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ORIGINAL RESEARCH

# Food insecurity and malnutrition in vulnerable households with children under 5 years on the Ecuadorian coast: a post-earthquake analysis

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## ABSTRACT:

**Introduction:** A household's nutritional status and food security can be affected after a natural disaster, especially in families who live in risk situations. The objective of this study was to determine the prevalence of food insecurity, inadequate dietary diversity and poor nutritional status of mothers and children under 5 years old from vulnerable families residing in the rural community of La Punta, after the earthquake in Ecuador on 16 April 2016.
**Methods:** Through a non-probabilistic sampling, 28 families were

selected. The levels of food insecurity in households were determined by applying a food safety scale and household dietary diversity score. Moreover, *Z*-scores were used to evaluate the nutritional status of children, while body mass index was used in mothers.

**Results:** All households suffered food insecurity, with mild food insecurity being the most prevalent (51.9%), followed by severe food insecurity (33.3%). Although all households had high diversity scores, the products they most consumed have low nutritional value, such as rice, soft drinks and oils. There was a low consumption of whole grains, fruits and vegetables. Additionally, there was a high percentage of overweight and obese mothers (57.1%) and a high prevalence of chronic undernutrition (40.9%) and global undernutrition (13.6%) in children under 5 years old.

**Conclusion:** The predominance of severe food insecurity occurred in overweight and obese mothers with inadequate dietary diversity. This probably happened because of a lack of access to food to adequately meet the nutritional needs of each member of the family. The results suggest that health promotion with actions aimed at food security is a priority within an integral action plan for natural disasters.

Keywords:

body mass index (BMI), chronic undernutrition, dietary diversity, earthquake, Ecuador, food insecurity, global undernutrition, undernutrition.

## FULL ARTICLE:

### Introduction

On 16 April 2016, an earthquake of magnitude 7.8 on the Richter scale affected the Ecuadorian coast. Its epicentre was in the province of Manabí and had a focal depth of 20 km. The earthquake killed more than 700 people, injured 30 000 people and completely destroyed towns such as Pedernales and surrounding rural areas[1].

Food insecurity is defined as 'the limited or uncertain availability of nutritionally adequate and safe foods; or the limited and uncertain capacity to acquire adequate food in socially acceptable ways'[2]. Once the emergency stage of a natural disaster has ended in a general manner, food insecurity is usually one of the food problems that has the greatest impact on populations affected by the disaster, especially among the poorest groups, because it increases risks of undernutrition and disease in the population[3-5]. These problems arise because natural disasters usually have many lasting consequences that affect food security, such as water pollution and poor sanitation. Disasters also increase economic problems due to the destruction of rural infrastructure and agriculture, such as loss of crops and harvests and the deaths of animals.[3,6-8]

Only one relevant report was written in Ecuador before the event. In 2011, the study found that the problem of food insecurity in Ecuador was specifically related to people's ability to purchase food, which affects the quality of life. Thus it was recorded that 8.7% of Ecuadorian households did not have the means to access a sufficient amount of food to cover their minimum needs, with 76% of cases occurring in rural areas of the country. The Amazon region had the highest prevalence of food insecurity in households (27.8%), whereas provinces such as Manabí, Esmeraldas, Loja, Cotopaxi and Imbabura recorded values between 10.4% and 16.4%[9] and showed no difference between rural and urban areas.

It is understood that the problem of food insecurity is also caused by economic constraints, such as lack of education. Moreover, at the national level, the probability of a family not being able to access a minimum amount of food increases by 8% if the head of the household is a woman and if there is a greater number of members per family. These findings are linked to the unequal distribution of food within the home and gender inequality. Likewise, a higher number of children under 5 years old generates pressure on household resources, increasing the risk of a family suffering from food insecurity. This situation is more evident in rural areas, where an additional infant increases the possibility that the household lacks access to a minimum amount of food by 2.6%[9,10]. All these factors contribute to increasing levels of food insecurity after a natural disaster, as evidenced in Nepal after the earthquake in 2015, where rural areas and families headed by women were the most affected[5,11].

Given the need to understand how earthquakes affect household food security in rural areas, this study evaluated the dietary diversity and prevalence of food insecurity in vulnerable families in the community of La Punta, which was affected by the earthquake.

### Methods

#### *Study population and design*

This was a cross-sectional observational study, which included a sample of 28 households living in the La Punta rural community, located 40 minutes by road from Pedernales (province of Manabí), the epicentre of the earthquake on 16 April 2016 (see Figure 1). The study was carried out 4 months after the natural disaster, once the emergency stage was over. Prior to the study, it was necessary to diagnose the community based on a sociodemographic survey that determined the socio-economic status of each households (*n*=44 heads of household, who represent approximately 34% of the total number of households in the community). The study was carried out using non-probabilistic sampling for convenience, where families that met the following inclusion criteria participated: a family nucleus with more than five members including at least two children under 10 years old or a teenager or an adult over 65 years old; the economic income depends on the work of only one member of the family who is engaged in work such as agriculture and fishing; and a home lacking a bathroom, sewerage or safe drinking water. For this study, the analysis also focused on households with children under 5 years of age (*n*=14 families).

***Nutritional status of the population***


**Figure 1: Geographic location of the rural community, La Punta.**

In order to determine the participants' nutritional status, the following anthropometric data were acquired. In children under 2 years old, weight (Seca paediatric scale, 354±10 g), height (Seca infantometer 417±1 mm) and head circumference (SECA anthropometric tape, 201±1 mm) were measured. In children over 2 years old, weight (Seca digital scale, 813±100 g), height (Seca stadiometer, 213±1 mm) and waist circumference (Seca anthropometric tape, 201±1 mm) were measured.

In mothers, nutritional status was estimated using body mass index (BMI) and the cut-off points established by WHO[12]. In addition, waist circumferences were analysed as an indicator of cardiovascular risk according to the cut-off points established for South America by the International Diabetes Federation[13].

In children, weight, length or height, BMI, and head circumference measurements were ultimately converted into weight-for-age *Z*-scores (WAZ), length-for-age *Z*-scores (LAZ), height-for-age *Z*-scores (HAZ), BMI-for-age *Z*-scores (BMIZ) and head-circumference-for-age *Z*-scores (HCAZ) (standard deviation (SD) scores), according to World Health Organization (WHO) child growth standards[14].

***Dietary diversity***

Household dietary diversity was assessed with the Household Dietary Diversity Score (HDDS) to establish each household's access to different types of food[15]. Prior to applying the instrument, an adapted pilot test was carried out with food from the area.

The HDDS is a continuous score, which measures the consumption of 16 food groups within the past 24 hours: (i) cereals, (ii) roots and white tubers, (iii) roots and tubers rich in vitamin A, (iv) green vegetables, (v) other vegetables, (vi) fruit rich in vitamin A, (vii) other fruit, (viii) offal, (ix) meat and poultry, (x) eggs, (xi) fish and seafood, (xii) legumes/nuts, (xiii) milk and dairy products, (xiv) oil/fats, (xv) sugar/honey, and (xvi) miscellaneous.

To estimate the consumption of vitamin A, two elements were taken into account: foods of animal origin and foods of vegetable origin. For the latter group, foods were considered to be a source of vitamin A if they had >120 retinol equivalents/100 g of product. For the estimation of iron consumption, foods of animal origin were taken into account, such as meat products (haem iron), and foods of vegetable origin, such as green leafy vegetables (non-haem iron)[15].

***Household food insecurity according to access to food***

To determine the level of food insecurity in the population, an adaptation of the Latin American and Caribbean Scale of Food Security used in Colombia was applied. The survey consists of 14 specific questions that identify the household's main problems in terms of access to food, classifying households with food security or mild, moderate or severe insecurity[16,17].

***Statistical analyses***

Statistical analyses were performed using the Statistical Package for the Social Sciences v22 (SPSS Inc.; http://www.spss.com). The Shapiro–Wilk test was used to study the normal distribution of the data, and non-normally distributed data were natural log-transformed.

Descriptive statistics were used to summarise background characteristics of the study population, reporting mean and SD for continuous data and proportions for categorical variables. The $\chi^2$ test was applied to analyse the independence of qualitative variables, and ANOVA with Scheffe post-hoc test used to analyse the difference between nutritional status groups.

### *Ethics approval*

This study was approved by the Ethics Committee of the Universidad San Francisco de Quito (code 2016-109IN) and respects the fundamentals of the Declaration of Helsinki. Prior to the study, informed consent was obtained from the head of the household of the participating families and also from the children who participated voluntarily.

## Results

### *Characteristics of the population*

La Punta is surrounded by the Beche River, which is 32.4 km long and a micro-basin of the Cojimíes River. It has a dry, warm climate in summer (between June and November), and a warm, rainy season (between December and May), with an average annual rainfall of 1113 mm (Fig1). Due to its proximity to the sea and to the eradication of mangroves by shrimp farming and rising sea levels, all of the land where the community is found comprises a fragile ecosystem, which is not very fertile for agricultural production. In summer, the low levels of water in the basins and reservoirs make it hard for the population to access running water.

The community does not have a health centre for primary care and has only a basic general education school (lacking the final two baccalaureate years). Neither does it have basic services such as piped water, sewerage, waste collection and bathrooms with running water, so families have to bathe and wash their clothes in the river near the community, which is characterised by low water flows. Approximately 16% of the families urinated or defecated outside and the remaining families used latrines. For food preparation, 50% used water brought up from the river, 39% used bottled, 4% used tanker water and 7% used rainwater.

Families are numerous: more than 60% had 5–10 members, a percentage that had remained unchanged despite the earthquake. About 40% of households had 4–8 children under 10 years old, 54% had children under 5 years old, 61% hadchildren between 5 and 10 years, and 15% of households had adults over 65 years. The prevalence of pregnancies was low (6.8%). At the time of the survey, 59% of the families lived in the same homes as they had before the earthquake, despite having suffered damage, while 31% lived in makeshift homes next to the destroyed houses.

Table 1 shows the characteristics of the population under study (28 families). The data for the mothers or women responsible for the household and children under 5 years old are reported. In all cases, the woman was responsible for feeding the household.

**Table 1: Population characteristics according to the mothers' nutritional status**

| Characteristics<br>Mother | Normal weight (*n*=12) | Overweight (*n*=10) | Obese (*n*=6) | *p*-value (mothers, *n*=14) |
|---|---|---|---|---|
| Members per family | 6.42±2.27 (3–10) | 7.60±2.55 (4–13) | 9.50±3.73 (5–14) | 0.096 |
| Age (years) | 29.67±9.21[a] | 40.00±10.26[b] | 47.17± 10.36[b] | 0.004 |
| 15–24 | 20.00±2.00 | – | – | 0.009 |
| 25–59 | 35.00±7.00 | 40.00±10.00 | 41.00±4.00 | |
| ≥60 | – | – | 60.00±0.00 | |
| Weight (kg) | 54.03±6.78[a] | 63.02±5.65[b] | 77.43±4.31[c] | <0.001 |
| Height (m) | 1.52±0.07 | 1.53±0.06 | 1.49±0.05 | 0.431 |
| BMI (kg/m$^2$) | 23.20±1.38[a] | 26.99±1.24[b] | 35.10±2.19[c] | <0.001 |
| Waist circumference (cm) | 78.63±8.53[a] | 90.32±14.00[b] | 105.25±7.79 [c] | <0.001 |
| **Children aged <5 years (*n*=22)†** | | | | |
| Age (years) | 1.73±1.24 (0–4) | 2.5±0.71 (2–3) | 2.50±1.0 (1–3) | 0.682 |
| Sex (%) | | | | 0.868 |
| Female | 62.50 | 50.00 | 50.00 | |
| Male | 37.50 | 50.00 | 50.00 | |
| Weight (kg) | 10.16±4.42 | 13.08±2.79 | 14.08±2.44 | 0.207 |
| Height (m) | 0.78±0.15 | 0.89±0.08 | 0.91±0.15 | 0.277 |
| BMI (kg/m$^2$) | 15.64±2.63 | 16.55±0.68 | 17.38±3.51 | 0.514 |
| Head circumference (cm) (<2 years) | 40.96±4.52 | – | 46.00±0.00 | 0.336 |
| WAZ | –0.86±1.70 | –1.15±0.92 | –0.01±0.45 | 0.571 |
| L-HAZ | –1.35±1.52 | –2.60±0.83 | –1.32±1.83 | 0.555 |
| BMIZ | –0.03±1.58 | 0.82±0.45 | 1.07±2.05 | 0.438 |
| HCAZ | –0.71±1.12 | – | –0.08±0.00 | 0.623 |

† Analysis of qualitative variables by $\chi^2$ test, quantitative variables by ANOVA with the Scheffe posthoc test. Different superscript letters show significant differences between groups of nutritional status ($p$<0.05).
BMI, body mass index. BMIZ, body mass index to age. HCAZ, head circumference to age. L-HAZ, length or height to age. WAZ, weight to age.

The age range of mothers was identified as 18–60 years old (37±11.8 years), with an average height of 1.51±0.06 m and an average weight of 62.25±10.6 kg. More than half the mothers were overweight or obese (57.14%). All women over 60 years old were obese; the older the women were, the higher the prevalence of obesity ($p$=0.009).

On average, households had seven members per family; however, that average increased to nine members where the mother's BMI indicated obesity ($p$=0.096). In addition, it was observed that 79% ($n$=22) of the women were at cardiometabolic risk given their waist circumferences, and only 21% were not at risk and were of healthy weights.

Of the total of families that were part of the study, 14 mothers had children under 5 years old (22 children: 13 girls and 9 boys) with an average age of 2±1.18 years.

There was no difference between the weight and height of the children of obese mothers and those of overweight and normal-weight mothers. The BMI of children increased according to the nutritional status of the mother without there being a significant difference between groups.

There were no significant differences in the *Z*-score values for any of the parameters established in the children, considering the nutritional status of their mothers.

Data additional to the nutritional indicators of children showed malnutrition, especially in the girls, of whom 23% had a low weight (*n*=3), 46.1% presented problems of short stature and severe short stature (*n*=6) and 23% were emaciated or severely emaciated.

In the case of children under 3 years of age, 7.6% of the girls were at risk of microcephaly (*n*=1).

***Household food security and the mother's nutritional status***

Regarding food security measured using the food security scale, of the 27 households, 51.9% (14 households) presented mild food insecurity, 14.8% (four households) had moderate food insecurity and 33.3% (nine households) had severe food insecurity. No family had food security in their home.

Figure 2 shows the distribution of the nutritional status of the mothers and the food security of the household. When classifying the mothers according to their nutritional status, it was observed that of the overweight or obese women (*n*=16), six had severe, three had moderate and seven had mild food insecurity. Mild food insecurity predominated in the group of normal-weight women.

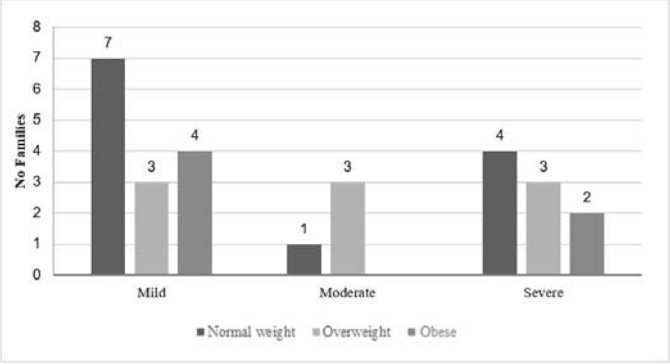


**Figure 2: Levels of food insecurity according to mother's nutritional status.**

***Dietary diversity***

The average score obtained by the HDSS of the families under study was 9.4. This tool indicates that scores of ≥6 food groups are related to high dietary diversity. It was found that 100% of the households consumed cereals, sweets, spices, condiments (salt and commercial condiments) and sugary drinks (fizzy drinks); followed by a 96% consumption of oils and fats; 93% of roots, white tubers and vegetables (green plantain bananas, onions, tomatoes and peppers) and 85.7% of meat (chicken, pork and beef). By contrast, consumptions of less than 70% were found for fruits (lemons, naranjillas and oranges) (68%); fish and seafood (white fish and shrimp) (64%); milk and dairy products (milk and cheese) (64%); eggs (57%); and legumes, nuts and seeds (lentils and beans) (18%), as shown in Figure 3. Most of the products were purchased; however, after the earthquake, food aid supplemented the delivery of basic foods such as rice, pasta, oats, lentils and oil. Some families had access to food by producing it themselves or by bartering for products such as tubers (green plantain bananas – considered as tubers here due to their high starch content), fruit (lemons, passion fruit and naranjillas), meat (chicken and pork) and eggs.

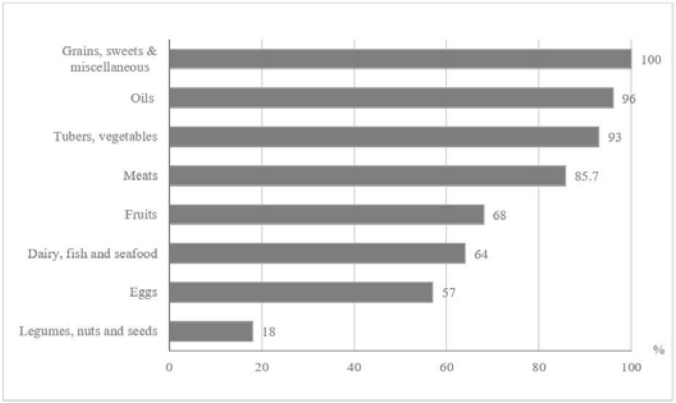


**Figure 3: Food groups consumed by the families.**

Upon quantifying the intake of vitamin A and iron according to the food consumed by households, it was found that 57% of the families consumed vitamin A of vegetable origin, which included dark green leafy vegetables and fruits, such as broccoli, lettuce, carrots, cauliflower, lemons, naranjillas, passion fruit, guinea bananas, papayas and pineapple. It was found that 78.5% of families consumed vitamin A of animal origin in offal, eggs, milk and dairy products. Similarly, it was observed that 96% of the families consumed haem iron through eating products such as offal, meat, fish and seafood.

***Undernutrition of children under 5 years according to the nutritional status of the mother***

Table 2 shows undernutrition classified as global undernutrition (weight/age) or chronic undernutrition (length or height/age) of the children according to the nutritional status of their mothers. Also, it shows 40.9% of children had chronic undernutrition, this being more prevalent in girls (31.8%) than in boys (9.1%). Of these, 13.6% of undernourished children were children of mothers who were overweight or obese.

Regarding global undernutrition, a prevalence of 13.6% is reported, in which for all cases of undernutrition, the girls had normal-weight mothers. Furthermore, all cases also presented chronic undernutrition.

**Table 2: Undernutrition according to mother's nutritional status**

| Type of undernutrition | Mother *n* (%) | | | Total (%) |
|---|---|---|---|---|
| | Normal weight | Overweight | Obese | |
| Global (WAZ) | 3 (13.6) | – | – | 3 (13.6) |
| Chronic (L-HAZ) | 9 (27.3) | 2 (9.1) | 1 (4.5) | 8 (40.9) |

L-HAZ, length or height to age; WAZ, weight to age.

**Discussion**

It is understood that households in rural areas are more susceptible to food insecurity due to the difficulty they have with respect to access to and availability of food, and this condition tends to increase after a natural disaster[18,19]. This study identified that the main obstacles to accessing nutritious food were the lack of economic resources households had for purchasing basic foods, which meant they did not have enough food for daily consumption. This affected the diet in each family in La Punta and resulted in no food security and 33.3% of households with severe food insecurity. Regarding the means used by households to acquire their food, it is evident that they accessed food mainly through purchasing with the rest being acquired through other mechanisms such as own production, food exchange, gifts or donations. These results suggest that the measures taken by the government after the earthquake, such as providing food during the emergency phase, only helped restore consumption in the short term, since rural households subsequently showed patterns of food consumption determined by their capacity to purchase.

These results are not comparable with those reported by Calero (2011), who determined that 8.7% of Ecuadorian households do not access enough food to meet minimum caloric requirements and almost three out of every 10 families have difficulties in paying their food expenses. However, it can be observed from these results that food insecurity increases by approximately 50% in the rural community when analysing the data reported for the province of Manabí (prevalence of 10.4–16.4%)[9]. To the best of the authors' knowledge, this is the first post-natural disaster study carried out in Ecuador where levels of food insecurity were evaluated from the perspective of food access in homes. The results obtained seem to indicate that this condition was accentuated after the earthquake but is also a consequence of the poverty and extreme poverty in which rural people live.

On the other hand, these results are similar to those found by Díaz et al, who analysed the food insecurity in 19 disadvantaged families in the rural area of Cajicá in Colombia after a strong winter. They found that 42% presented severe food insecurity. Overcrowding, increased fertility, larger household size and extensive household composition influenced rates of food insecurity[16]. Also, Vega-Macedo et al analysed the food insecurity and variety of food in 9070 households with children under 5 years

of age; they registered that 48% presented some type of food insecurity and of these 8.1% presented severe food insecurity. The results highlight that the level of food insecurity is higher in marginalised areas and it affects the nutritional status of children under 5 years of age[20].

In this research dietary diversity was also assessed through the HDDS (ie the type of food that households can access), where it was found that although households had a high food distribution, when the percentage of consumption by subgroups of foods was analysed, 100% of households consumed foods of low nutritional value such as refined cereals, sweets, spices, condiments, oils and sugary drinks, mainly soft drinks, and there was a low consumption of legumes, fruits, meats, eggs and dairy products. In addition, although 93% of households consumed vegetables, they were used only as condiments in preparations and not as individual portions to cover their nutritional needs. The fact that La Punta households had the most food groups (in agreement with the food safety scale used) is not a sufficient condition to guarantee the food security of its members, given the small variety of foods used in each group.

These results are in line with Hernández, who determined dietary diversity among 215 families from 43 communities of the eight municipalities of the department of Totonicapán in Guatemala, who lived in the rural area. It was observed that the most consumed food groups were cereals, sugars and fats. Moreover, the households' diets did not offer much diversity of food, but instead was a monotonous diet, in spite of the different types of preparation. Therefore, quality of the diet was also affected since all food groups were not used for the preparation of daily meals[21]. Similarly, Álvarez et al evaluated the variety and sufficiency of food available in 326 households in the rural and urban area of Acandí in Colombia. They confirmed that households in rural areas had less variety and availability of food than their urban counterparts[22].

Oroxon-Carbajal et al studied 146 families of the population of Colotenango in Guatemala, demonstrating that the families had a high food diversity but the consumption of corn and sugar predominated[23]. There was also a minimum consumption of fruits, influenced by the geographical area and food culture of each area even within the same country. In the present study, although households were expected to have a greater opportunity to produce their own food, collect wild vegetable products, go hunting and go fishing, this was not evident, so most food was purchased and of low nutritional value.

Both domestic food insecurity and inadequate dietary diversity affected the nutritional status of the family members, so 40.9% of children under 5 years had chronic malnutrition, surpassing the data reported for the province of Manabí by the National Health and Nutrition Survey (ENSANUT-ECU 2011–2013) where a prevalence of 21.0% was registered. It also exceeded the prevalence reported for the rural coast, which was 25.4%, which is comparative only with the prevalence reported for Quintile 1 (poorest) where 36.5% chronic malnutrition was found[24].

We must point out that in the present study presents some limitations in its execution, namely the small sample size. However, since it is a study that worked with vulnerable families, it considered a non-probabilistic sampling that justifies the descriptive results presented. Being a cross-sectional study, it was not possible to determine the direct association between the natural disaster and the consequences on household nutritional status and food security. However, although these relationships were not established, the results are in agreement with those found by Bauermann et al, who analysed the relationship of family food insecurity, nutritional status and morbidity in 4064 children under 5 years of age in Brazil[25]. It was found that the prevalence of coughs, fever, hospitalisation due to diarrhoea, and especially stunting were associated with food insecurity in the home. In addition, there was a significant relationship between morbidity and chronic malnutrition in children from households with severe food insecurity.

In this study, it was observed that in households with mild and moderate food insecurity, women in charge of feeding children had a normal nutritional status, and that the prevalence of chronic malnutrition was focused on the children of this group of women. These results are a warning about insufficient government intervention, since over time malnutrition problems in mothers could be triggered precisely by this limitation. So more cases of chronic malnutrition in children would be observed, as in countries such as Cambodia, where McDonald et al, analysing household food insecurity and dietary diversity associated with maternal and child undernutrition of 900 households in four rural districts of Prey Veng-Cambodia, identified that the risk of maternal weakness increased as the level of food insecurity increased[26]. In addition, women in households with moderate and severe food insecurity were 1.5–2.0 times more likely to be underweight than women in households with food security. However, family food security was not the only determinant of infant growth or wasting.

Conversely, in this study a marked group of overweight or obese women with a slight level of food insecurity was observed. That is, they had a greater capacity to buy food and this was also due to an increase in the number of household members. However, when analysing the type of food they consumed, it was evident that the purchasing capacity was oriented to cheap products of low nutritional value in order to be able to supply food to all members of the family. Meanwhile, it was generally observed that most of the overweight or obese women had levels of moderate or severe food insecurity. This showed that the low purchasing capacity they had is again mainly for cheap foods with little nutritional value, such as rice, sugar and oils, which impacted on their nutritional status. This increased the risk of obesity in adults while in their children it increased the risk of malnutrition. Thus it is evident that the nutritional status of family members depended to a large extent on the level of food security and the type or quality of food they consumed, the equity in distribution within the household and the number of family members.

**Conclusion**

The presence of food insecurity was evident in all households that lived in the rural community. This might have increased

significantly after the natural disaster, given the conditions of precariousness and poverty in which the population had always lived. Given the family burden, the distribution of food was focused on the purchase of foods with low nutritional value and high energy density such as refined grains (rice, flour and noodles), sweets, fats, oils and sugary drinks. In addition, the double nutritional burden identified revealed that in households headed by overweight and obese mothers, food insecurity was moderate and severe, which could have had a short-term impact on the nutritional status of their children, with a tendency to develop more problems of chronic and acute malnutrition.

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