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WITHIN-YEAR CHANGES IN HOUSEHOLDS' ACCESS TO FOOD IN A UNIMODAL CLIMATE RURAL AREA OF BENIN REPUBLIC

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ABSTRACT

Food insecurity is a concern in Benin not only because of seasonal variations in food availability but also the limited access to food experienced by some households. This study analysed the effect of seasonality on household access to food in a rural area of Benin characterised by a unimodal climate. One hundred and seventy volunteer households were recruited in the study area and monitored during the increased, intermediate and decreased (or lean) food availability periods (FAPs) from September 2018 to July 2019. Socio-demographic data were collected during individual interviews with household heads and used to describe the sample. Data on households' access to food were collected on a bimonthly basis using a food consumption score (FCS) questionnaire. Food consumption scores were used to divide the households into three food consumption groups (FCGs): poor (FCS ≤ 21), borderline (21.5 ≤ FCS ≤ 35) and acceptable (FCS > 35). Generalized estimate equation (GEE) was used to compare FCGs among the repeated measures. The principal occupation of household heads was agriculture (72.9%) and the mean household size was 6.8±3.6 persons. The FCS ranged from 59.7±15.5 to 69.4±15.9. The lowest FCS was recorded in September (intermediate FAP) whereas the highest was obtained in May (lean FAP). All the households (100%) had acceptable food consumption during the increased FAP (November to January). The proportion of households with acceptable food consumption was 91% in September and decreased from 99% in March to 90% in July, that is, during the lean FAP. On the other hand, the proportion of households with borderline and poor food consumption was 9% in September and increased from 1% in March to 10% in July. The proportions of FCGs obtained in November, January, March and May significantly differed from that of July ($p<0.05$) whereas there was no significant difference between September and July. Households had frequent (5 to 7 days/week) and regular (all months) intakes of starchy staples, vegetables, meats and fish. In contrast, the frequency of pulses and fruits consumption varied between months. In conclusion, the lean FAP (May to July) and the following intermediate FAP (September) are characterised by a deterioration in households' access to food. The variation of pulses and fruits consumption throughout the year is the result of food insecurity and constitutes a major risk factor for micronutrient malnutrition for household members.

Keys words: Households, access to food, food consumption score, longitudinal studies, unimodal climate, Benin Republic

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INTRODUCTION

Over the past five years, the hunger rate in the world has increased. It was estimated that there would be an annual increase of about 60 million food insecure people in the world, reaching 811 million people in 2020 [1]. The regions most affected are sub-Saharan Africa and South Asia [1]. The Food and Agriculture Organization of the United Nations (FAO) uses hunger as an important indicator to analyse food insecurity [1]. An individual or household is food insecure if the entity is unable to acquire and consume nutritionally adequate, safe and preferred food to guarantee wellbeing through socially acceptable means and in a sustainable manner [2]. In sub-Saharan Africa, households are often unable to consistently access sufficient nutritious food although agriculture is their main activity [3, 4]. During the harvesting season, crops are built up into food stocks to supposedly be used throughout the year [4]. However, the stocks often only cover household food needs for a few months of the year (post-harvest) while in the pre-harvest season, food availability decreases for most of the households in rural areas [5,6]. Market prices increase during pre-harvest seasons due to this scarcity, further limiting access to food for many households relying on the market to cover at least parts of their needs and pushing households into a period of food scarcity known as the "hunger period" or “lean period" [7]. Generally, the lean period coincides with the rainy season, when diseases, particularly diarrhoea, strike hardest [5, 8]. Households are often forced to sell already restricted food stocks to pay for hospitalization of members, further exacerbating their food shortage [8, 9].

This study contributes to a better understanding of the effects of seasonality on food security to improve intervention strategies for stable and sustainable access to food in developing countries. It benefited from the support of the AMSANA programme (Appui-multisectoriels à la sécurité alimentaire et nutritionnelle dans l’Atacora) [10]. The programme was implemented from 2015 to 2020 by five Non-governmental Organizations, namely Belgian Croix rouge, Enabel, Iles de paix, Louvain Coopération and Protos. The objective of the program was to improve food security in the department of Atacora in northwest Benin where the AMSANA programme is active, and which has the highest food insecurity rate (24%) in the country [11]. The few studies assessing food security patterns in the area are more than a decade old and did not analyse within-year changes in households’ access to food [12-14]. Furthermore, the seasons, as defined nowadays, have been progressively influenced by the effects of climate change [15]. Altered temperature and rainfall patterns impact crop yields, water availability, pests and diseases, and livestock health. In 2009, the World Food Program (WFP) estimated a decline in global cereal production (rice, wheat and maize) of 1 to 7% by 2060 [15], and

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climate change is projected to be responsible for putting 10-20% more people in the world at risk of hunger by 2050 [15,16]. In Benin, the dry season is projected to expand by one to two months, and to cause crop losses of between 3 and 18% by 2100 [17, 18].

MATERIALS AND METHODS

Study design

This longitudinal study was carried out between September 2018, start of the harvest period (hence, increased food availability), and July 2019, end of the lean or decreased FAP. Participating households were recruited from among beneficiaries of the AMSANA programme on a voluntary basis [11]. Socio-demographic data were collected during the first interviews in September 2018 and were used to describe the study sample. Data on households' access to food were collected on a bimonthly basis using an FCS questionnaire in order to analyse the level of food access (poor, borderline or acceptable) and the frequency with which foods from the various food groups were consumed. All data were collected by trained field assistants.

Study area

The study was carried out in four communities (Boukombé, Cobly, Matéri and Tanguiéta) located in Atacora department in north-western Benin (Figure 1). The communities are located between 10°0' and 11°50' North latitude and between 0°10' and 1°83' East longitude [19] and cover an area of 9,252 km^2. The total estimated population of the area is 338,686 inhabitants [19]. The study area is characterised by one rainy season (May to October) and one dry season (November to April; Table 1). Agriculture is the main economic activity of the population (70.4%). Two categories of crops are produced by the households: food crops and cash crops. The main food crops are cereals (corn, sorghum, millet and rice), roots and tubers (cassava, yam, sweet potato, Irish potato and taro), pulses (beans, cowpeas and soybeans) and oilseeds (peanuts, citrullus, and baobab seeds), while cotton is the main cash crop [20].

The month of May marks the start of the agricultural year when seeding and planting starts. Harvesting starts in October and continues until January, depending on the crop. While harvesting allows households to build up their food stocks between October and January, March to September is considered the lean or decreased FAP when households experience increasing rates of food insecurity characterised by tensions in food availability and market price increases. October to February is, theoretically, an increased FAP (Table 1) [20].

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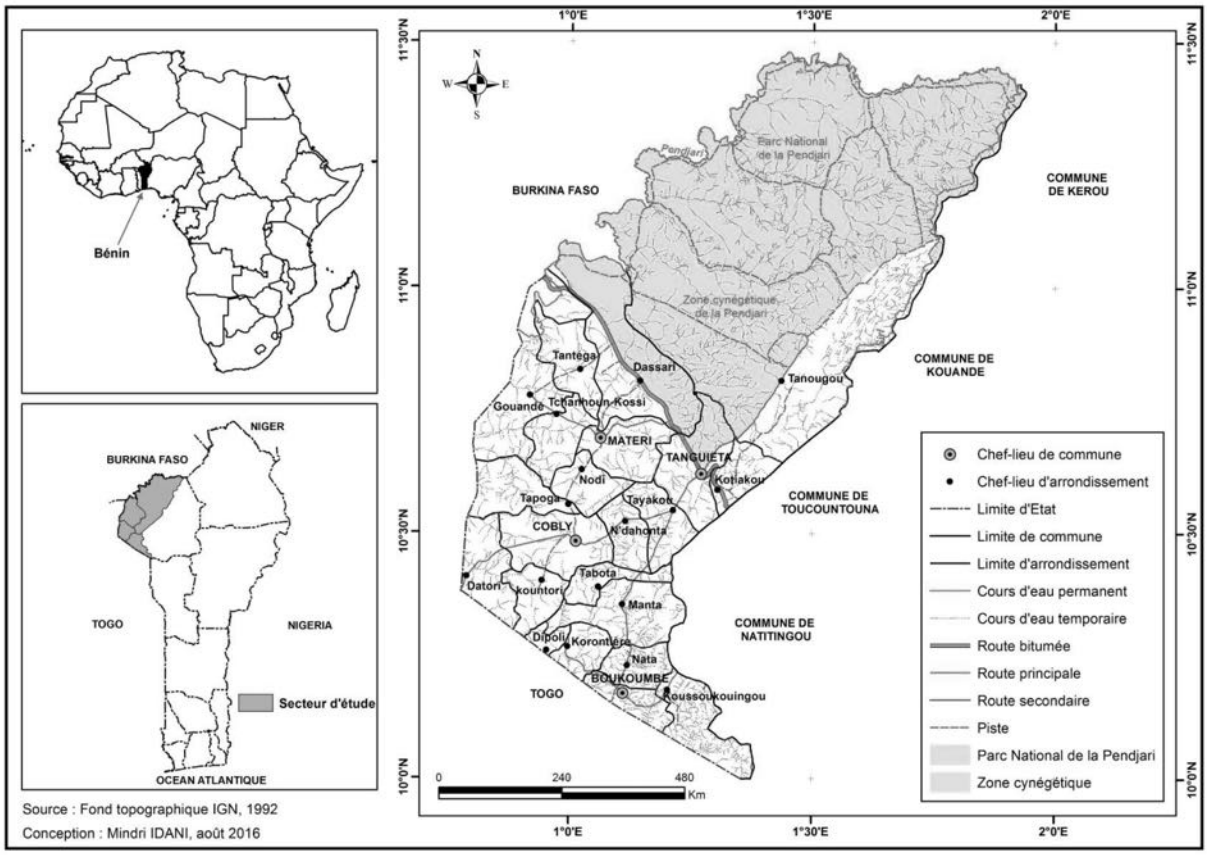

Figure 1: Location of the study area [17]

Sampling

The sample size for this study was calculated using the formula proposed by Magnani [21] for longitudinal studies: $n = D[(Z\alpha+Z\beta)^2*(P1(1-P1) + P2(1 - P2)) / (P2 - P1)^2]$, where D = 1 is the sample design effect and is equal to 1, $Z\alpha = 1.96$ is the Z-score corresponding to the degree of confidence concluding that an observed change in size (P2 - P1) did not occur by chance only (95% statistical significance level), $Z\beta = 0.84$ is the Z-score corresponding to the degree of confidence for correctly detecting a change in size (P2 - P1; 80% statistical power), P1 = is the proportion of households with inadequate consumption (borderline and poor) during the lean period in July 2017 and is equal to 33.7% [20], and P2 = is the proportion of households with inadequate consumption expected during the increased FAP and is equal to 20%. A minimum sample size of 160 was calculated. Adding a non-response rate of 5% finally led to a sample size of 170 households. On the basis of convenience sampling, 170 volunteer households were finally identified among the beneficiaries of the AMSANA programme. A total of 5,199 households were enrolled for the implementation of the AMSANA programme starting July 2018. From the database of beneficiaries, 170 volunteer

households were selected using four inclusion criteria, namely: (i) consenting to the study, (ii) being available during the entire survey period, (iii) living within the communities during the whole survey period and (iv) agreeing to provide the required information during the entire process. The recruitment of participating households lasted four weeks (1st to 30th July 2018). Each household head was informed about the purpose, activities and duration of the study. Before data collection, informed consent was obtained from all household heads.

Data collection

Two categories of data were collected: socio-demographic data and data on households' access to food. Socio-demographic data were collected at baseline (September 2018) through individual face-to-face interviews with the household heads using a standardized questionnaire. Data included the gender, principal occupation, marital status and age of household head, and household size.
Data on households' access to food were collected on a bimonthly basis from September 2018 to July 2019 using an FCS questionnaire developed by WFP [22]. Food consumption score is a composite score ranging from 0 to 112 and used as a proxy indicator for food accessibility. It is based on dietary diversity, frequency of consumption and the relative nutritional importance of the different food groups consumed. During each interview, the respondents (the woman or any other person in charge of food preparation) were asked about their household's frequency of consumption of several food items in number of days over the past week. Food items were then grouped into eight recommended groups: starchy staples, pulses, vegetables, fruits, meat and fish, milk, sugar and oil [22]. FSC is thus a weighted sum of weekly consumption frequencies of these eight food groups and is calculated in two steps: (i) multiplication of the value obtained for each food group by its weight and creation of new weighted food group scores; and (ii) summing-up of the food group scores to obtain household-specific FCS. The FCS was used to define three FCGs (poor, borderline and acceptable). WFP has established FCS≤21.0 as the cut-off to indicate poor food consumption, FCS=21.5 to 35.0 to indicate borderline food consumption and FCS>35.0 to indicate acceptable food consumption [22, 23]. The FCS is calculated to reflect both the diversity and frequency of household food consumption. A high FCS indicates that the household frequently consumes foods from various food groups and generally has good access to food [23].

Data analysis and statistics

Frequencies were calculated for socio-demographic characteristics of the households in order to describe the study sample. Mean FCS, median numbers of days each food group was consumed and frequencies were used to analyse data

on households' food access. To account for data structure (panel data), mean FCS and median numbers of days each food group was consumed were compared over time using the model of Poisson with loglinear distribution in GEE [24]. The model was adjusted for the gender, principal occupation, marital status and age of household head, and household size. All analyses were performed using SPSS, version 20 and differences between data were considered significant if $P < 0.05$.

RESULTS AND DISCUSSION

Socio-demographic characteristics of households

Of the 170 households completing the baseline interview of this study, 95.9% were men-headed. The principal occupation of household heads was agriculture (72.9%) and, in terms of marital status, 78.2% were monogamously married. The household heads' mean±standard deviation (SD) age was 36.5±10.7 years and mean±SD household size was 6.8±3.6 people (Table 2).

Throughout the data collection period, some households were repeatedly missed leading to an unstable sample size. Still, comparison of the socio-demographic characteristics between households included in all data collection rounds and households missing some rounds of data collection showed no significant difference ($p > 0.05$; Table 2). Also, the characteristics of the sample described above are similar to the characteristics of the population in the study area, except for the marital status of the head of households, which is 95.9% headed by men, compared to 78.1% household headed by men in the study area [19].

Households' access to food during the year

After adjustment of FCS for the gender, principal occupation, marital status and age of the household head as well as household size, FCS between 59.7±15.5 and 69.4±15.9 were calculated for the individual survey months (September 2018, November 2018, January 2019, March 2019, May 2019 and July 2019; Table 3). The lowest FCS was recorded in September (intermediate FAP) whereas the highest was obtained in May (lean FAP). All bimonthly FCS significantly differed from FCS during September (reference month, where the lowest FCS was found, $p<0.05$; Table 3).

When categorising each household at each survey moment based on standard FCS cut-offs into the three FCGs (poor, borderline or acceptable), most of the households (90-100%) had acceptable food consumption during all the months (Figure 2). The highest proportion (100%) of households with acceptable food consumption were observed in November and January (increased FAP), while the

lowest proportion (90%) of households with acceptable food consumption were reported in July (lean FAP; Figure 2). In March, May, July and September, 1%, 4%, 9% and 8% of the households had borderline food consumption, respectively. No households had borderline food consumption in November to January. Only in July and September, about 1% of households had poor food consumption while there was no poor food consumption during the other months. While FCGs do not significantly differ between September and July ($p>0.05$), they are significantly different from September and July in the other months when a survey was conducted ($p<0.05$). Between November, January, March and May, FCGs do not differ significantly ($p>0.05$; Figure 2). The FCG patterns in this study are similar to previous studies in the area and show annual changes in the food pattern [12-14]. However, the results are different with respect to the effect of seasonality on food security. FCSs are designed to capture both diet diversity at the household level and energy sufficiency [23]. While Mitchikpè *et al.* [14] and Van Liere [13] found no significant changes in energy intake over the year, Ategbo [12] revealed that energy intake in intermediate FAP (March to April) is significantly lower than intakes in increased FAP (November to January) and decreased FAP (July). With respect to the food security rate, the results of this study differ from previous studies. This study found a maximum of 10% of households to be food insecure, compared to 24% observed by WFP in lean FAP in 2017 in the study area [11]. Differences could be due to the beneficial effects of the AMSANA programme [10]. However, further analysis of the effect of seasonality on nutritional intakes at the individual level is needed to better understand the effect of seasonality on household food security in the study area.

In the study area, the pre-harvest period refers to the intermediate and lean FAPs after cultivation season, from March to September [11]. The pre-harvest period is characterized by low food availability in the households, low incomes and increases in farming expenditures occasioned by farm activities, especially for households which are not seriously involved in non-farm income generating activities. The post-harvest period refers to increased FAP after harvest. It is usually characterized by increased household food availability, selling of farm produce and consequently, improved income earnings, and low farm activities [4, 11, 25]. As in this study, other studies in sub-Saharan Africa found higher proportions of households with borderline food consumption in the pre-harvest period compared to the post-harvest period [7, 26]. Edeh and Gyimah-Brempong [7] as well as Jeronim *et al* [26] hypothesised that the increase in the proportion of households with borderline food consumption in the pre-harvest period is due to the fact that many households sell their crops immediately after the harvest period at low prices, depleting their food stocks. They are then forced to rely on higher-

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priced market purchases in the lean period as they do not have enough to subsist on all the year round [7, 26]. In this study, monitoring of food stocks and prices was not taken into account. However, a future study on the evolution of food stocks and prices could give further insight into the situation and lead to the development of appropriate coping strategies to deal with food insecurity in Benin. Another possible explanation for the variation in household food consumption during the year is farmwork. Households are busy with farmwork during the period from May to October, when they carry out most of the planting and harvesting activities. The intensity of work affects women's availability to prepare the food in the household even when it is available in the household. Several studies have found strong links between food insecurity, food scarcity and women's occupation in farms during the planting period [9, 27].

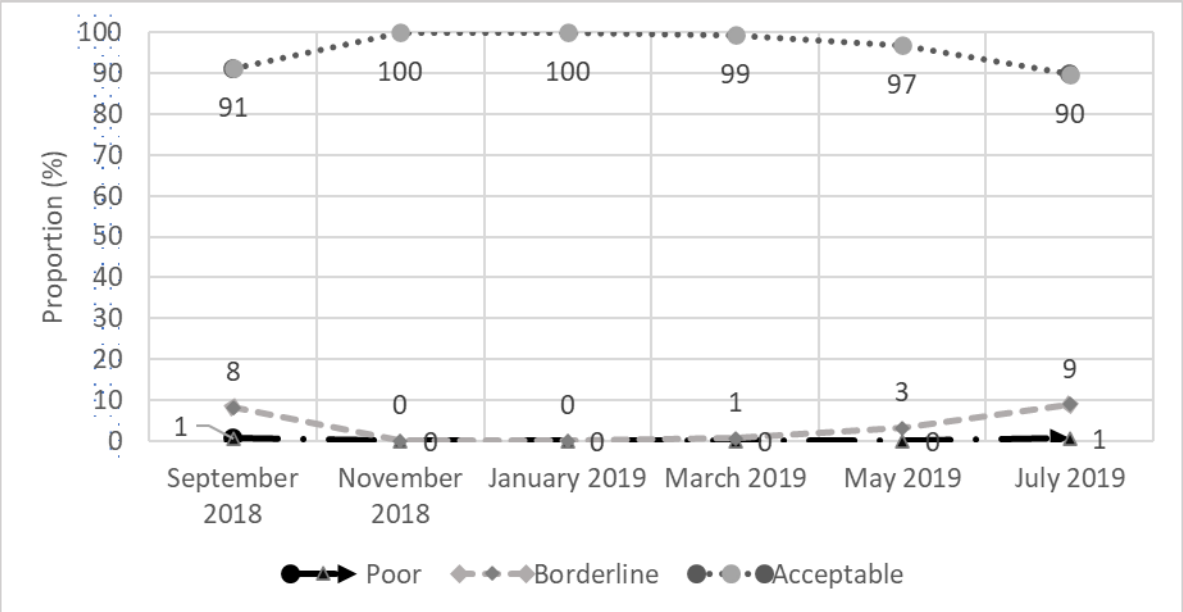

Figure 2: Proportions of households who had acceptable, borderline or poor food consumption during the year

Households' food group consumption during the year

The analysis of food groups consumed during the year shows that households had a frequent (5 to 7 days/week) and regular (all months) intake of starchy staples, vegetables, meat and fish. In contrast, pulses, fruits, milk and dairy products were not as frequently consumed (less than 3 days/week; Figure 3). Except for meat and fish, the consumption frequencies of the food groups differed significantly between the collection months ($p<0.05$; Figure 4). In the months of July and September, when the highest proportions borderline food consumption were recorded, the median frequency of fruit consumption was 1 day/week compared to

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2 days/week in November, January and May, and 7 days/week in March (Figure 3). Other studies described a similar pattern of food consumption in households in West Africa [28, 29]. Typical family dishes in the study area consisted of a solid mash or porridge prepared with cereal flour (maize, sorghum and millet), tuber pods (yam) or roots (cassava) accompanied by a vegetable-based sauce. In the study area, the vegetable-based sauce is generally not very nutritious (nutrient-dense), consisting of vegetables (notably fresh or dried okra and Hibiscus flowers in the post-harvest season and leafy vegetables in pre-harvest season), oil, "afitin/soumbala" and salt, sometimes supplemented with groundnut paste, fish or pieces of meat depending on the household's economic opportunities. In addition to main dishes, households often snack on fruits (mango, shea and cowpea pulp) in March and May when these foods are harvested [29].

The low frequency of consumption of nutrient-dense food groups (pulses, fruits and dairy products) is a risk factor for malnutrition and micronutrient deficiency in children and adults and could explain the high rate of malnutrition in the study area. Anaemia prevalence is 85% among children aged 6 to 59 months and 67.4% among women in the Atacora department [30].

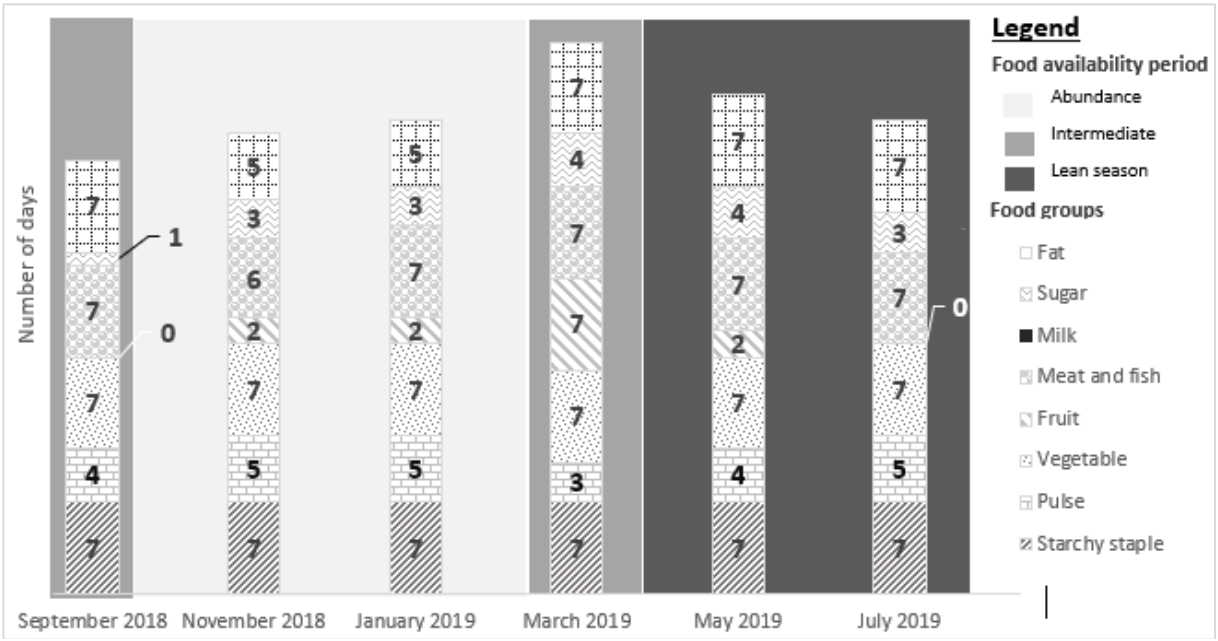

Figure 3: Frequency of food consumption by households during the year

This study had some limitations. As convenience sampling was used to recruit participants benefitting from the AMSANA programme, results were not representative of the entire population of the study area and external validity of the results was limited. Having benefited from an intervention in the frame of the

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AMSANA programme could have altered the participants' dietary habits. Still, socio-demographic and food access characteristics are comparable between the study population and the general population in the Atacora department.

CONCLUSION

The results of this study show that most households in the study area in North Western Benin maintain acceptable food consumption throughout the year despite differences in food availability between the pre- and post-harvest seasons. Some households lived with only borderline food consumption in March, May, July and September. The period from March to September thus appears to be a lean period. Frequency of pulses, fruit and dairy products consumption is generally low in the area, thereby contributing to the risk of malnutrition in children and adults. Interventions to improve the accessibility and availability of pulses, fruits and dairy products would help improve the diet quality, but the production of these types of foods is still very poorly organised in the study area. Milk production is the prerogative of Fulani herders who are temporarily settled in the villages, while access to fruits remains seasonal. Globally, an effective food fluctuation warning system with mitigation actions would also improve household access to food.

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Table 1: Climate and agriculture calendar and food availability periods in the study area [20]

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
Climate calendar	Dry season				Rainy season						Dry season	
Agricultural Calendar	Harvest	No farm activity			Planting			No farm activity		Harvest		
Food availability period	Increased		Intermediate		Lean period			Intermediate		Increased		

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Table 2: Socio-demographic characteristics of households (% or mean ± SD)

	September 2018	November 2018	January 2019	March 2019	May 2019	July 2019	P-value*
Number of participants	170	167	160	159	163	157	
Gender of household heads							**0.81**
Male	95.9	95.8	95.6	95.6	95.7	96.2	
Female	4.1	4.2	4.4	4.4	4.3	3.8	
Principal occupation of household heads							**0.72**
Employee	21.2	21.0	21.3	20.1	20.9	21.0	
Farmer	72.9	73.1	72.5	73.6	73.6	73.9	
Trader	2.9	3.0	3.1	3.1	3.1	2.5	
craftsman	2.9	3.0	3.1	3.1	2.5	2.5	
Marital status of household heads							**0.15**
Monogamous	78.2	78.4	79.4	77.4	77.9	77.7	
Polygamous	21.8	21.6	20.6	22.6	22.1	22.3	
Age group of household heads							**0.09**
Mean ± SD	36.5±10.7	36.5±10.8	36.9±10.8	36.5±10.5	36.6±10.4	36.5±10.5	
≤ 37 years	62.9	62.3	61.3	62.9	62.0	61.8	
> 37 years	37.1	37.7	38.7	37.1	38.0	38.2	
Household size							**0.00**
Mean ± SD	6.8±3.6	7.8±4.2	8±4.1	7.9±3.9	8.4±4.7	8.2±4.4	
≤ 7 persons	64.7	57.5	49.4	57.2	52.1	51.6	
> 7 persons	35.3	42.5	50.6	42.8	47.9	48.4	

*The value of P indicates the level of significance (at the 5% level) of the comparison of the characteristics of households in other months to those obtained at the first pass in September 2018 (reference month). Comparisons tests were made using the generalized estimating equation.

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Table 3: Mean food consumption scores during the year

Parameter	September 2018	November 2018	January 2019	March 2019	May 2019	July 2019	P-value*
Mean±SD	59.7±15.5	67.9±14.5	67.6±12.7	67.6±12.6	69.4±15.9	60.2±16.1	0.00
95% [CI]	[52.5-62.3]	[61.0-70.6]	[62.7-73.6]	[58.6-69.6]	[62.9-73.1]	[50.5-61.8]	

SD=Standard Deviation. * P-value for testing differences among month using as reference the month of lowest FCS (September 2018), adjusted by gender, principal occupation, marital status and age of household heads, and household size. Comparisons tests were made using the generalized estimating equation

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