" to
181 "7-10 hours/day") and the number of days of the week watching TV, movies and/or videos
182 (ranging from "1 day/week" to ">6 days/week"). For the association analysis, screen time was
183 categorized as "≤ 1.25 hours/day" and "> 1.25 hours/day".

184

185 **Anthropometric measurements.** The participant's weights were measured to the nearest 0.1 kg
186 with a previously calibrated digital SECA scale (model Clara 803). Participants were weighed
187 barefoot, with minimal clothing and without objects in their pockets, eyeglasses, belts, necklaces
188 and other jewelry items. Height was measured to the nearest 0.1cm using a portable Seca
189 stadiometer (model 213) while the participants were standing barefoot, with their shoulders in a
190 relaxed position. A Seca fiberglass ergonomic measuring tape with a length up to 200 cm and an
191 accuracy of 1 mm (model 201) was used to obtain waist and hip circumferences. Waist
192 circumference was measured at the nearest 0.1 cm, at the highest point of the iliac crest,
193 following a regular expiration. Hip circumference was measured around the maximum
194 circumference of the buttocks. All measurements were obtained by trained and standardized
195 personnel following international protocols.

196 Nutritional status was determined for each participant by calculating Z-scores for age and gender
197 of body mass index (BMI= weight in kg / height^2 in meters) with the World Health Organization
198 (WHO) AnthroPlus software (WHO, 2009) (World Health Organization, 2009). The
199 recommended cut-off points for overweight and obesity, according to the WHO reference for
200 children aged 5-19 years, was +1 SD < z ≤+2 SD (equivalent to the 85th percentile) and +2 SD <
201 z ≤+3 SD (equivalent to the 97th percentile), respectively.

202

203 **Statistical analysis**

204 Following the methodology used by the 2006 National Nutrition Survey (Rodríguez-Ramírez,
205 Mundo-Rosas, Jiménez-Aguilar, & Shamah-Levy, 2009), the daily intake database of
206 macronutrients was cleaned and any biologically implausible outliers were excluded from the

207 analysis. Briefly, the total energy intake was standardized to z scores. Those children whose
208 total energy intake and screen time was greater than 4 standard deviations from the mean were
209 excluded from the analysis (21/878 children or 2.39% of the sample). A final sample size of 857
210 participants was included in our analysis.
211
212 Selected general characteristics were compared across dietary patterns by the Kruskal-Wallis test
213 or one-way ANOVA test with a Scheffe multiple comparison test for continuous non-normally
214 and normally distributed data respectively (age, monthly family income and screen time). For
215 categorical variables (Sex, BMI, family history of obesity in parents and grandparents, parents'
216 educational level, and parents' occupation), comparisons were made with the chi-squared tests or
217 Fisher's exact test (when an expected cell value was less than 5). Due to the skewed nutrient
218 distributions, non-parametric tests were used to compare energy and micronutrient intakes
219 between dietary patterns.
220
221 The association between dietary patterns and socioeconomic and home environmental factors
222 was assessed by a multinomial logistic regression model. We computed OR's adjusting for age
223 (years), sex and nutritional status (normal weight, overweight and obese). Statistical significance
224 was achieved when $P < 0.05$. Trend tests were performed introducing the categorical variables in
225 the model as continuous variables. All analyses were performed using the statistical software
226 STATA version 12 (STATA Corporation, College Station, Texas, USA).
227
228
229

Results

Three major dietary patterns were identified: Diverse dietary pattern (D), High fat dietary pattern (HF), and High sugar dietary pattern (HS) (Table 1 and Figure 1). The D pattern was followed by 13% of the study population; meanwhile 36% followed the HF pattern and 51% the HS pattern. Food intake in the D pattern was characterized by a high contribution to total energy intake from: other fruits, other vegetables, melons, citrus fruits, orange vegetables, fish, probiotic dairy products, dry beans and peas, berries, dark-green leafy vegetables and starchy vegetables (Table 1 and Figure 1). The HF pattern showed a high contribution to total energy intake from high fat and processed food products; where traditional Mexican dishes accounted for 218.45% of total energy intake and the fast food group, which is equally high in fats, accounted for 180.14% (Table 1 and Figure 1). Food groups such as: refined grains, processed meat, red meat, whole grain products, fats and processed dairy also contributed significantly to the total energy intake of this dietary pattern. Contrariwise to the HF pattern, the HS pattern lacked dietary diversity. Grain products with more fat and sugar, sugar-sweetened beverages and high-fat and sugar milk products contributed the most to the total energy intake (Table 1 and Figure 1). Likewise, as is shown in Table 1 and Figure 1, this pattern (HS) had the least contribution of fruits and vegetables.

Table 2 shows the energy and macronutrient intake distributions by dietary patterns. Median energy intake was significantly higher in the HS dietary pattern than in the D or HF patterns (2560 vs. 2241 and 2164; $p < 0.0001$). Moreover, total carbohydrate, fat, saturated fat, and monounsaturated fat intakes were significantly higher in the HS dietary pattern. The second

highest fat intake was observed in the HF pattern (84g). Conversely, total fat, saturated fat, and monounsaturated fat intakes were the lowest in the D pattern.

Total carbohydrate intake was the lowest in the HF dietary pattern. Fiber intake was higher in the D pattern (29.4 g) than in the HF (23g) and HS patterns (22g) ($p<0.0001$). There was no statistically significant difference in protein intake between dietary patterns (Table 2).

Selected socioeconomic and home environment characteristics of study population by dietary patterns are presented in Table 3. The mean age of the participants was 9.64 y, ~83% were children aged five to eleven, 55% were male, 22% were overweight, and ~24% were obese. The mean monthly family income was $6667.3 (SD ± $1.82). 37% of the fathers had high school or technical education, while a slightly higher percentage of the mothers had that educational level (45%). However, ~52% of the participants' mothers were unemployed and 49% of the fathers were predominantly employed in administrative positions. More than 50% of the children had a parental history of obesity, of which in 33% of them either parent was obese. Similarly, history of obesity in either maternal or paternal grandparents was reported (33%). The mean screen time was 1.31 (SD ± 1.1) hours/day.

In relation with the parents' educational level by their children's dietary pattern, as shown in Table 3, a higher percentage of children whose mothers had college education or more (43.8%) were observed in the D dietary pattern, whereas in the HS and HF dietary patterns, the children who predominated were those whose mothers had high school or technical education (45.2% and 48.3%, respectively). Regarding the father's educational level, among participants who followed

the HS dietary pattern, 35.6% of their fathers completed an education level of middle school or less, meanwhile in the D pattern only 19.6% of their fathers reported that level.

Regarding the mother's occupation, the highest percentage of children whose mothers were professionals was classified into the D dietary pattern vs. the HS pattern, where they were the lowest (35.4% vs 20.5%, respectively). In contrast, the highest number of children whose mothers were unemployed were classified as HS dietary pattern vs. the D pattern (55.7% vs. 40.7%, respectively) (Table 3).

Mean screen time was significantly higher among participants following a HS dietary pattern vs. those of the D pattern (1.4 ± 1.2 hours/day vs. 0.9 ± 0.9 hours/day, respectively). Also, more than twice as many children who had reported being in front of the screen > 1.25 hours/day, were classified in the HF and HS dietary patterns vs. a D pattern (35.6% and 34.3% vs. 19.8%, respectively) (Table 3).

Dietary pattern and parental education level

Higher level of education in the parents showed a lower likelihood of their children to follow a HF and HS dietary patterns, but this finding was only statistically significant for the HS pattern, as is shown in Table 4. Participants whose parents had attained a college or higher educational level had a 58% and 59% lower possibility to consume the HS pattern, respectively, as compared to those following a D pattern and whose parents had an educational level of middle school or less (OR=0.42; 95% CI: 0.23-0.75; test for trend *P*=0.002 and OR=0.41; 95% CI: 0.23-0.73; test for trend *P*=0.003, respectively) (Table 4).

298

299

300 *Dietary patterns and parental occupation*

301 Participants whose mother reported being unemployed or having an ´informal employment´ had
302 a greater likelihood of following the HS or HF dietary patterns vs. the D pattern as compared to
303 their counter parts -children whose mother reported having a ´professional´ employment type-
304 (OR=2.31; 95% CI: 1.40-3.81; test for trend *P* =0.001; OR=1.75; 95%CI: 1.04-2.94; test for
305 trend *P*=0.039, respectively) (Table 4). Participants whose father reported being unemployed or
306 having an ´informal employment´ had an 84% greater probability to follow a HS dietary pattern
307 vs. the D pattern as compared to their counter parts (OR=1.84; 95% CI: 0.98-3.45; test for trend
308 *P*=0.046) (Table 4).

309

310 *Dietary patterns and family history of obesity*

311 As is shown in Table 4, participants whom both *grandparents* had a history of obesity had a 17%
312 and 102% increased likelihood of following a HF and HS dietary patterns vs. the D pattern as
313 compared to their counterparts; however, statistical significance was only reached in the HS
314 pattern (OR=1.17; 95% CI: 0.59-2.30; test for trend *P*=0.786 and OR=2.02; 95% CI: 1.06-3.85;
315 test for trend *P*=0.041, respectively). Similarly, participants whose both parents—mom and
316 dad—had a history of obesity, had a 45% and 93% greater probability of following a HF or HS
317 dietary pattern vs. the D pattern as compared to their counterparts -children whose parents didn't
318 had history of obesity- (OR=1.45; 95% CI: 0.76-2.90; test for trend *P*=0.310 and OR=1.93; 95%
319 CI: 1.01-3.67; test for trend *P* =0.057). However, none reached statistical significance (Table 4).

320

Dietary patterns and screen time

Participants who reported more than 1.25 hours daily of watching TV, movies and/or videos were twice as likely to follow a HF or HS dietary pattern in comparison to their counterparts in the D pattern with less than 1.25 hours of watching TV, movies and/or videos (OR= 2.33; 95% CI: 1.34-4.04; test for trend P=0.002 and OR= 2.10; 95% CI: 1.23-3.61; test for trend P=0.004, respectively) (Table 4).

Discussion

This study aimed to characterize the dietary patterns of Mexican children and adolescents and to assess its association with socioeconomic and home environmental factors. Our results indicated that 51% of the children and adolescents included in this study followed a HS dietary pattern, where most of the total energy intake contribution was given by the consumption of high-fat and high-sugar grains, sugar-sweetened beverages and dairy products with high sugar content. A HF pattern was followed by 36% of the participants and was characterized by a greater energy intake contribution from traditional Mexican dishes, fast foods, refined grains, dairy products and processed meat products. The D pattern was followed by only 13% of the interviewees; and it was characterized by a greater energy intake contribution from vegetables, fruits, fish and whole grains. Factors such as educational level and parents' occupation, history of obesity in both grandparents and a screen time greater than one hour 25 minutes per day in children were associated with a HS dietary pattern. On the other hand, consumption of a HF dietary pattern was associated with screen time and maternal occupation.

The findings of this study are relevant for public health considering two important facts; first, the evidence of the association between overweight and obesity with the Western dietary pattern – which was similar to our HS and HF dietary patterns-, and secondly, the high prevalence of overweight and obesity in Mexican children and adolescents. A recent literature review reported an association between a Western dietary pattern (characterized by the consumption of red meat, desserts, fast foods, sugar sweetened beverages and fried foods) and an increased risk of overweight, obesity and metabolic syndrome (Funtikova, Navarro, Bawaked, Fto, & Schrder, 2015). Specifically in Mexico, cross-sectional studies in schoolchildren and adolescents have shown a positive association between a Western dietary pattern and a higher prevalence of overweight and obesity, as well as a greater likelihood of insulin resistance (Gutiérrez-Pliego, Camarillo-Romero, Montenegro-Morales, & Garduño-García, 2016; Rodríguez-Ramírez et al., 2011; Romero-Polvo et al., 2012). Also, Vilchis-Gil et al. in a case-control study with schoolchildren aged 6-12 years, showed that obese children consumed more sugar-sweetened beverages and fatty food than eutrophic children (Vilchis-Gil, Galván-Portillo, Klünder-Klünder, Cruz, & Flores-Huerta, 2015).

The prevalence of overweight and obesity in Mexico has shown a tendency to increase. The combined prevalence of overweight and obesity raised from 26.9% to 34.4% between 1999 and 2012 in children aged five to eleven years, and from 33.2% to 35% in adolescents during the period of 2006-2012 (Instituto Nacional de Salud Pública, 2012). Therefore, the characterization of dietary patterns in this population and its association with socioeconomic and home environmental factors contributes to the evidence that guides the targeting of prevention and control actions.

Our results regarding the association between a HS and HF dietary patterns and the educational level of the parents are consistent with the findings previously reported in the literature (Camara et al., 2015; Cameron et al., 2012; Fernández-Alvira et al., 2015; Moreira et al., 2010; Rasmussen et al., 2006; Zarnowiecki et al., 2014). This association is the most consistent evidence regarding the socioeconomic indicators and food consumption at early ages and underlines the existence of structural conditions that go beyond the individual level. From a life course perspective, this socioeconomic gradient in the diet of children and adolescents defines and accentuates inequality gaps in growth and development befitting of this stage as well as patterns of cardiovascular disease in adulthood (Lynch & Kaplan, 2000).

In this study, an unemployed or housework status in the mother was associated with a greater possibility of following both a HS dietary pattern and a HF pattern. This association was also found for the father's occupation, but was marginally significant regarding the HF pattern. These findings could be explained by the possibility of a better income and educational level in parents with a professional job that provides the opportunity of better food choices and purchases (Martin et al., 2015). However, these results are contrary to some reported in European countries and in the United States, where higher consumption of healthy foods or fruits and vegetables have been reported in children and adolescents of non-employed mothers or fathers (Datar et al., 2014; Gwozdz et al., 2013); and whose explanation was focused on an increased time spent on children, less frequency of meals outside the home and a greater accompaniment of the children at the time of eating (Datar et al., 2014; Gwozdz et al., 2013). Clearly, our results are comprehensible in the light of other conditions in the Mexican context that are different from those of the aforementioned countries, such as the inexistence of social welfare programs,

unemployment assistance and poor wage conditions in the working class that could mark dissimilarities in the dietary patterns reported in a given moment.

Although the association between household income and dietary patterns was not statistically significant in our study, its direction was in accordance with previous evidence in the literature and allows us to better understand the role of income in feeding decisions among individuals and populations. It has been previously pointed out that energy-dense foods and nutrient-poor diets are the cheapest and consequently the most widely available diets for people with limited resources (Darmon & Drewnowski, 2008); a relevant aspect in the Mexican environment where a lower income defines the little diversity of foods that the population consume (García-Cardona et al., 2008).

A greater likelihood to follow a HS and HF dietary pattern was found in children and adolescents when both parents and either or both grandparents had a history of obesity. The aforementioned, in addition to revealing a genetic component of the taste for greasy and sweet foods (García-Cardona et al., 2008), shows that many health behaviors are shared by the family members and social networks (Christakis & Fowler, 2007). Therefore, obesogenic behaviors in parents and grandparents can become reproduced in the new generations, which ignites an alarm signal given the possibility of early onset of BMI alterations and other markers of cardio-metabolic risk in this population (Cárdenas-Cárdenas et al., 2015).

Mean screen time in the participants of this study (1.31 hours/day) was lower than that reported previously in Mexican population included in representative surveys (Janssen,

Medina, Pedroza, & Barquera, 2013; Shamah-Levy, 2010)**. According to the 2008 National Health Survey in Schoolchildren, sixty percent of the schoolchildren aged five to sixteen years who were attending public schools in Mexico reported less than two hours per day of screen time** (Shamah-Levy, 2010)**. Likewise, the 2012 National Health and Nutrition Survey found a mean screen time of about three hours in adolescents aged ten to eighteen years** (Janssen et al., 2013)**. The findings in our study are comprehensible by the fact that the participants were children and adolescents who were attending the sports units of the Mexican Social Security Institute, which provides them an opportunity to invest their free time in activities other than watching television or using video games.**

The association between the HS and HF dietary patterns and a screen time greater than one hour and 25 minutes per day is consistent with available literature (Moreira et al., 2010; Rasmussen et al., 2006). A systematic review of clinical trials conducted in subjects aged 2 to 18 years reported that the advertising of unhealthy foods and beverages influenced the food preferences and consumption, with this effect being even greater in children under the age of eight (Sadeghirad et al., 2016). The context of advertising in Mexico is not favorable, a study found that of the total food advertising on television, more than 64% corresponded to products that did not meet any standards according to the guidelines of the Ministry of Health of Mexico; additionally, it was found that during the cartoon programs, whose target population is focused in children and adolescents, the products that were advertised were those with the highest caloric and sugar content (Rincón-Gallardo Patiño et al., 2016). The above, demonstrated the need to continue withactions aimed towards thecompliance with the regulations of food advertising in Mexico, in order to encourage healthier food consumption patterns in children and adolescents.

436 The strengths of this study are given by the fact of exploring the socioeconomic factors not only
437 of the mother, but also of the father of the participants. This aspect is relevant considering the
438 current dynamics in which a greater participation of women in the labor market has led to an
439 increase of the participation of men in domestic work, and therefore, child care. Another strength
440 of this study lies in the operationalization of food consumption through dietary patterns, which
441 allows an approximation to the fact that combinations of foods and non-nutrient mixtures are not
442 consumed in isolation. Additionally, the strategy of food consumption patterns allowed the
443 identification of higher risk groups, such as those children and adolescents who reported a HS or
444 HF dietary pattern.

445

446 The limitations of this study are three: a) Its cross-sectional design, which does not allow for the
447 establishment of temporality as a criterion of causality, however, this does not invalidate the
448 results regarding the parents' education and the HS and HF dietary patterns, due to the certainty
449 that this, as a structural condition, underlies the practices of food consumption and not in reverse;
450 b) The FFQ instrument used to evaluate food consumption, which is based on the memory of the
451 parents, implies a non-differential measurement error that leads to an underestimation of the
452 association measures; and c) Context conditions that could help explain the dietary patterns were
453 not taken into account, such as the socioeconomic level of the area, food availability at school,
454 and peer influence. Although not considering these aspects does not invalidate the results found
455 in this study, its exploration in future research would help a better understanding of the eating
456 habits in the age group of interest, and its results could guide the decision making at a population
457 level.

458

In conclusion, the results of this study indicated that a high percentage of children and adolescents from our sample reported following a HS or HF dietary pattern (87%), which were characterized by the consumption of high fat and sugar grains, sugar-sweetened beverages, dairy products with high sugar content, traditional Mexican dishes, fast foods and refined grains. Following a HS and HF dietary patterns was significantly associated with the educational level and occupation of the parents, the history of obesity in the grandparents, and screen time. The importance of these results for public health lies in the identification of groups exposed to risk conditions, which require prevention and control actions that go beyond the individual level and involve a familiar context as well as the compliance and generation of public policies from different governmental sectors, in order to improve eating habits in children and adolescents.

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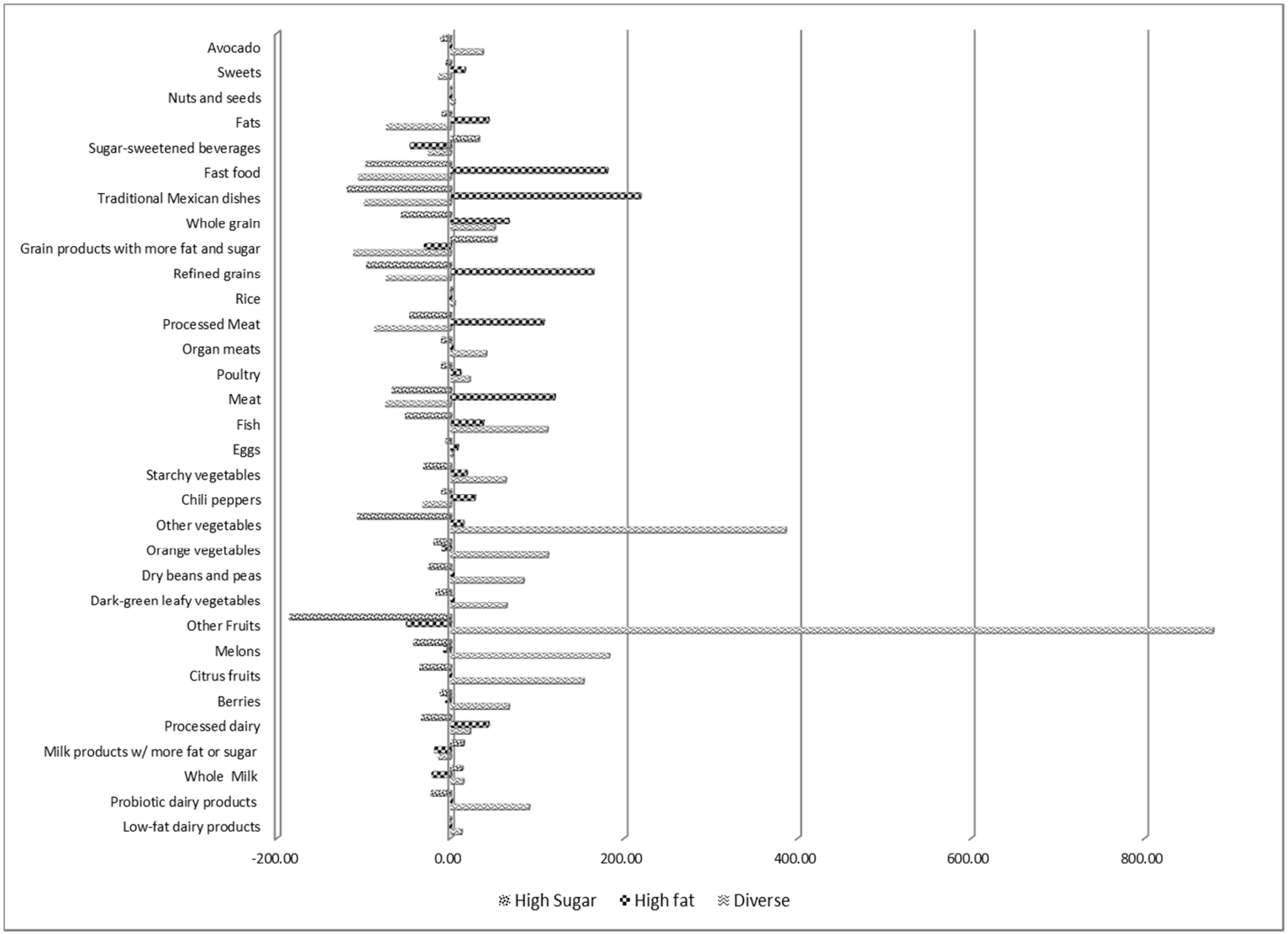
644 **Figure 1. Food groups contribution to dietary patterns of Mexican children and adolescents, 2012**



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647 **Table 1. Food groups contribution to dietary patterns of Mexican children and adolescents,**
648 **2012**

Food Group	Dietary Patterns (%)		
	Diverse	**High fat**	**High Sugar**
	13%	36%	51%
1. Low-fat dairy products	12.35	-2.42	-0.34
2. Probiotic dairy products *	90.15 [a, b]	0.70	-22.98
3. Whole milk *	14.33 [a]	-21.82 [c]	13.20
4. Milk products w/ more fat or sugar *	-14.17	-18.90 [c]	14.72
5. Processed dairy*	22.28 [b]	43.22 [c]	-33.89
6. Berries*	66.86 [a, b]	-5.88	-12.19
7. Citrus*	152.94 [a, b]	-2.83 [c]	-35.74
8. Melons*	182.51 [a, b]	-8.31 [c]	-42.64
9. Other fruits*	878.57 [a, b]	-51.20 [c]	-185.94
10. Dark-green leafy vegetables*	64.30 [a, b]	2.72 [c]	-17.01
11. Dry beans and peas*	83.70 [a, b]	2.59	-25.79
12. Orange vegetables*	111.96 [a, b]	-10.33	-19.60
13. Other vegetables*	386.06 [a, b]	14.18 [c]	-107.63
14. Chili peppers*	-32.23 [a]	27.78 [c]	-10.69
15. Starchy vegetables*	63.28 [a, b]	18.29 [c]	-31.37
16. Eggs	2.25	7.95	-5.77
17. Fish*	111.36 [a, b]	37.27 [c]	-52.63
18. Meat*	-75.07 [a]	119.62 [c]	-67.72
19. Poultry*	21.81 [b]	11.08 [c]	-10.65
20. Organ meats*	40.72 [a, b]	1.12	-10.78
21. Processed meat*	-88.01 [a]	106.75 [c]	-47.26
22. Rice	4.34	-1.66	0.81
23. Refined grains*	-74.64 [a]	164.08 [c]	-97.36

24. Grain products with more fat and sugar*	-112.33 [a b]	-30.52 [c]	52.43
25. Whole grain*	50.55 [b]	66.64 [c]	-57.61
26. Traditional Mexican dishes*	-99.81 [a]	218.45 [c]	-119.5
27. Fast food*	-106.61 [a]	180.14 [c]	-98.22
28. Sugar-sweetened beverages*	-26.04	-47.00 [c]	32.33
29. Fats*	-74.30 [a b]	43.24 [c]	-10.03
30. Nuts and seeds	4.06	-0.99	0.18
31. Sweets	-14.29	15.94	-5.26
32. Avocado*	36.99 [a b]	-0.75	-11.43

649 * p-value ANOVA test <0.05
650 [a] p-value <0.05; Diverse vs. High-fat pattern; Scheffe
651 [b] p-value <0.05; Diverse vs. High-sugar pattern; Scheffe
652 [c] p-value <0.05; High fat vs. Hig-sugar pattern; Scheffe

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668 **Table 2. Energy and macronutrient median intake distribution by dietary patterns in**
669 **Mexican children and adolescents, 2012**

Macronutrients	Dietary Patterns						p-value*
	Diverse		High Fat		High Sugar		
	Median	p25 - p75	Median	p25 - p75	Median	p25 - p75	
Energy							
Kcals/day	2241	1699 - 2801	2164	1716 - 2852	2560	2126 - 3255	0.0001
Protein							
g/d	83.6	68 - 104.4	86.3	71.2 - 109.5	89.1	71.4 - 108.3	0.5178
% kcal/d	15.6	13.8 - 16.8	16.00	14.4 - 17.2	13.96	12.6 - 15.7	0.0001
Total carbohydrates							
g/d	320.5	231.1 - 420.1	275.3	218.9 - 370.7	360.3	274.6 - 464.1	0.0001
% kcal/d	57.0	53.0 - 64.2	50.9	48.2 - 54.1	55.4	51.7 - 59.7	0.0001
Total fats							
g/d	76.95	53.0 - 95.2	83.6	66.5 - 109.3	90.3	70.4 - 109.2	0.0001
% kcal/d	29.97	27.7 - 33.1	35.23	32.5 - 37.2	32.42	29.3 - 35.1	0.0001
Total fiber							
g/d	29.36	21.7 - 40.8	23.0	17.4 - 30.3	22.2	16.6 - 29.0	0.0001
% kcal/d	2.7	2.4 - 3.1	2.1	1.7 - 2.4	1.7	1.4 - 2.1	0.0001
Saturated fat							
g/d	27.5	19.2 - 34.4	27.7	21.9 - 37.9	32.4	24.4 - 41.4	0.0001
Monounsaturated fat							
g/d	18.4	13.3 - 23.7	21.8	17.5 - 27.8	22.1	17.7 - 27.3	0.0001
Polyunsaturated fat							
g/d	10.9	8.4 - 13.9	13.4	10.4 - 17.7	13.0	9.8 - 16.5	0.0001
Trans-saturated fat							
g/d	1.06	0.64 - 1.6	1.7	1.2 - 2.5	1.6	0.93- 2.2	0.0001

670 * p-value for statistical significance of the Kruskal-Wallis test

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Table 3. Distribution of selected socioeconomic and home environment characteristics of study population by dietary patterns, Mexico 2012

Variables	Total sample (n=857)		Dietary Patterns						p-value *
			Diverse		High-fat		High-sugar		
	Mean or n	*SD* or %	*Mean* or n	*SD* or %	*Mean* or n	*SD* or %	*Mean* or n	*SD* or %	
			113	13	309	36	438	51	
Age [a]	*9.64*	*2.24*	*9.5*	*2.2*	*9.7*	*2.3*	*9.6*	*2.2*	*0.6959*
5-11	708	82.6	95	84.1	250	81.7	363	82.9	
12-15	149	17.4	18	15.9	56	18.3	75	17.1	*0.833*
Sex									
Male	473	55.2	63	55.7	171	55.9	239	54.6	
Female	384	44.8	50	44.3	135	44.1	199	45.4	*0.931*
BMI									
Normal	461	53.8	56	49.6	157	51.3	248	56.6	
Overweight	192	22.4	30	26.5	74	24.2	88	20.1	
Obese	204	23.8	27	23.9	75	24.5	102	23.3	*0.428*
Monthly family income [b]	*6667.3*	*1.82*	*6495.5*	*1.8*	*6894.8*	*1.8*	*6556.9*	*1.8*	*0.4665*
Mother's educational level[&]									
Middle school or less	210	24.8	24	21.4	64	21.2	122	28.1	
High school or technical education	381	44.9	39	34.8	146	48.3	196	45.2	*0.003*
College or more	257	30.3	49	43.8	92	30.5	116	26.7	
Father's educational level[&]									
Middle school or less	254	30.7	21	19.6	81	27.6	152	35.6	
High school or technical education	305	36.9	43	40.2	111	37.9	151	35.4	*0.011*
College or more	268	32.4	43	40.2	101	34.5	124	29.0	
Mother's occupation									
Professional	203	23.7	40	35.4	73	23.9	90	20.5	
Administrative assistant	213	24.8	27	23.9	82	26.8	104	23.7	

Home/Unemployed	441	51.5	46	40.7	151	49.3	244	55.7	*0.009*
Father's occupation									
Professional	243	28.3	41	36.3	91	29.7	111	25.3	
Administrative assistant	423	49.4	54	47.8	139	45.4	230	52.5	
Home/Unemployed	191	22.3	18	15.9	76	24.8	97	22.1	*0.062*
Parents' history of obesity[&]									
Neither	366	45.9	55	51.9	132	46.6	179	43.9	
Either	263	33.0	36	34.0	92	32.5	135	33.1	
Both	168	21.1	15	14.1	59	20.8	94	23.0	*0.340*
Grandparents' history of obesity[&]									
Neither	380	46.2	51	49.0	146	49.8	183	43.1	
Either	275	33.4	36	34.6	96	32.8	143	33.6	
Both	167	20.3	17	16.3	51	17.4	99	23.3	*0.207*
Screen time (h/d)[a] [&]	1.31	*1.1*	*0.9* [1, 2]	*0.9*	*1.33*	*1.0*	*1.4*	*1.2*	*0.0006*
≤ 1.25 h/d	569	67.1	89	80.2	197	64.4	283	65.7	
> 1.25 h/d	279	32.9	22	19.8	109	35.6	148	34.3	*0.007*

BMI= Body mass index, * p-value for statistical significance of chi-squared tests or Fisher's exact test for qualitative variables and of the Kruskal-Wallis test or one-way ANOVA test for quantitative variables, a Values are arithmetic means ± SD, b Values are geometric means ± SD or n.,1p-value <0.05; Diverse vs. High-fat pattern; Scheffe 2 p-value <0.05; Diverse vs. High-sugar pattern; Scheffe & Due to lack of information, the sum of the data does not correspond to the total of the sample

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683 **Table 4. Multinomial logistic regression model for dietary patterns, lifestyle and socio-**
684 **demographic factors in Mexican children and adolescents, 2012**

		Dietary Patterns	
	Diverse	**High Fat**	**High Sugar**
		*OR (95%CI)**	*OR (95%CI)**
Gross monthly income[1]	1.00		
≤$9,500		*Ref*	*Ref*
>$9,500		0.94 (0.58 – 1.52)	0.87 (0.54 – 1.39)
P for trend		*0.291*	*0.723*
Mother's educational level[2]	1.00		
Middle school or less		*Ref*	*Ref*
High school or technical education		1.27 (0.69 – 2.36)	0.95 (0.50 – 1.64)
College or more		0.67 (0.36 – 1.25)	0.42 (0.23 – 0.75)
P for trend		*0.118*	*0.002*
Father's educational level[1]	1.00		
Middle school or less		*Ref*	*Ref*
High school or technical education		0.64 (0.35 - 1.17)	0.46 (0.26 – 0.83)
College or more		0.62 (0.34 – 1.14)	0.41 (0.23 – 0.73)
P for trend		*0.160*	*0.003*
Mother's occupation[1]	1.00		
Professional		*Ref*	*Ref*
Administrative assistant		1.52 (0.84 – 2.75)	1.59 (0.89 – 2.82)
Home/Unemployed		1.75 (1.04 – 2.94)	2.31 (1.40 – 3.81)
P for trend		*0.039*	*0.001*
Father's occupation[1]	1.00		
Professional		*Ref*	*Ref*
Administrative assistant		1.11 (0.68 – 1.83)	1.51 (0.94 – 2.43)
Home/Unemployed		1.79 (0.94 – 3.39)	1.84 (0.98 – 3.45)
P for trend		*0.079*	*0.046*

Parents' history of obesity[3]	1.00		
Neither		*Ref*	*Ref*
Either		1.03 (0.61 – 1.71)	1.15 (0.70 – 1.88)
Both		1.45 (0.76 – 2.90)	1.93 (1.01 – 3.67)
P for trend		*0.310*	*0.057*
Grandparents' history of obesity[3]	1.00		
Neither		*Ref*	*Ref*
Either		0.95 (0.57 – 1.59)	1.18 (0.72 – 1.93)
Both		1.17 (0.59 – 2.30)	2.02 (1.06 – 3.85)
P for trend		*0.786*	*0.041*
Screen time (h/d)[4]	1.00		
≤ 1.25		*Ref*	*Ref*
> 1.25		*2.33 (1.34-4.04)*	*2.10 (1.23-3.61)*
P for trend		*0.002*	*0.004*

1 Adjusted for age, sex, BMI and screen time, 2 Adjusted for age, sex, Grandparents' history of obesity, BMI and screen time. 3 Adjusted for age, sex, mother's education, BMI and screen time, 4 Adjusted for age, sex, Grandparents' history of obesity, mother's education, BMI