

Relationship between food security and food environments in Mexico City conurbation area vulnerable neighborhoods

Relación entre seguridad alimentaria y entornos alimentarios en colonias vulnerables del área conurbada de la Ciudad de México

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Abstract

Objective: In this research, the relationship between food security level and socioeconomic status, food environment perception, and shopping habits was determined.

Materials and Methods: A descriptive analysis to determine the relationship between food security status and socioeconomic characteristics, and food environment perception was conducted. Data was collected by surveys in vulnerable neighborhoods of Ecatepec de Morelos, México.

Results: Food insecurity was predominantly a consequence of the socioeconomic conditions, although the places to buy foods seem to be adequate since there is no preference for where to buy, by distance or price, finding fresh fruits and vegetables, representing a healthy, cheap, and affordable diet. Nonetheless, the barriers to buying foods were price and income, limiting the quality and amount of food to buy, denoting the necessity to expand open-air markets operation, to bring affordable and healthy food in poor neighborhoods within conurbation capital cities areas.

Conclusion: Enhancing affordable foods is necessary to improve food insecurity status for families living in poor neighborhoods.

Keywords: Food security, Social vulnerability, Poverty, Environment and public health.

Resumen

Objetivo: El objetivo de esta investigación fue determinar la relación entre el nivel de seguridad alimentaria con el estado socioeconómico, la percepción del ambiente alimentario, y los hábitos de compra.

Materiales y Métodos: Se realizó un análisis descriptivo para determinar la relación entre el estado de seguridad alimentaria con las características socioeconómicas y la percepción del entorno alimentario. Los datos fueron recolectados mediante encuestas en colonias vulnerables de Ecatepec de Morelos, México.

Resultados: La inseguridad alimentaria fue predominante una consecuencia de las condiciones socioeconómicas, aunque los lugares para comprar alimentos parecían ser adecuados ya que no hubo preferencia de donde comprar, la distancia o el precio, encontrando frutas y vegetales frescos, representando una dieta saludable, barata y asequible. Sin embargo, las barreras para comprar alimentos fueron el precio y el ingreso, limitando la calidad y cantidad de alimentos para comprar, denotando la necesidad de expandir la operación de mercados al aire libre, para traer alimentos saludables y asequibles a los barrios pobres dentro de las áreas conurbadas de las ciudades capital.

Conclusión: Mejorando la oferta de alimentos asequibles es necesaria con el propósito de mejorar el estado de inseguridad alimentaria de las familias que viven en barrios pobres.

Una oferta de alimentos asequibles es necesaria para mejorar el estado de inseguridad alimentarias de familias en barrios pobres.

Palabras clave: Seguridad alimentaria, Vulnerabilidad social, Pobreza, Medio ambiente y salud pública.

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Introduction

Food insecurity has become an issue of increasing interest since it occurs typically throughout the appreciation of the adequate food supply to households, and the individual experiences of the lack of food. Understanding of the relationship between food insecurity at the household or individual level with an adequate diet is important to evaluate the consequences of this food insecurity status on nutritional health and wellness¹. In the same manner, food insecurity is linked to vulnerability in poverty conditions. The analysis and evaluation of this vulnerability allow the diagnostic of the population's quality of life in susceptible areas and marginal sectors, where sociocultural factors influence regional vulnerabilities, among other factors, in the understanding of risk perception².

Since household income in marginal zones is low and inconstant, food supply chains are different, where instead of big supermarket chains with a wide offer of food products, the main sources to buy foods are markets, open-air markets, grocery stores, convenience stores, or informal street vendors. Food access is not equitable, since differences in population characteristics result in different food necessities³. According to Donkin *et al.*,⁴ even if the food price in the neighborhood is reasonable, not more expensive than in other places, this does not imply that persons in vulnerable status can buy them. In this view, in marginal urban areas it is necessary to establish the relationship between retailed food establishments and both the consumers' behavior and consumers' appreciation. At the household level, a stable and regular income is necessary to maintain food security, but other aspects like the limited capacity to store foods reduce the capacity to maintain fresh products, and in some moments to take advantage of buying larger amounts of foods to store, limiting their diet diversity, plus limitans in food preparation capacity (energy source to cook meals), force them most of the times to buy processed foods or prepared meals⁵.

In this view, the objective of this research was to determine the food security level in some neighborhoods of the Ecatepec municipality, part of the conurbation of Mexico City, characterized by higher poverty rates and vulnerability, to establish the relationship between socioeconomic indicators and food environment perception with shopping habits. We hypothesize that in marginal urban zones, and low socioeconomic levels, food insecurity will be present, due mainly to the lack of adequate food access. This research was designed to develop an understanding of the direct perception of food environments by persons in a vulnerable situation, linked to food insecurity status.

Materials and methods

This cross-sectional research was based on a questionnaire with close questions within three modules: 1) food security level, employing the first six-question of the Food Security Mexican Survey, where no affirmative answer implies food security status, from 1 to 2 implies mild food insecurity status, from 3 to 4 moderated food insecurity status, and 5 to 6 severe food insecurity status⁶; 2) socioeconomic information about the household income, education level, government monetary support, the diseases that they know to suffer, and the body mass index, according to interviewer appreciation; and, 3) consumers' shopping behavior and the perception of the food environment (adapted from Kaiser *et al.*⁷). Before starting the questioning, interviewers explained the objective of the study, and oral consent was obtained. Surveys were conducted in places close to main food shopping places, like markets, supermarkets, and/or air-open markets, from August to October 2022, with an average duration of 25-35 min, and participants were recruited through purposive snowball sampling. A total of 350 surveys were conducted, analyzing only those with complete answers (289 in total).

Descriptive analysis was performed with the command PROC SURVEYFREQ in the SAS v. 9.1 statistical software to calculate the frequency and percent of the answers into the different food security levels clusters, according to the Food Security Mexican Survey, reporting Rao-Scott χ^2 and the significance (P value) to determinate the relationship of the survey answers with the food security level. Regression analysis was performed with the command PROC SURVEYLOGISTIC fitting generalized logit function (*glogit*). The procedure performs maximum likelihood estimation of the regression coefficients and calculated the estimated odds ratio and the confidence interval with the food security level "severe" as the reference category.

Results

According to the food security survey, most of the households presented a food insecurity status: 42% are in mild food insecurity, 10% in moderate food insecurity, and 9% in severe food insecurity. Only 39% presented food security status during the period of the study. The relationship between the food security level and the sociodemographic characteristics is listed in Table 1. For the household income level reported by the interviewed persons, there was a highly significant ($P < 0.01$) relationship with the food security level. Of the total, 38% said to have a medium income (level D+), but 32% perceived a lower income (level E). Households in both food security (16.96%) and mild food insecurity (16.61%) situations reported a D+ income, and households in moderate (4.84%) and severe (5.88%) food insecurity reported a lower income level. Regarding their schooling, there was as well a

significant ($P < 0.01$) relation between education and the food security level, where from the total, most of the people said to have attended high school (31%) and secondary (29%). High school was the most reported scholar level for persons in food security situations (14.19%), but the increase in food insecurity was inversely proportional to their educational level since persons in moderate (3.46%) and severe (2.77%) food insecurity presented a lower one. Since a high percentage of persons reported not having received any monetary help from the government (80.97%), there was not a consequentially significant ($P > 0.05$) relationship between this support and the food security level.

Regarding health issues, there was no significant ($P > 0.05$) relationship between the food security level and the illness that the persons said to suffer. Nonetheless, most of the surveyed persons said to have no illness (31.14%), followed by persons who do not know if they suffer from any illness (17.65%). After this, being overweight (26.96%), high blood pressure (12.11%), and diabetes (11.07%) were the most common illnesses. For the body mass index, there was a significant ($P < 0.01$) relationship between the food security level and this parameter, since from the total of surveyed persons 49% have a normal appearance, and 38% presented overweight. Persons with food security status were overweight (19.03%), whereas persons with food insecurity presented a normal BMI, according to the appreciation of the interviewer.

Table 1. Distribution of the sociodemographic characteristics (frequency, percent) according to food security level.

	Total (n=289)		Food security (n=113)		Mild insecurity (n=122)		Moderated insecurity (n=28)		Severe insecurity (n=28)	
	n	%	n	%	n	%	n	%	n	%
Household income in USD per month ($\chi^2 = 33.3684, P = 0.0009$)										
C+ (>\$1,760)	31	10.73	19	6.57	10	3.46	1	0.35	1	0.35
C (<\$1,759)	4	1.38	1	0.35	1	0.35	1	0.35	1	0.35
D+ (<\$583)	112	38.75	49	16.96	48	16.61	9	3.11	6	2.08
D (<\$342)	48	16.61	22	7.61	22	7.61	3	1.04	1	0.35
E (<\$136)	94	32.53	22	7.61	41	14.19	14	4.84	17	5.88
Education ($\chi^2 = 19.5422, P = 0.0210$)										
Primary	58	20.07	15	5.19	25	8.65	10	3.46	8	2.77
Secondary	82	29.41	26	9.00	42	14.53	9	3.11	8	2.77
High school	91	31.49	41	14.19	36	12.46	7	2.42	7	2.42
College	55	19.03	31	10.73	19	6.57	2	0.69	3	1.04
Food program ($\chi^2 = 3.3585, P = 0.3402$)										
Yes	55	19.03	20	6.92	26	9.00	7	2.42	2	0.69
No	234	80.97	93	32.18	96	33.22	21	7.27	24	8.30
Diseases ($\chi^2 = 19.3977, P = 0.3677$)										
Cholesterol	13	4.50	3	1.04	5	1.73	3	1.04	2	0.69
Diabetes	32	11.07	13	4.50	14	4.84	4	1.38	1	0.35
None	90	31.14	37	12.80	41	14.19	7	2.41	5	1.73
Do not know	51	17.65	16	5.54	20	6.92	5	1.73	10	3.46
Other	19	6.57	7	2.42	8	2.77	3	1.04	1	0.35
High pressure	35	12.11	12	4.15	16	5.54	3	1.041	4	1.38
Overweight	49	16.96	25	9.65	18	6.23	3	1.04	3	1.04
Body mass index ($\chi^2 = 25.7473, P = 0.0022$)										
Low	15	5.19	2	0.69	6	2.08	6	2.08	1	0.35
Normal	144	49.83	49	16.96	65	22.49	15	5.19	15	5.19
Obesity	20	6.92	7	2.42	10	3.46	1	0.35	2	0.69
Overweight	110	38.06	55	19.03	41	14.19	6	2.08	8	2.77

Source: Own elaboration based on statistical analysis output.



Table 2. Distribution of shopping habits (frequency, percent) according to food security level

	Total (n= 289)		Food security (n=113)		Mild insecurity (n=122)		Moderated insecurity (n=28)		Severe insecurity (n=28)	
	n	%	n	%	n	%	n	%	n	%
Place where do you purchase foods ($\chi^2 = 23.0390, P= 0.0839$)										
Market	80	27.68	30	10.38	36	12.46	7	2.42	7	2.42
Mini supermarket	50	17.30	23	7.96	20	6.92	3	1.04	4	1.38
Supermarket	60	20.76	33	11.42	19	6.57	5	1.73	3	1.04
Open-air food market	78	26.99	23	7.96	36	12.46	11	3.81	8	2.77
Grocery store	8	2.77	1	0.35	3	1.04	1	0.35	3	1.04
Convenience store	13	4.50	1	1.04	8	2.77	1	0.35	1	0.35
Place where do you shop by lower price ($\chi^2 = 14.6808, P= 0.4746$)										
Market	59	20.42	24	8.30	25	8.65	7	2.42	3	1.04
Mini supermarket	54	18.69	22	7.61	19	6.57	7	2.42	6	2.085
Supermarket	38	13.15	21	7.26	15	5.19	1	0.35	1	0.35
Open-air food market	115	39.79	38	13.15	52	17.99	11	3.81	14	4.84
Grocery store	8	2.77	4	1.38	2	0.69	1	0.35	1	0.35
Convenience store	15	5.19	4	1.38	9	3.11	1	0.35	1	0.35
Place to shop food closer to your home ($\chi^2 = 36.1237, P= 0.0017$)										
Market	50	17.30	18	6.23	15	5.19	11	3.81	6	2.08
Mini supermarket	58	20.07	24	8.30	24	8.30	4	1.38	6	2.08
Supermarket	24	8.30	8	2.77	13	4.50	1	0.35	2	0.69
Open-air food market	49	16.96	14	4.84	27	9.34	6	2.08	2	0.69
Grocery store	22	7.61	4	1.38	9	3.11	4	1.38	5	1.73
Convenience store	86	29.76	45	15.57	34	11.76	2	0.69	5	1.73
Place to buy healthier foods ($\chi^2 = 14.2801, P= 0.2832$)										
Market	100	34.60	38	13.15	35	12.11	13	4.50	14	4.84
Mini supermarket	43	14.88	20	6.92	17	5.88	3	1.04	3	1.04
Supermarket	32	11.07	14	4.84	16	5.54	1	0.35	1	0.35
Open-air food market	110	38.06	40	13.94	53	18.34	10	3.46	7	2.42
Grocery store	4	1.38	1	0.35	1	0.35	1	0.35	1	0.35
Place to buy fresh fruit and vegetables ($\chi^2 = 12.8665, P= 0.3788$)										
Market	91	31.49	38	13.15	29	10.03	12	4.15	12	4.15
Mini supermarket	16	5.54	8	2.77	5	1.73	1	0.34	2	0.69
Supermarket	22	7.61	9	3.11	11	3.81	1	0.34	1	0.35
Open-air food market	155	53.63	57	19.72	75	25.95	13	4.50	10	3.46
Grocery store	5	1.73	1	0.35	2	0.69	1	0.34	1	0.35
How easy is to find fresh fruits and vegetables in your neighborhood ($\chi^2 = 23.6982, P= 0.0048$)										
Very easy	127	43.94	63	21.80	45	15.57	9	3.11	10	3.46
Easy	40	13.84	12	4.15	25	8.65	2	0.69	1	0.35
More or less easy	101	34.95	30	10.38	47	16.26	13	4.50	11	3.80
Not easy	21	7.27	8	2.77	5	1.73	4	1.38	4	1.38
How satisfied are you with the ease to access foods in your neighborhood ($\chi^2 = 51.4221, P< 0.0001$)										
Very satisfied	89	30.80	42	14.53	37	12.80	7	2.42	3	1.04
Satisfied	43	14.88	13	4.50	27	9.34	2	0.69	1	0.35
More or less satisfied	136	47.06	56	19.37	53	18.34	14	4.84	13	4.50
Not satisfied	21	7.27	2	0.69	5	1.73	5	1.73	9	3.11

Source: Own elaboration based on statistical analysis output.



Table 3. Distribution of food environment perception (frequency, percent) according to food security level

	Total (n= 289)		Food security (n=113)		Mild insecurity (n=122)		Moderated insecurity (n=28)		Severe insecurity (n=28)	
	n	%	n	%	n	%	n	%	n	%
How important is the nutritional value ($\chi^2 = 12.7016, P= 0.1766$)										
Very important	148	51.21	66	22.84	62	21.45	11	3.81	9	3.11
Important	105	36.33	35	12.11	43	14.88	14	4.84	13	4.50
More or less important	25	8.65	11	3.81	9	3.11	2	0.69	3	1.04
Not important	11	3.81	1	0.35	8	2.77	1	0.35	1	0.35
Household income is a barrier ($\chi^2 = 22.1970, P=< 0.0001$)										
Yes	151	52.25	44	15.22	65	22.49	22	7.61	20	6.92
No	138	47.75	69	23.88	57	19.72	6	2.08	6	2.08
How important is the price ($\chi^2 = 20.2718, P= 0.0163$)										
Very important	119	41.18	43	14.88	50	17.30	6	5.54	7	3.81
Important	122	42.21	49	16.96	59	20.42	16	2.08	11	2.42
More or less important	33	11.42	17	5.88	9	3.11	2	0.69	5	1.73
Not important	15	5.19	4	1.38	4	1.38	4	1.38	3	1.04
Transport or distance are a barrier ($\chi^2 = 4.9065, P= 0.1788$)										
Yes	40	13.84	10	3.46	19	6.57	5	1.73	6	2.08
No	249	86.16	103	35.64	103	35.64	23	7.96	20	6.92
Transportation ($\chi^2 = 12.7879, P= 0.1724$)										
Bicycle	22	7.61	4	1.38	11	3.81	4	1.38	3	1.04
Own car	38	13.15	20	6.92	14	4.84	1	0.35	3	1.04
Public transport	31	10.73	11	3.81	11	3.81	6	2.08	3	1.04
Walking	198	68.51	78	26.99	86	29.76	17	5.88	17	5.88

Source: Own elaboration based on statistical analysis output.

In the consumers' behavior and the perception of the food environment, there was no significant ($P>0.05$) relationship between the place to buy foods nor the place to buy food for the lower price, and the food security level. The closest place to buy foods has a highly significant ($P<0.01$) relationship with the food security level, where 29.76% of the total surveys reported that the grocery store was the closest place to their homes, followed by the mini supermarket (20.07%). The convenience store was the closest place to buy food for households in food security situations (15.57%), but for both moderate and severe food insecurity status the market was the closest place to buy food (3.81 and 2.08, respectively). When people were asked about where to buy healthier food, there was not a significant ($P>0.05$) relation between this place and the food security level, but most of the persons answered open-air food markets (38.06%) and markets (34.60%). In the same manner, the place to buy fresh fruit and vegetables showed no significant ($P>0.05$) relationship with the food security level (53.63% went to the open-air food market to buy fresh fruit and vegetables). However, when persons were asked about the ease of shopping for fresh fruit and vegetables, there was a highly significant ($P<0.01$) relationship between easy access to this type of foods and the food security situation, and from the total 44% reported that it was very easy; for those in a food security situation it

was the case for 21.80% of them, but for the households with food insecurity to find these types of foods was "more or less easy" to obtain. Finally, for the question about how satisfied they were with the facility to access food, a highly significant ($P<0.01$) effect was found on this parameter with the food security level. In general, 47% of the total said that they were "more or less" satisfied with the ease of buying food, a tendency observed in all the food security levels (Table 2).

Regarding the food environment (Table 3), about the importance of nutritional value, there was not a significant ($P>0.05$) relationship with food security level. When persons were asked about the importance of the food price, a significant ($P<0.01$) relationship was found, where a total of 42% said that food price was important. It was the case for households in food security (16.96%) and mild food insecurity (20.42%), whereas for households in moderate (5.54%) and severe food insecurity (3.81%) the food price was very important. There was a highly significant ($P<0.01$) relationship between household income as an obstacle to buying food and food security level, where above half (52.25%) answered affirmatively to this item. Only for households in food security situations (23.88%), the household income was not a barrier. Relating to the fact of transportation or distance as a barrier to getting food,

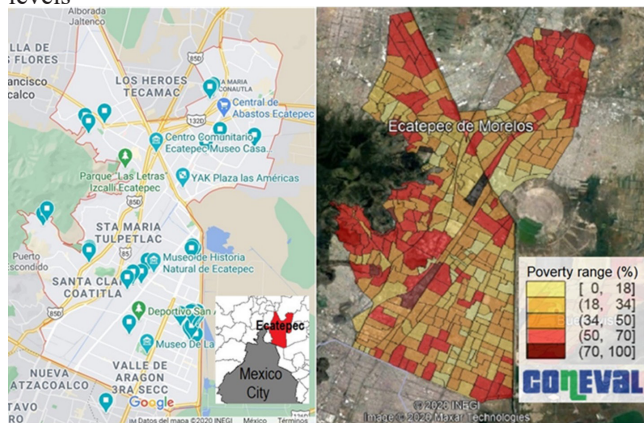


there was not a significant ($P>0.05$) relationship between this obstacle and food security level, with the predominant negative answer (67.13%). The mean of transportation employed when persons buy food did not represent a significant parameter ($P>0.05$) with the food security level, as most of the persons walk to buy their food (68.51%).

Discussion

In the municipality of Ecatepec, there were 40.8% of the population in poverty conditions, besides social deprivation, 35.3% without social security, and 20.0% with no access to adequate food (Figure 1)⁸. The food security levels found in this research were close to the reported in Mexico at the national level since above half of the households are in some degree of food insecurity⁹.

Figure 1. Places where surveys were taken (left, source: Google Maps, Ecatepec, 28 September 2022) and poverty levels



Source: Google Earth, Ecatepec, 28 September 2022.

According to the descriptive analysis, there are two factors with statistical incidence on food security status: income level and educational level. The low-income level is inherently related to the poverty situation. Mundo-Rosas *et al.*¹⁰ reported that households with lower socioeconomic levels are in a situation of food insecurity, where a high portion of their low income is destined to buy food. Based on the results of this research, income level was reflected in the food security level, since lower income means reduced capacity to buy food. The other significant factor is schooling, a higher level of education is implicitly linked to a better household income, and improved food security. Food insecurity perception is determined by the uncertainty and insufficiency of current income, resulting in vulnerability¹¹. Although the beneficiaries of social assistance programs improved the consumption of higher nutritional value foods¹⁰, in this research there was no effect of these kinds of programs, where persons probably destinate this money to other expenses besides food, like medicines (economical

supports are for third age persons and single mothers). Food insecurity and financial insecurity intersection with other economic and sociocultural influences are associated with lower energy and nutrient ingestion¹². Regarding education level, in developing countries, a higher level of education is associated with an increase in food security, since in the urban context shopping for food depends on income¹³. Severe food insecurity is directly related to educational level and per capita GDP^{11,14,15}. According to the OECD, income inequalities are blunt and persistently marked in some less developed regions and capital cities, such as Mexico, Colombia, Czech Republic, and Lithuania, based on GDP, where the relative poverty rate across OECD regions was around 21% in 2020, with the largest differences in Colombia and Mexico¹⁶.

Both education and income levels had a relationship with the food security level, where higher education does not necessarily correspond to a higher income because of the inequality and inequity of the classification levels in education and activity, besides sex and city. In addition, in general, obesity and diabetes fall on the person with limited resources and a low educative level¹⁷. There is a relationship between sociodemographic characteristics and diseases like diabetes or cholesterol in marginal urban zones with food insecurity conditions¹⁸. The socio-economic environment of a neighborhood definitively has an impact on the overweight prevalence throughout potential mediators at a community level that influences individual level, like grocery shops access, healthy restaurants, parks and sports facilities, and food price and availability¹⁹. These factors have a key role in food security due to calorie ingestion, independently of household economic status, since a higher food availability by itself is not healthier, unless the access to other goods and services was improved as well²⁰. These are the reasons to find obesity in people in a food security situation, in contrast to a person in a food insecurity status, where malnutrition implies skipping meals or eating less food.

The way people conduct their shopping behaviors revealed no relationship preference between the main place to purchase foods, looking for the lower price, or buying healthier foods, and finding fruits and vegetables. This could be due to economic restriction, since grocery shops or mini supermarkets were the closest places to buy food for persons in food security status, implying the consumption of high caloric content foods, at a relatively higher cost. In contrast, markets were the closest place to get food for families with lower food security status (moderate and severe). In any case, the food options are barely satisfactory since for most people it was easy to find fruit and vegetables and they were, in general, “more or less satisfied” with the food offered in the neighborhood.

Logistic regression showed that food expenditures were an important concern for the families, and they would like to have access to diverse kinds of foods in their neighborhoods, since it was very easy to find healthy foods such as fresh fruits and vegetables, and access to affordable foods must be improved. The cost of food was important in food acquisition since income and price were a barrier to buying the food that people desire. Economic factors, such as money availability to buy healthy foods, are determinants of diet quality²¹. For marginal groups in big cities, food price is the dominant factor in the purchase decision, and economic restrictions to households with lower incomes result in food insecurity²². Nonetheless, establishing a relationship between socioeconomic status and nutritional and health status is not easy due to household heterogeneity²³, since the household heterogeneity income on nutrients ingestion and the response to the rise in food prices has different levels²⁴.

There are households in the same city areas with different geographic access to food and different food security levels, where households with different income patterns obtain foods differently in the same food environment (home, neighborhood, and city as a set)²⁵. Food accessibility is mainly a geographic notion, where perception measures can include security in walking routes and/or public transportation²⁵. Since transport costs could influence the funds to buy food, local access to foods within walking distance is a favorable determining factor²⁶, and hence affordable foods must be close to the households with food insecurity status. According to our results, not even an open-air market or supermarket was the closest place to buy food. Open-air or streets markets offer lower prices since most of the vendors have their transport and the local taxes that they must pay to the municipality are marginal, permitting them to sell their merchandise through a vendor organization in determined and itinerant locations, usually, one day per week. Although supermarkets present several advantages like food freshness and healthfulness, other concerns like food price change, besides the concern for the environment and society are well perceived by consumers with the benefits of convenience, hygiene, and lower waste²⁸. According to Minten and Reardon²⁹ supermarkets anticipate traditional food retailers since the scale economy allows them to offer lower prices, and poor consumers take advantage to buy processed foods since fresh products are more expensive than in open-air food markets.

According to the present results the representative sample population within this demarcation perceived that their household income was a barrier during food shopping, irrespectively of the food security level, since the price was also important, although they said to be satisfied with the food that they could easily find in their neighbourhoods. Nonetheless, the spatial access to food in poor marginal

areas, such as the municipality of Ecatepec, must change in order to offer an affordable variety of foods for these families, since although the available food supplies facilities seem to generate a static food desert, due to the lack of cheaper foods to increase shopping satisfaction, where open-air food markets must be the place to find food at a lower price. Future research attention should be focused on understanding shopping behaviour and determining the number and locations of food stores, also determining the availability of open-air food markets to suggest a more frequent presence or allow other producers to offer food in a similar marketing scheme.

The strength of this research is referred to the face-to-face survey process, since this kind of interactions promotes reflexivity, this is the direct documenting of how persons perceive physical and psychologically their food environment, instead the use of unpersonal metadata from another sources, as INEGI. The obvious limitation is the sample size, but surveys were applied in representative areas that can be extrapolated to similar vulnerability conditions in other cities.

Conclusion

The food security level among the Ecatepec neighborhoods was predominantly the consequence of the socioeconomic conditions, like limited educational level and low household income level, resulting in an insufficient diet based on the food that they can provide. Places to buy foods seem to be sufficient since there is no preference for where to buy, by distance or price, finding fresh fruits and vegetables, representing a healthy -cheap and affordable- diet. Nonetheless, since the barriers to buying foods were price and income, limiting the quality and amount of food to buy, it suggests a static food desert environment, denoting the necessity to expand open-air markets operation, to bring affordable and healthy food to poor neighborhoods in conurbation capital cities areas. Thus, social inequalities in this vulnerable urban demarcation into Mexico City metropolitan area are the result of different food security levels, with a consequence on each person's health, like being overweight, but the food environment is benevolent, with purchasing power as the main constraint. Enhancing the affordable foods offered is necessary to improve food insecurity status for families living in poor neighborhoods.

Conflict of interest

The author has no conflict of interest to declare.

Ethical consideration

This study was estimated as exempted by the internal ethical committee board since there were no interventional procedures within the research protocol and the recollected personal confidential information will not be made public.

Contributions of the authors

Conceptualization: A.T.; Formal Analysis: A.T.; Investigation: A.T.; Methodology: A.T.; Visualization: A.T.; Writing ³/₄ review and editing: A.T.

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References

1. Tarasuk V, Beaton GH. Women's dietary intakes in the context of household a food insecurity. *J Nutr.* 1999; 129:672-9. Available in: <https://doi.org/10.1093/jn/129.3.672>
2. Foschiatti AHM. Vulnerabilidad global y pobreza. *Rev Geog Digital.* 2004; 1:1-20. Available in: <https://doi.org/10.30972/geo.122589>
3. Thomas BJ. Food deserts and the sociology of space: distance to food retailers and food insecurity in an urban American neighborhood. *Int J Hum Soc Sci.* 2010; 4(7):1545-54. Available in: <https://doi.org/10.5281/zenodo.1076064>
4. Donkin AJM, Dowler EA, Stevenson SJ, Turner S. Mapping access to food in a deprived area: The development of price and availability indices. *Pub Health Nutr.* 2000; 3:33-8. Available in: <https://doi.org/10.1017/S1368980000000057>
5. Battersby J, Crush J. The making of urban food deserts. In: Crush J, Battersby J, eds. *Rapid Urbanisation, Urban Food Deserts and Food Security in Africa.* Cham: Springer; 2016. Available in: https://doi.org/10.1007/978-3-319-43567-1_1
6. Villagómez-Ornelas P, Hernández-López P, Carrasco-Enríquez B, Barrios-Sánchez K, Pérez-Escamilla R, Melgar-Quinónez H. Validez estadística de la Escala Mexicana de Seguridad Alimentaria y la Escala Latinoamericana y Caribeña de Seguridad Alimentaria. *Salud Pública de México.* 2014; 56(Supl. 1):s5-s11. Available in: <https://doi.org/10.21149/spm.v56s1.5160>
7. Kaiser ML, Carr JK, Fontanella S. A tale of two food environments: Differences in food availability and food shopping behaviors between food insecure and food secure households. *J Hunger Environ Nutr.* 2017; 14(3):297-317. Available in: <https://doi.org/10.1080/19320248.2017.1407723>
8. Informe Anual sobre la Situación de Pobreza y Rezago Social 2023. México. Ecatepec de Morelos. Available in: <https://www.gob.mx/cms/uploads/attachment/file/793527/15033-EcatepecDeMorelos23.pdf>
9. Valencia-Valero RG, Ortiz-Hernández L. Disponibilidad de alimentos en los hogares mexicanos de acuerdo con el grado de inseguridad alimentaria. *Salud Pública de México.* 2014; 56:154-64. Available in: <https://doi.org/10.21149/spm.v56i2.7331>
10. Mundo-Rosas V, Unar-Munguía M, Hernández-F M, Pérez-Escamilla R, Shamah-Levy T. La seguridad alimentaria en los hogares en pobreza de México: una mirada desde el acceso, la disponibilidad y el consumo. *Salud Pública de México.* 2019; 61:866-75. Available in: <https://doi.org/10.21149/10579>
11. Félix-Verduzco G, Aboites-Manrique G, Castro-Lugo D. La seguridad alimentaria y su relación con la suficiencia e incertidumbre del ingreso: un análisis de las percepciones del hogar. *Acta Univ.* 2018; 28:74-86. Available in: <https://doi.org/10.15174/au.2018.1757>
12. Tarasuk VS. Household food insecurity with hunger is associated with women's food intakes, health and household circumstances. *J Nutr.* 2001; 131(10):2670-6. Available in: <https://doi.org/10.1093/jn/131.10.2670>
13. Mutisya M, Ngware MW, Kabiru CW, Kandala N-B. The effect of education on household food security in two informal urban settlements in Kenya: a longitudinal analysis. *Food Sec.* 2016; 8(4):743-56. Available in: <https://doi.org/10.1007/s12571-016-0589-3>

14. De Haro-Mota R, Marcelaño-Flores S, Bojórquez-Serrano JI, Nájera-González O. La inseguridad alimentaria en el estado de Nayarit, México, y su asociación con factores socioeconómicos. *Salud Pública de México*. 2016; 58:421-7. Available in: <https://doi.org/10.21149/spm.v58i4.8022>
15. Díaz-Carreño MÁ, Sánchez-León M, Díaz-Bustamante A. Inseguridad alimentaria en los estados de México: un estudio de sus principales determinantes. *Econ Soc Terr*. 2016; 16:459-83. Available in: <https://doi.org/10.22136/est002016818>
16. Organization for Economic Co-operation and Development (OECD). *OECD Regions and Cities at a Glance 2022*. OECD Publishing, Paris. Available in: <https://doi.org/10.1787/14108660-en>
17. Shamah-Levy T, Mundo-Rosas V, Rivera-Dommarco JA. La magnitud de la inseguridad alimentaria en México: su relación con el estado de nutrición y con factores socioeconómicos. *Salud Pública de México*. 2014; 56(Supl. 1):S79-S85. Available in: <https://doi.org/10.21149/spm.v56s1.5169>
18. Ramsey R, Giskes K, Turrell G, Gallegos D. Food insecurity among adults residing in disadvantaged urban areas: potential health and dietary consequences. *Public Health Nutr*. 2011; 15:227-37. Available in: <https://doi.org/10.1017/S1368980011001996>
19. Jaime PC, Duran AC, Sarti FM, Lock K. Investigating environmental determinants of diet, physical activity, and overweight among adults in Sao Paulo, Brazil *J Urban Health* 2011; 88(3):567-81. Available in: <https://doi.org/10.1007/s11524-010-9537-2>
20. Iram U, Butt MS. Determinants of household food security: An empirical analysis for Pakistan. *Int J Social Econ*. 2004; 3:753-66. Available in: <https://doi.org/10.1108/03068290410546011>
21. Drisdelle C, Kestens Y, Hamelin A-M, Mercille G. Disparities in access to healthy diets: how food security and food shopping behaviors relate to fruit and vegetable intake. *J Acad Nutr Diet*. 2020; 120:1847-58. Available in: <https://doi.org/10.1016/j.jand.2020.03.020>
22. Dachner N, Ricciuto L, Kirkpatrick SI, Tarasuk V. Food purchasing and food insecurity among low-income families in Toronto. *Can J Diet Pract Res*. 2010; 71(3):e50-6. Available in: <https://doi.org/10.3148/71.3.2010.127>
23. Mashingaidze N, Ekesa B, Ndayisaba CP, Njukwe E, Groot CJ, Gwazane M, Vanlauwe B. Participatory exploration of the heterogeneity in household socioeconomic, food, and nutrition security status for the identification of nutrition-sensitive interventions in the Rwandan highlands. *Front Sust Food Sys*. 2020; 4: 47. Available in: <https://doi.org/10.3389/fsufs.2020.00047>
24. You J, Imai KS, Gaiha R. Declining nutrient intake in a growing China: does household heterogeneity matter? *World Dev*. 2016; 77:171-91. Available in: <https://doi.org/10.1016/j.worlddev.2015.08.016>
25. Caspi CE, Sorensen G, Subramanian SV, Kawachi I. The local food environment and diet: a systematic review. *Health Place* 2012; 18:1172-87. Available in: <https://doi.org/10.1016/j.healthplace.2012.05.006>
26. Kirkpatrick S, Tarasuk V. Assessing the relevance of neighborhood characteristics to the household food security of low-income Toronto families. *Pub Health Nutr*. 2010; 13:1139-48. Available in: <https://doi.org/10.1017/S1368980010000339>
27. Rajagopal. Street markets influencing urban consumer behavior in Mexico. *Latin Am Bus Rev*. 2010; 11:77-110. Available in: <https://doi.org/10.1080/10978526.2010.487028>
28. Stanton JV. Changing consumer preferences in emerging markets: food market challenges in central Mexico. *J Food Prod Mark*. 2019; 25:378-403. Available in: <https://doi.org/10.1080/10454446.2019.1566807>
29. Minten B, Reardon T. Food prices, quality, and quality's pricing in supermarkets versus traditional markets in developing countries. *Rev Agricult Econ*. 2008; 30:480-90. Available in: <https://doi.org/10.1111/j.1467-9353.2008.00422.x>