

RESEARCH ARTICLE

Open Access



# Exploring mechanisms of food insecurity in indigenous agricultural communities in Guatemala: a mixed methods study

Meghan Farley Webb<sup>1</sup>, Anita N. Chary<sup>1,2</sup>, Thomas T. De Vries<sup>3</sup>, Samantha Davis<sup>1</sup>, Michael Dykstra<sup>4</sup>, David Flood<sup>1,5</sup>, Margaret Haley Rhodes<sup>6</sup> and Peter Rohloff<sup>1,3\*</sup> 

## Abstract

**Background:** The country of Guatemala has one of the highest rates of chronic child malnutrition in the world, which primarily affects the rural, indigenous Maya population. In this study we explore the apparent paradox of endemic food insecurity and child malnutrition coexisting in Maya communities alongside a predominance of agricultural land holdings and food production.

**Methods:** A mixed methods design explored food availability and access in a rural indigenous agricultural community, as compared to a nearby urban indigenous community. Structured surveys in both open-air markets and corner stores examined price, quality, and availability of foods. Structured household surveys examined land ownership, crop production, perceptions of food security, and the diversity of children's diets. Key informant interviews with local farmers clarified findings related to land holdings and farming patterns.

**Results:** Children's diets demonstrated a lack of diversity, and were especially deficient in dairy, flesh foods, eggs, and vitamin A-rich foods. Food insecurity was highly prevalent, with limited availability of, and access to, nutritionally diverse foods. In particular, the expansion of nontraditional agricultural exports (NTAEs) reduced food availability by displacing subsistence crops. Poor returns on investment for NTAEs limited the available cash for food purchasing, further exacerbating poor diets. Food availability was further reduced by infrequent access to open-air markets in the rural setting as compared to the urban setting, with high risk of food spoilage. As a result much food purchasing was of low-cost, low-quality processed food which, unlike higher-quality fresh foods, were equally affordable and available in both the rural and the urban environment.

**Conclusions:** The proliferation of NTAEs and commoditized foods reduce dietary diversity and displace the production and consumption of fresh, nutritious foods, even in rural communities devoted primarily to food production. Rural agricultural communities in Guatemala therefore bear many resemblances to the urban "food deserts" of higher-income countries.

**Keywords:** Food security, Nontraditional agricultural exports, Food deserts, Guatemala, Maya, Junk food

**Abbreviations:** FANTA, Food and nutrition technical assistance; NGO, Non-governmental Organization; NTAE, Nontraditional agricultural export; WHO, World Health Organization

\* Correspondence: [prohloff@partners.org](mailto:prohloff@partners.org); [peter@wuqukawoq.org](mailto:peter@wuqukawoq.org)

<sup>1</sup>Wuqu' Kawoq | Maya Health Alliance 2 Calle 5-43, Zona 1, Santiago Sacatepéquez, Guatemala

<sup>3</sup>Brigham and Women's Hospital, 75 Francis Street, Boston, MA 02115, USA

Full list of author information is available at the end of the article

## Background

Food security, defined as “when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life,” [1] is mediated by four key variables. These are food availability (consistent, adequate quantity of food); food accessibility (both physical and economic access to food); food utilization (appropriate use-based knowledge regarding nutrition, water, and sanitation); and stability along these preceding three dimensions over time [1, 2]. Globally, nearly 800 million people worldwide suffer from undernutrition as a result of food insecurity [1, 3]. Much of the existing literature emphasizes the macro-structural causes of food insecurity, such as the health of regional agricultural systems, unemployment and poverty alleviation mechanisms, marginalization of distinct ethnic or other social groups, and the impact of changes in food prices [1, 4]. At the same time, within a given region or population, the impacts of food insecurity are quite heterogeneous, often conditioned by a given family’s or community’s social, cultural, or economic capital. For example, in diverse settings, factors such as household size, maternal age or educational status, and status of civil or marriage unions all have a profound impact on food security [5–10].

Situated within the theoretical perspective of community-based development, our work is invested in exploring and understanding these latter phenomena, i.e., the factors that foster family or community-level resilience, even within larger regional structures with high levels of food insecurity. We conduct this work in Guatemala, a Central American country of approximately 15 million persons, with one of the proportionally largest indigenous populations (45 % indigenous) in the world. Guatemala also has one of the highest rates of chronic child malnutrition in the world [11]. These nutritional outcomes disproportionately affect the indigenous population, which often suffers from rates of malnutrition twice those of the nonindigenous population [12].

Recently, several reports have described the devastating effects of rising food prices on diet quality and micronutrient consumption in rural indigenous Guatemalan communities [13–15]. In our own recent work, we have shown how these effects extend even to communities with high rates of local land ownership and food production [16]. At the same time, this endemic food insecurity coexists with a rapid increase in the country-wide availability and market penetration of highly-processed or pre-packaged snack foods [17, 18]. In a recent study we conducted in an indigenous Maya farming village, Xejuyu,<sup>1</sup> less than 3 % of children under five years of age met World Health Organization standards for dietary diversity and meal frequency [15, 16],

subjective perceptions of food insecurity were common, and the majority of households regularly consumed processed and pre-packaged snack foods. This was despite the fact that a majority of the population owned agricultural land and dedicated significant efforts to food production.

This paper reports on a follow-up study in this same community, designed to elucidate, in greater detail, the factors that contribute to this apparent paradox of high rates of land ownership and food production coupled with a high prevalence of child undernutrition, food insecurity, and increasing processed snack food consumption. From within a food security paradigm, our and others’ previous work in rural Guatemala has primarily examined one food security dimension, that of utilization, documenting deficiencies in local nutrition or sanitation knowledge and practice [12, 15, 16]. Here, we extend our food security analysis by systematically investigating two additional dimensions, food availability and food access. We hypothesized that Xejuyu’s geographic isolation would result in high levels of food insecurity due to lower availability and higher prices of diverse, nutritious foods. We further anticipated reduced availability in both open-air markets and corner stores when compared to the nearest large city, Tecpán.

## Methods

### Overall study site description

Xejuyu’ is a rural, agricultural Kaqchikel Maya-speaking (henceforth Kaqchikel) community in the central highlands of Guatemala. Forty-five percent of the 230 families in Xejuyu’ have an income of less than \$2 USD/day, and nearly 60 % of children under 5 years of age suffer from chronic malnutrition [16, 19]. The nearest large town is Tecpán, located approximately 1 h away by public bus transport. As it is the municipal center of the region, inhabitants of Xejuyu’ periodically travel to Tecpán to buy or sell goods. In collaboration with a local primary health care nonprofit organization, Wuqu’ Kawoq | Maya Health Alliance, the authors of this paper have been working for several years to explore local drivers of malnutrition and mechanisms underlying food insecurity [16]. This study, which was approved by the institutional review boards of Wuqu’ Kawoq and of Partners Healthcare (Boston, MA), was designed to investigate food availability, land utilization, and food production patterns in an agricultural community that, despite agricultural activity, faces significant food insecurity and high levels of malnutrition. Data were collected in the rural settlement of Xejuyu’ as well as Tecpán over a seven-month period (June through December 2014) using the tools described below. A replication data set, as well as copies of all the survey instruments used in the study and described below in

more detail are available at the associated data repository: doi:10.7910/DVN/YEH8PF.

### Corner store surveys

To assess the availability, quality, price, and diversity of food items for sale in Xejuyu', we designed a structured inventory survey of local corner stores. Other than periodic open-air markets, these small owner-operated stores are the primary source for food purchases in rural towns throughout Guatemala. They vary in both size and formality, ranging from small wooden stalls with irregular schedules and only a few items available for purchase to well-stocked one-room stores with regular operating hours. The structured survey was inspired by other instruments in the published literature that are used to measure nutritional environments, especially the Nutrition Environment Measures Survey in Stores [20–22]. In designing the final survey, we constructed an initial food item list in consultation with nutrition staff members from the partner non-governmental organization (NGO). Essential missing food items from this initial list were identified by review of World Health Organization (WHO) food group classifications (to ensure that inventory items included items typically underrepresented in the diets of rural indigenous children, such as animal proteins and vitamin A-rich foods) and by reviewing a standardized food frequency questionnaire for Guatemala developed by the Institute for Nutrition of Central America and Panama [23]. One round of iterative testing in a convenience sample of 5 stores was used to refine the structured survey. The final survey queried a total of 124 food items for availability, price, and quality.

In Xejuyu', trained research assistants carried out the structured survey with all corner stores in the community ( $n = 20$ ). For comparison, the survey was conducted with a random sample of corner stores in the closest municipality, Tecpán ( $n = 53$ ). Shopping patterns we have observed in prior ethnographic work showed that stores around the Tecpán's central square and bus stops were the most likely to be frequented by residents of Xejuyu' when in the city. Therefore, every third store within a three-block radius of the central square was surveyed.

### Open-air markets

Periodic open-air markets are the other major venue used by Guatemalans to purchase foods. Unlike corner stores, open-air markets are primarily a source of fresh fruits and vegetables, with less availability of processed and packaged foods. In Xejuyu', the open-air market occurs regularly once a week, whereas in the municipality of Tecpán it occurs 2 times a week. Again, in consultation with nutrition staff, WHO food group classifications, and a Guatemala-specific standardized food

frequency questionnaire [23], we developed a 48-item market survey to assess the availability of commonly-consumed foods in the open-air market. The survey was carried out once by a trained research assistant in both Xejuyu' and Tecpán's weekly open-air markets.<sup>2</sup> The research assistant, a middle-aged indigenous woman from the region, was instructed to "go shopping" as she normally would in each market using the 48-item survey as a guide and marking down all items which were available. Importantly, this method did not provide a rigorous enumeration of all produce items for sale—a feat that would be impossible given the immensity of Tecpán's market, which features thousands of vendors and covers more than 19 square blocks [24]. We also chose not to investigate pricing in open-air markets, given that such pricing relies on highly variable price negotiation between buyer and seller for each transaction. However, the method used did provide a "snap-shot" of availability in a typical naturalistic shopping transaction.

### Household surveys

Household surveys collecting socioeconomic and demographic information were conducted with a systematic sample of households in Xejuyu'. Researchers surveyed every third household in each street row with a child aged 6–36 months, resulting in a random sample of 68 households. Surveys were translated into both Spanish and Kaqchikel, allowing for their completion in the preferred language of the respondent. Back translations and one round of pilot testing ensured accurate translations. Those individuals who preferred Kaqchikel had their surveys administered through an interpreter.

The survey was administered to female primary caregivers with the participation of male heads of household in each home when available. Each household survey consisted of 90 items focusing on demographics, land ownership, crop production, animal ownership, household expenses, and decisions-making for food purchases. The survey included the Food and Nutrition Technical Assistance's (FANTA) Household Food Insecurity Access Scale, a validated tool for assessing household food security [25]. It also included a 7-day dietary recall (78 items) derived from a previously validated Guatemala-specific food frequency questionnaire [23], which we have previously used to assess dietary diversity in this region of Guatemala [16]. Specific supplementary questions were administered to male heads of household (on a second visit, if necessary, if the male was not present when the index survey was conducted) to ensure accurate reporting of their demographic data as well as to elicit data about land inheritance and debt, since our pilot data showed that these were questions female participants often did not know the answers to.

### Longitudinal household expenditures survey

When conducting demographic surveys, female heads of households were also asked to participate in a weekly survey of food expenditures. Researchers then contacted these households by telephone once per week over a six-week period. Each week they were asked, “How much money did you spend on food last week?” and the amount was recorded. Overall 33 participants (of 68 surveyed in the demographic survey) provided data over this period of 6 weeks and were included in this analysis. To control for variability in household spending as a function of household size and composition, demographic data collected during the household survey was used to calculate an adjusted household size based on basal caloric requirements, using the Institute of Medicine equations for energy expenditure and an adult male as a base of 1 person-unit [26].

### Key informant interviews

Upon completion of the community-wide household surveys, five key informant interviews were completed with local farmers already known to study members. These short, ethnographic interviews focused on land ownership, crop cultivation, and the selling of NTAEs. These interviews were conducted to clarify several areas of ambiguity around the selling of agricultural products and the inheritance of land that we identified in the initial round of survey data analysis.

### Data analysis

Quantitative data collected via the corner store, market, expenditures, and household surveys were coded and entered into spreadsheets by members of the research team and independently checked for accuracy by other members of the team. Data was subsequently imported into Stata 14 (College Station, TX), which was used to calculate descriptive statistics and tests of significance (Student’s *t*-test; Chi square). For key informant interviews, researchers reviewed transcripts together and inductively assigned codes to participant responses to each question. Codes predominantly addressed themes of decision-making for land inherited by female heads of households, the use of “coyotes” (middlemen) in the selling and distribution of NTAEs, debt burden related to NTAE cultivation, and perceived motivations and profitability of NTAE cultivation. Codes were organized into a matrix to facilitate comparison of participant responses. A complete list of codes used is presented in Additional file 1: Table S1, and the matrix is available in the study data repository.

## Results

### Demographic findings and food purchasing behaviors from household survey

Key demographic findings from the household survey are presented in Table 1. In all households surveyed, the participating female primary caregiver was also the biological mother of the home’s youngest children. In most cases (77 %), the male head-of-household was the spouse or partner; however, in other households, the primary caregiver’s father (18 %), father-in-law (4 %), or brother (2 %) was the head-of-household. As demonstrated in Table 1, the majority of female primary caregivers were employed as homemakers, with a minority (7 %) also engaging in small-scale economic activities outside the home. The majority of male heads-of-households (58 %) were self-employed as agriculturalists, while others engaged in day labor (usually also in agriculture), construction, or as vendors. The primary language of most respondents was either Kaqchikel or K’iche’ Maya, although most could also speak Spanish.

Surveyed households reported purchasing foods at all locations identified above under the Methods, including both open-air markets and corner stores in Xejuyu’ itself, as well as occasional trips to the nearest large town, Tecpán. Virtually all (94 %) of households frequented Xejuyu’s open-air market on a nearly weekly basis ( $3.38 \pm 1.0$  times/month). In addition, most (82 %) also purchased regularly in Xejuyu’s corner stores, on average  $3.41 \pm 2.02$  times per

**Table 1** Demographic data from household survey

Variable		Women ( <i>n</i> = 68)	Men ( <i>n</i> = 56)
Civil Status (%)	Married	71	
	Cohabiting	15	
	Single	13	
	Widowed	1	
Age, yrs. (mean ± SD)		27.74 ± 7.25	35.61 ± 11.57
Occupation (%)	Homemaker	93	
	Vendor	7	3
	Farmer		58
	Day Laborer		30
	Construction		3
Completed Primary School (%)		68	73
Preferred Language (%)	Kaqchikel	85	78
	K’iche’	11	14
	Spanish	3	8
Speaks Spanish (%)		57	71
Children Living in the Home (mean ± SD)	3.26 ± 2.53		
Total Household Size (mean ± SD)	7.23 ± 3.26		



week. On the other hand, only 50 % of household reported making trips to Tecpán to purchase food, either in Tecpán's much larger open-air market or in one of its numerous stores. Among those who did purchase food in Tecpán, purchasing trips were also less frequent, on average  $2.03 \pm 1.34$  times/month. Key informant interviews described the high cost of public bus transportation (\$2.59 USD/round trip) as well as time constraints (2–3 h round trip) as the main factors making shopping more regularly in Tecpán impractical.

### Household food insecurity and dietary indicators of young children

Female respondents in each home were asked to rate their experiences of food insecurity using the FANTA scale. Based on these responses, 100 % of surveyed households experienced food insecurity, with 49 % reporting moderate levels of food insecurity, and 51 % reporting severe levels of food insecurity.

Results from the seven-day dietary recalls (Table 2) revealed very high frequencies of consumption of cereal and sweets, and very low frequencies of legumes, dairy, flesh foods, and egg consumption. Although overall frequencies of fruit and vegetable consumption were high, consumption of the most important vitamin A-rich fruits and vegetables was much more modest. The seven-day dietary recall revealed that children consumed on average 2.08 servings of flesh foods, 3.12 serving of legumes, and 3.35 servings of eggs.

### Food availability

The remainder of the Results section explores the dynamics leading to high rates of food insecurity and child malnutrition in Xejuyu' through a detailed examination of study findings as they relate to two important dimensions, namely food availability and food access. Several factors impact food availability—i.e., the consistent presence of adequately nutritious and diverse foods—in Xejuyu' as detailed here.

**Table 2** Seven-day food recalls

Food Group	Servings/Week (mean $\pm$ SD)
Cereals & Tubers	32.12 $\pm$ 10.67
Legumes & Nuts	3.12 $\pm$ 2.47
Dairy Products	1.04 $\pm$ 1.34
Flesh Foods	2.08 $\pm$ 1.65
Eggs	3.35 $\pm$ 2.70
Vitamin A -Rich Foods	7.31 $\pm$ 9.55
Other Fruits and Vegetables	17.53 $\pm$ 9.55
Fats	5.78 $\pm$ 4.73
Sweets	14.96 $\pm$ 7.15

### Land ownership and cropping patterns

A majority of households (57 %) in Xejuyu' reported owning land and growing crops. Key informant interviews revealed that most (4/5) viewed growing crops as an important source of food for household consumption. At the same time, the average land holdings reported by survey informants was only  $2.27 \pm 3.63$  cuerdas (1 cuerda is approximately 1,118 m<sup>2</sup>). Using prior estimates that 10.5 cuerdas are required in order to maintain a subsistence agricultural lifestyle for an average-sized family [27], 4.4 % of households in our sample (3/68) had sufficient land holdings to maintain a subsistence agricultural lifestyle. To counter this lack of sufficient land, key informants explained that many households in Xejuyu' attempted to adapt by renting additional fields from other landholders. In our household survey, 60 % reported renting additional agricultural land in addition to their own holdings.

Although it was common for key informants to mention the importance of growing food for domestic consumption, only 10 % of household survey respondents with land holdings reported devoting most of their agricultural efforts to growing food for domestic consumption. To the contrary, most reported cultivating a wider range of other crops for both domestic consumption (primarily *milpa*, intercropped beans and corn) and export (coffee and NTAEs, of which the most common were green beans, snow peas, broccoli, and blackberries) (Table 3). The pattern also held true for cropping patterns on rented land, with a significant proportion of this land devoted to export agriculture. On the whole, only 36 % of owned land and 53 % of rented land was devoted to subsistence production (*milpa*, Table 3). Surveys of Xejuyu's open-air market showed that several of the most commonly grown NTAEs in Xejuyu' were not available for purchase by local inhabitants in either the open-air market or at corner stores in Xejuyu'. Finally, domestic food production was rarely supplemented by household gardens. Only nine percent of households report having any form of household garden, and none considered it a significant source of food.

**Table 3** Crops grown on land parcels in Xejuyu'

	Owned Land	Rented Land
Milpa (%)	36	53
Coffee (%)	18	3
NTAEs (%)	37	41
Green Beans (%)	13	23
Peas (%)	10	12
Broccoli (%)	7	6
Blackberries (%)	7	0

### Animal husbandry

Animal husbandry can provide households a means of supplementing both food sources and income. As such, animal ownership is widespread. For example, 63 % of households owned chickens (average of 7–8 chickens per home). Chicken ownership improved food availability by providing an important source of animal proteins; 100 % of households surveyed reported consuming both eggs and chickens on a regular basis. Chicken ownership also provided some households with extra income, as 16 % sold surplus eggs and 44 % sold surplus chickens. Ownership of other animals did not represent an important source of food in Xejuyu', although it did provide extra income. For example, 62 % of households owned pigs and 18 % owned cows, and the majority of these (as well as cow milk) were sold for extra income and rarely consumed in the home.

### Markets and corner stores

Household food production was supplemented by purchases made in weekly open-air market and at corner stores. The availability of foods in open-air markets in Tecpán and Xejuyu' was not markedly different (Table 4). A wide variety of different foods from most WHO food group classifications [28] were available in both locations, with only dairy products not being available in Xejuyu's market. Although Tecpán's much larger market afforded increased diversity of options, especially in the Fruits and Vegetables category, 11 different options were also available in this category in Xejuyu' (Table 4). Given the bartering nature of market exchanges, we were unable to reliably assess for pricing differences between the two markets.

In key informant interviews we further explored perceptions of food availability in open-air markets in Xejuyu'. Although diverse foods were available in Xejuyu's market, informants reminded us that this market was only held once a week, unlike Tecpán's larger two-times-a-week market, and that these foods were typically not available in corner stores or other venues on non-market days. Furthermore, a lack of refrigeration in most households in Xejuyu' meant that perishable items

**Table 4** Single day food availability surveys in open-air markets

Food Group	Xejuyu' (number of items)	Tecpán (number of items)
Cereals & Tubers	6	8
Legumes & Nuts	2	3
Dairy Products	0	1
Flesh Foods	2	2
Eggs	1	1
Vitamin A -Rich Foods	8	9
Other Fruits and Vegetables	11	16

like meats, fruits, and vegetables were more likely to be consumed only on, and immediately following, the market day. Informants remarked, and we also observed when conducting our surveys, that fruits and vegetables were more likely to be close to spoiling in the Xejuyu' market than in the Tecpán market. Informants explained that vendors often would travel to Xejuyu' to sell off food remainders from Tecpán or other regional markets.

Given that Xejuyu's open-air market was only one day per week, food availability in corner stores is an important determinant of diets in Xejuyu. In the household survey, respondents reported making purchases at these stores on average 3–4 times/week. Corner store survey data shows that corner stores in Xejuyu' had low rates of availability of several key food categories, including dairy, vitamin A-rich foods, flesh foods, and other fruits and vegetables. In two cases—dairy and flesh foods—the lower availability in Xejuyu' when compared to stores in Tecpán reached statistical significance. In comparison, junk food categories, such as sweets, chips, and sugared beverages, were universally available (Table 5).

What's more, food category analysis of corner store inventories overestimated the actual quality and diversity of available foods. For example, only two of 20 stores in Xejuyu' sold vitamin A-rich foods and only two products—carrots and red bell peppers—were available. The only dairy item available in any store in Xejuyu' was powdered milk. With the exception of one store that sold chicken, the only available flesh foods item was hot dogs. Nuts and legumes were widely carried by corner stores in Xejuyu'; however only 4 stores stocked dried legumes or other similar unprocessed options. Seventy-nine percent of available legumes and nut products were small tins of processed refried black beans or packets of candied peanuts. The products that comprised the category "Other Fruits and Vegetables" in Xejuyu' included bananas (5 stores), tomatoes (4 stores), limes (1 store),

**Table 5** Items sold in corner stores, by WHO food groups

Food Group	Xejuyu' (n = 20) Tecpán (n = 53)		P-value ( $\chi^2$ )
	Stores Selling, % (n)	Stores Selling, % (n)	
Dairy	35 (7)	72 (38)	0.004
Grains	95 (19)	94 (50)	0.912
Vitamin A-Rich Foods	10 (2)	8 (4)	0.734
Nuts & Legumes	95 (19)	100 (53)	0.814
Flesh Foods	30 (6)	60 (32)	0.021
Eggs	90 (18)	92 (49)	0.734
Other Fruits & Vegetables	45 (9)	32 (17)	0.304
Sweets	100 (20)	100 (53)	NA
Chips	100 (20)	100 (53)	NA
Sugared Beverages	95 (19)	100 (53)	0.101

and onions (1 store). Importantly, in the local diet, tomatoes, limes, and onions are used exclusively as condiments and food garnishes, and therefore do not represent major dietary contributions.

Furthermore, corner store surveys assessed quality of fruits and vegetables for sale. Paralleling the results obtained from key informant interviews, fruits and vegetables available for purchase in corner stores in Tecpán largely received an “A” quality rating (“pristine, of highest quality”). On the hand, fruits and vegetables for sale in Xejuyu’ tended to be of lower quality, receiving an average rating of “B” (“discolored and/or bruised”).

The paucity of diverse food options in corner stores is well summarized in Table 6, which gives the average number of available items in surveyed stores for both Xejuyu’ and Tecpán. This table underscores the fact that, for many key food categories, the number of available product options was one or less. On the other hand, there was significant diversity of processed food options—especially chips, sugared beverages, and sweets. For example, on average, corner stores in Xejuyu’ stocked 33 different varieties of chips. There was no statistically significant variation on product diversity for processed and junk food items between Xejuyu’ and Tecpán, indicating that, despite its geographic isolation, Xejuyu’ has equal junk food availability.

### Food access

Food availability alone is not sufficient to guarantee food security or high-quality, diverse diets. Adequate food access—i.e., having sufficient resources to procure diverse foods—is also critically important. In particular, households’ economic resources are a key factor limiting access, even in communities where healthy food options exist. As we detail in this section, limited economic resources; high variability in income and expenditures; the low cost of processed foods; and the proliferation of

NTAEs in Xejuyu’ reduce access to nutritionally diverse food options.

### Weekly food expenditures

In Xejuyu’, high rates of poverty limit the accessibility of nutritionally diverse and healthy food options. When conducting our food insecurity assessment during the household survey, 86 % of men and 59 % of women reported lack of resources as limiting the diversity of their diets. The most commonly-cited factor limiting food availability was limited money to spend on food. On average, households participating in the longitudinal expenditures survey spent  $151.46 \pm 79.51$  Q ( $\$19.59 \pm 10.25$  USD) per week on food, which translates to 19.85Q ( $\$2.56$  USD) per person per week spent on food, based on household sizes we obtained during the household survey (Table 7).

Gross household size underestimates food spending, since indigenous families in Guatemala tend to have many young children with lower caloric needs. Using an adjusted household size, the amount of money spent for the equivalent of the caloric needs of an adult male per week increased to an average of 37.16Q ( $\$4.89$  USD) per person per week. Longitudinal surveys of week-to-week food expenditures revealed significant variation in income and, consequently, money available for food purchasing. Indeed, while all households experienced some level of income variation, 24 % of all households who participated in this survey experienced week-to-week fluctuations in income that exceeded 100 %. Key informants described how fluctuations in income, especially those who worked as day laborers or in other forms of temporary work, were a significant source of food insecurity. Among household surveys, roughly half of respondents reported significant stress from outstanding debts and 13 % of these debts were loans taken out to purchase food for household consumption.

### Food costs

In our study design, we hypothesized that the geographic isolation of Xejuyu’ would result in higher food prices when compared to the urban center of Tecpán, which would contribute to food insecurity. However, corner store surveys revealed very little price variation between

**Table 6** Mean number of available products in corner stores, by category

Item	Xejuyu <sup>a</sup>	Tecpán <sup>a</sup>	P-value <sup>b</sup>
Powdered Milk	0.50 ± 0.76	1 ± 0.89	0.02
Hot Cereal Mix	1.65 ± 1.23	2.89 ± 1.53	0.001
Fruits	0.30 ± 0.57	0.57 ± 1.13	0.32
Vegetables	0.65 ± 1.27	0.45 ± 1.12	0.41
Flesh Foods	0.35 ± 0.59	0.62 ± 0.53	0.06
Instant Soups	2.8 ± 1.44	4.64 ± 2.09	0.17
Chips	33.2 ± 20.67	36.94 ± 19.31	0.47
Cookies	5.65 ± 3	6.98 ± 2.65	0.39
Sweets	10.35 ± 12.48	14.17 ± 9.36	0.16

<sup>a</sup>Mean ± SD

<sup>b</sup>Student’s t-test

**Table 7** Weekly food expenditures

Gross Household Size (mean ± SD)	7.23 ± 3.26
Dollars/Person, based on gross household size (mean ± SD)	2.80 ± 1.67
Adjusted Household Size (mean ± SD)	4.53 ± 2.05
Dollars/Person, based on adjusted household size (mean ± SD)	4.89 ± 3.23
Households Experiencing ≥ 100 % Weekly Income Fluctuation (%)	24

processed products sold in Tecpán and Xejuyu'. Of 124 individual processed food products identified on store inventories, 57 were present in multiple stores, permitting price comparisons. Only 10 of the 57 items exhibited a price differential that was statistically significant (see Additional file 1: Table S2).

#### **Nontraditional agricultural exports**

NTAEs also influenced food accessibility in Xejuyu'. All (5/5) key informant interviews described dissatisfaction with low returns on NTAEs: "broccoli and green beans don't provide much. You always lose money and it is pointless to cultivate them." Another man reported abandoning his efforts to grow NTAEs, "It's pointless to grow these crops because you don't get a good price [for them]." The increasing cost of agricultural inputs, especially fertilizer, has further decreased the profitability of growing NTAEs: "Also, the price of the final product hasn't gone up like the expenses of the farmer." Despite such dissatisfaction, informants described how farmers in Xejuyu' continue to grow NTAEs in the hopes of increased returns and the ability to achieve "something more" for their families [29]. One informant described the false hope that many in Xejuyu' hold: "the majority have the hope that they will get ahead, but that is not the situation I see." One factor that limited financial returns on NTAEs was poor entry into the formal export market. Farmers in Xejuyu' reaped very poor returns on NTAEs in part because the majority (86 %) sell their crops to middlemen rather than directly to exporters, as reported in the household survey. All key informant interviews (5/5) described this pattern of selling to middlemen, some from Xejuyu' and others from neighboring cities.

#### **Discussion**

In this paper, we use mixed methods to investigate the mechanisms underlying food insecurity, especially the availability and accessibility of diverse, nutritious foods in one rural, indigenous agricultural community in Guatemala. This work is an ongoing part of our investigation into the paradox of high rates of chronic child malnutrition and poor dietary diversity in communities that devote a large amount of time and effort to the cultivation of food crops [16]. Our findings are of broad significance for policy and food security interventions both in other indigenous communities throughout Guatemala and in other global settings where similar changes in agricultural practices and food-ways are at work.

Like many other rural indigenous communities in Guatemala, our household-level assessments of Xejuyu' demonstrated high levels of perceived food insecurity, despite land holdings and significant agricultural production (Table 1). Young children's diets included large quantities of cereals and tubers and of sweetened, processed foods.

These diets were especially deficient in dairy, flesh foods, eggs, and vitamin A-rich foods (Table 2).

Our study identified several probable mechanisms underlying this lack of dietary diversity. First, average weekly expenditures on food are low. Our results show the average amount of money spent for the equivalent of the caloric needs of an adult male per week was 37.16Q (\$4.89 USD) per person per week. For comparison, a recent systematic analysis of the dietary needs of indigenous women and children in the Guatemalan highlands estimated that the lowest cost of a minimally adequate diet that met caloric and micronutrient needs would cost \$5.18 USD/week for a child aged 12–23 months and \$17.22 USD/week for a lactating or pregnant female [15]. In other words, in our sample, the available food spending for the adjusted equivalent of a grown adult male was less than the suggested minimum requirements for a toddler.

Second, it became apparent from structured surveys about agricultural practices and land holdings that household landholdings are small and unlikely to be able to sustain meaningful domestic consumption, as previous work has also suggested [27, 30, 31]. Furthermore, while research from other contexts has demonstrated the importance of household gardens as a supplementary source for improved dietary diversity, especially when land holdings or other sources of food decline [32, 33], home gardens were not a significant source of food for households in our sample.

Additionally, our research confirms a large-scale shift towards NTAEs that has further limited the availability of diverse foods for local consumption [29]. The investment in NTAE production is a source of significant debt and financial risk for households. Previous research on this phenomenon has underscored how early adopters of NTAEs in Guatemala saw significant profits, triggering a mass conversion among most small landholders away from subsistence agriculture and towards NTAE production [34]. However, more recent longitudinal analyses have shown that few, if any, later converts to NTAE production have experienced any significant improvement in welfare or return on investment [34]. As such, as our results underscore, NTAE production in the region has simultaneously reduced both local food availability and, because of its inherent long-term risks and poor payouts, households' access to cash for purchasing other foods on the open market. As one clear example from our data, only 10 % of agricultural household reported food production primarily for their own consumption, while average food purchasing expenditures for an adult male did not reach even the minimum requirements for sustaining an adequate toddler's diet [16].

In our study design, we had initially hypothesized that Xejuyu's geographic isolation would further exacerbate



food insecurity by leading to lower availability and higher prices of diverse, nutritious foods. Our hypothesis was partly confirmed. Although food availability was similar in open-air markets in the rural Xejuyu' and the nearby urban Tecpán (Table 4), foods were limited in Xejuyu' practically, given the fact that the open-air market was only once a week and served as a site for regional vendors to offload foods that were near-spoiling and had not been sold earlier in the week in other markets. Foods purchased in open-air markets in Xejuyu' must be consumed quickly, and cannot sustain a diverse diet throughout the week. Limited economic resources meant that most households could not make regular trips to supplement their diets with purchases in urban Tecpán on non-market days.

Consequently, throughout the rest of the week, the majority of residents of Xejuyu' depend on corner stores for their food purchases. Corner stores overwhelmingly stock non-perishable snack foods, such as candy and chips, with a diverse range of products and labels (Tables 5 and 6). Furthermore, the availability of dairy, flesh foods, eggs, and vitamin A-rich foods was low in these stores, mirroring the observed deficiencies in children's diets (Table 2). Thus, our hypothesis about decreased dietary diversity as a function of store food inventories in rural Xejuyu' as compared to urban Tecpán was partly confirmed, as dairy and flesh foods were both less available (Table 5). Fresh fruits and vegetables were largely unavailable in corner stores and, when available, were of lower quality than their counterparts in Tecpán.

Interestingly, we did not find many significant differences in either the pricing or variety of processed food commodities between corner stores in Xejuyu' and Tecpán (Table 6, Additional file 1: Table S2). This price parity resulted in a situation whereby processed foods remain highly available and affordable, even while fresher, more nutritious foods were more expensive or unavailable. These findings are consistent with other literature showing the rapid incursion of processed foods marketing in urban, non-indigenous Guatemalan populations [17, 18]. They are also consistent with the global scholarly literature, which has repeatedly demonstrated that the commoditization of diets decreases dietary diversity in both rural and urban settings [35, 36]. Our study is the first to examine these processes systematically in a rural, indigenous Guatemalan context.

Based on the totality of our findings in this study, we propose that the dynamics of food insecurity in indigenous agricultural communities in Guatemala is best comprehended by an analogy to the scholarly literature on urban food deserts. Food deserts are particular contexts characterized by "relatively poor access to healthy and affordable food" [37]. While the term "food desert" has been more commonly associated with urban food

environments and disparities in higher-income countries [37, 38], agricultural communities from high- as well as low and middle-income countries also face limited availability of, and access to, nutritionally diverse foods [39, 40]. Indeed, some research in lower-income countries has documented precisely what our own research here shows: that expansion of cash crops results in the erosion of local food-ways and decreased dietary diversity [40]. In Xejuyu' and other rural towns like it in Guatemala, the expansion of NTAEs has played a major role in desertifying the local food ecology. Diversion of land usage for NTAEs reduces the availability of diverse foods for household consumption. High debts loads and low returns on investments for NTAE production mean simultaneously reduced amounts of cash for purchasing supplementary foods on the market. The end result is a diet that is increasingly restricted in diversity and heavily dependent on processed food commodities, which contributes to very high, endemic rates of food insecurity and chronic child malnutrition.

Our study presents several limitations. First, our sampling of open-air markets understates the difference in produce availability in open-air markets. An exhaustive sample of the Tecpán market would certainly reveal a greater diversity of fruits and vegetables, especially those in the "other fruits and vegetables" category, given the immensity of Tecpán's open-air market. Additionally, the study was conducted during Guatemala's rainy season in a region of the country with low seasonal variation in food availability. Multiple rounds of market surveys may have revealed potential subtle seasonal variation in food availability or pricing. Similarly, our findings are not generalizable to other parts of the country with longer dry seasons and higher seasonal variations in food availability. Finally, although providing a general description of food availability, land ownership, and food production in a representative sample of households from one rural community, this study is not able to make specific, causal inferences at the household level. Further research which we are conducting examines various demographic, land ownership, and food production variables to determine if they predict child malnutrition or household-level food insecurity scores and will address this issue.

## Conclusions

Our study explores the apparent paradox of the coexistence of agricultural production and lifestyles with endemic food insecurity and child malnutrition in rural, indigenous Guatemala. We show that the expansion of NTAEs has worsened conditions of food insecurity in Xejuyu'. Displacement of local food production in favor of export crop production and reduced availability of high-quality fresh food due to geographic isolation produce a situation in which nutritious food availability is limited. This is coupled

with the rapid expansion of the availability of low-cost processed food commodities. High debt loads and poor cash flows, which limit economic access to foods, encourage the consumption of cheap and ubiquitous junk and processed food alternatives. These findings suggest potential programming and policy solutions to improve child nutrition and household food insecurity in rural Guatemala and other global contexts undergoing similar changes in food-ways. First, community-based discussions about the possibility of conversion of lands used for NTAEs back to subsistence crops must be initiated [41]. Similarly, the implementation of small-plot household gardens could improve dietary diversity and serve as bridge to more large-scale transitions in cropping practices [32, 33]. Finally, exploration of strategies to improve the availability of fresh foods in local corner stores with packaging and pricing that makes them competitive to processed foods is essential to improving dietary quality [17, 18].

## Endnotes

<sup>1</sup>Xejuyu' is a pseudonym.

<sup>2</sup>As a larger city and municipal seat, Tecpán has two markets a week. Thursday's market, the larger of the two was surveyed.

## Additional file

**Additional file 1: Table S1.** Qualitative coding scheme for key informant interviews. **Table S2.** Price comparison of food items in corner stores. (DOCX 19 kb)

## Acknowledgments

The authors wish to thank Anne E. Kraemer-Diaz, Nicole Illic, Ixchel Rodriguez, Juan Ajsivinac, Mildred Cristal Marroquin, and the communities of Tecpán and Xejuyu'.

## Funding

None.

## Availability of data and materials

The dataset supporting the conclusions of this article is included within the article (and its Additional file 1: Tables S1 and S2) or is available in the Dataverse repository at doi:10.7910/DVN/YEH8PF.

## Authors' contributions

MFW designed the study, coded and reviewed qualitative and quantitative data, analyzed qualitative and quantitative data, and drafted the manuscript. ANC designed the study, coded qualitative data, analyzed qualitative data, and revised the manuscript. TD analyzed quantitative data and revised the manuscript. SD collected and coded quantitative data. MD collected and coded quantitative data. DF collected qualitative data. MHR collected and coded quantitative data. PR designed the study, analyzed quantitative data, and revised the manuscript. All authors approved the final version of the manuscript.

## Competing interests

The authors declare that they have no competing interests.

## Consent for publication

Not Applicable.

## Ethics approval and consent to participate

All study protocols and consenting procedures were approved through Wuqu' Kawoq | Maya Health Alliance's Institutional Review Board (WK-2014-001) and Partners Healthcare (2014P000872). Community participation was approved by the government of Xejuyu'. Verbal informed consent was provided by all research participants, and was obtained by trained research staff bilingual in Spanish and Kaqchikel Maya. Both reviewing IRBs approved a verbal consent procedure and consent script, given that the study posed minimal risk to participants; that the only record linking subjects to research data would have been a consent document; and that the principal risk from the study was the potential harm from breach of confidentiality.

## Author details

<sup>1</sup>Wuqu' Kawoq | Maya Health Alliance 2 Calle 5-43, Zona 1, Santiago Sacatepéquez, Guatemala. <sup>2</sup>Department of Anthropology and School of Medicine, Washington University in St. Louis, 660 S. Euclid Ave, St. Louis, MO 63110, USA. <sup>3</sup>Brigham and Women's Hospital, 75 Francis Street, Boston, MA 02115, USA. <sup>4</sup>Harvard Medical School, 25 Shattuck Street, Boston, MA 02115, USA. <sup>5</sup>Department of Medicine, University of Minnesota, 420 Delaware Street S.E. MMC 913, Minneapolis, MN 55455, USA. <sup>6</sup>Davidson College, Center for Interdisciplinary Studies, 209 Ridge Road, Davidson, NC 28035, USA.

Received: 12 April 2016 Accepted: 11 August 2016

Published online: 23 August 2016

## References

1. FAO, IFAD, and WFP. The state of food insecurity in the world. Meeting the 2015 international hunger targets: Taking stock of uneven progress. Rome: Food and Agriculture Organization; 2015.
2. World Health Organization. Trade and Health. In: Trade, foreign policy, diplomacy and health. 2015. [http://www.who.int/trade/trade\\_and\\_health/en/](http://www.who.int/trade/trade_and_health/en/). Accessed 15 Dec 2015.
3. Food and Agriculture Organization of the United Nations (FAO). Food security. Policy Brief. 2006;2:1–4.
4. Martínez B, Palma A, Atalah E, Pinheiro AC. Food and nutrition insecurity in Latin American and the Caribbean. Santiago: United Nations; 2009.
5. Feleke S, Kilmer R, Gladwin C. Determinants of food security in southern Ethiopia at the household level. *Agric Econ*. 2005;31:351–63.
6. Hackett M, Melgar-Quinóez H, Taylor C, Alvarez Uribe MC. Factors associated with household food security of participants of the Mana food supplement program in Colombia. *Arch Latinoam Nutr*. 2010;60:42–7.
7. Hanson K, Sobal J, Frongillo E. Gender and marital status clarify associations between food insecurity and body weight. *J Nutr*. 2007;137:1460–5.
8. Ben-Davis ME, Kinlaw A, del Campo Estrada Y, Bentley ME, Siega-Riz AM. Risk factors associated with the presence and severity of food insecurity in rural Honduras. *Public Health Nutr*. 2014;17:5–13.
9. Regassa N, Stoecker B. Household food insecurity and hunger among households in Sidama district, southern Ethiopia. *Public Health Nutr*. 2012; 15:1276–83.
10. Chowdhury M, Khan M, Islam M, Perera N, Shumack M, Kader M. Low maternal education and socioeconomic status were associated with household food insecurity in children under five with diarrhoea in Bangladesh. *Acta Paediatrica*. 2016; doi:10.1111/apa.13325
11. Black RE, Victora CG, Walker SP, Bhutta ZA, Christian P, de Onis M, et al. Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet*. 2013;382:427–51.
12. Ministerio de Salud Pública y Asistencia Social (MSPAS), Instituto Nacional de Estadística (INE), Secretaría de Planificación y Programación de la Presidencia. Encuesta nacional de salud materno infantil 2014–2015: Informe de indicadores básicos. Guatemala City: Ministerio de Salud Pública y Asistencia Social (MSPAS); 2015.
13. Iannotti L, Robles M, Pachón H, Chiarella C. Food prices and poverty negatively affect micronutrient intakes in Guatemala. *J Nutr*. 2012;142:1568–76.
14. Chaparro C. Household food insecurity and nutritional status of women of reproductive age and children under five years of age in five departments of the western highlands of Guatemala: An analysis of data from the national maternal-infant health survey 2008–09 of Guatemala. Washington, DC: FHI 360/FANTA II Bridge; 2012.
15. Food and Nutritional Assistance III Project (FANTA). Summary report: Development of evidence-based dietary recommendations for children,

- pregnant women, and lactating women living in the western highlands in Guatemala. Washington DC: FHI360/FANTA; 2013.
16. Brown K, Henretty N, Chary A, Webb MF, Wehr H, Moore J, et al. Mixed-methods study identifies key strategies for improving infant and young child feeding practices in a highly stunted rural indigenous population in Guatemala. *Maternal and Child Nutrition*. 2014; doi:10.1111/mcn.12141
  17. Chacon V, Letona P, Barnoya J. Child-oriented marketing techniques in snack food packages in Guatemala. *BMC Public Health*. 2013;13:967–73.
  18. Letona P, Chacon V, Roberto C, Barnoya J. A qualitative study of children's snack food packaging perceptions and preferences. *BMC Public Health*. 2014;14:1274–80.
  19. Rohloff P, Calí F, Calí JF. Xejuyu: Demographic survey. Guatemala: WUQU' Kawoq; 2011.
  20. Glanz K, Sallis J, Saelens B, Frank L. Nutrition environment measures survey in stores (NEMS-S): Development and evaluation. *Am J Prev Med*. 2007;32:282–9.
  21. Jilcott Pitts S, Bringolf K, Lawton K, McGuirt J, Wall-Bassett E, Morgan J, et al. Formative evaluation for a health corner store initiative in Pitt County, North Carolina: Assessing the rural food environment, part 1. *Prev Chronic Dis*. 2013;10:120318.
  22. Laska M, Borradaile K, Tester J, Foster G, Gittelsohn J. Health food availability in small urban food stores: A comparison of four US cities. *Public Health Nutr*. 2010;13:1031–5.
  23. Rodriguez MM, Mendez H, Torun B, Schroeder D, Stein AD. Validation of a semi-quantitative food-frequency questionnaire for use among adults in Guatemala. *Public Health Nutr*. 2002;5:691–9.
  24. Fischer EF, Hendrickson C. Tecpán, Guatemala: Global connections and Mayan struggles in postwar Guatemala. Boulder: Westview; 2003.
  25. Coates J, Swindale A, Bilinsky P. Household food insecurity access scale (HFIAS) for measurement of household food access: Indicator guide (v. 3). Washington, DC: FHI 360/FANTA; 2007.
  26. Institute of Medicine. Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein and amino acids. Washington, DC: National Academy Press; 2005.
  27. Lovell WG. A beauty that hurts: Life and death in Guatemala. Austin: University of Texas Press; 2010.
  28. World Health Organization. Indicators for assessing infant and young child feeding practices: Conclusions of a consensus meeting held 6–8 November 2007 in Washington, DC, USA. Geneva: WHO; 2008.
  29. Fischer EF, Benson P. Broccoli and desire: Global connections and Mayan struggles in postwar Guatemala. Stanford: Stanford University Press; 2006.
  30. Webb MF. Yojkanäj wawe' (we remain here): Kaqchikel migrants' wives under surveillance. Lawrence: University of Kansas; 2015.
  31. Davis TE, Fischer EF, Rohloff PJ, Heimbürger DC. Chronic malnutrition, breastfeeding, and ready to use supplementary food in a Guatemalan Maya town. *Hum Organ*. 2014;73:72–81.
  32. Cabalda A, Rayco-Solon P, Solon J, Solon F. Home gardening is associated with Filipino preschool children's dietary diversity. *J Am Diet Assoc*. 2011;111:711–5.
  33. Masset E, Haddad L, Cornelius A. Effectiveness of agricultural interventions that aim to improve nutritional status of children: Systematic review. *BMJ*. 2012;344:d8222.
  34. Carletto C, Kilic T, Kirk A. Non-traditional crops, traditional constraints: Long-term welfare impacts of export crop adoption among Guatemalan smallholders. Washington, DC: The World Bank; 2009.
  35. Cannuscio C, Tappe K, Buttenheim A, Karpyn A, Glanz K. Urban food environments and residents' shopping behaviors. *Am J Prev Med*. 2013;45:606–14.
  36. Dewey K. Nutrition and the commoditization of food systems in Latin America and the Caribbean. *Soc Sci Med*. 1989;28:415–24.
  37. Beaulac J, Kristjansson E, Cummins S. A systematic review of food deserts, 1966–2007. *Prev Chronic Dis*. 2007;6:1–10.
  38. Walker R, Kean C, Burke J. Disparities and access to healthy food in the United States: A review of food deserts literature. *Health and Place*. 2010;15:876–84.
  39. Morton L, Bitto E, Oakland M, Sand M. Solving the problems of low food deserts: Food insecurity and civic structure. *Rural Sociol*. 2005;70:94–112.
  40. Shack K, Grivetti L, Dewey K. Cash cropping, subsistence agriculture, and nutritional status among mothers and children in lowland Papua New Guinea. *Soc Sci Med*. 1990;31:61–8.
  41. Aliber M, Hart T. Should subsistence agriculture be supported as a strategy to address rural food insecurity. *Agrekon*. 2009;48:434–58.

Submit your next manuscript to BioMed Central and we will help you at every step:

- We accept pre-submission inquiries
- Our selector tool helps you to find the most relevant journal
- We provide round the clock customer support
- Convenient online submission
- Thorough peer review
- Inclusion in PubMed and all major indexing services
- Maximum visibility for your research

Submit your manuscript at  
[www.biomedcentral.com/submit](http://www.biomedcentral.com/submit)

