Food Sec. (2016) 8:1123–1134
DOI 10.1007/s12571-016-0615-5

ORIGINAL PAPER

Determinants of diet quality among rural households in an intervention zone of Grande Anse, Haiti

Elise Pauzé[1] · Malek Batal[2] · Yvens Philizaire[3] · Rosanne Blanchet[1] · Dia Sanou[1,4]

Received: 10 February 2016 / Accepted: 20 September 2016 / Published online: 24 November 2016

Abstract In Haiti, nutrient deficiencies and stunting are major public health concerns. These health problems are caused by poor access and consumption of nutrient-rich foods, among other factors. The aim of this study was to assess the diet quality of rural Haitian households and identify its socioeconomic determinants. In August–September 2012, female caregivers from 529 rural households from the Department of Grande Anse participated in a cross-sectional survey. Collected data included household food production activities and socioeconomic characteristics. Diet quality was assessed using the Household Dietary Diversity Score. Its determinants were identified using multiple linear regression analyses. Results revealed that many households consumed oil/fats, condiments/beverages/spices, roots/tubers, and cereals, whereas few households consumed animal-based foods such as meats/organs, dairy products and eggs. Among household-level determinants, the number of adults per household, land ownership, practice of livestock rearing, number of meals consumed by children, use of latrines and accessibility of the dwelling location perceived as difficult were all associated with higher household dietary diversity. Among individual-level variables, respondent participation in petty commerce and practice of agriculture as main occupation, in addition to increased level of education were positively associated with household dietary diversity. In sum, determinants of diet quality were multidimensional and were associated with various factors including socio-economic status, household demographics, and physical environment. Moreover, diet quality is concurrently linked with household- and individual-level determinants. This highlights the need for multisectoral and multilevel interventions to improve household diet quality in Haiti.

Keywords Dietary diversity · Diet quality · Food security · Haiti · HDDS

✉ Dia Sanou
dsanou@uottawa.ca

[1] Interdisciplinary School of Health Sciences, Faculty of Health Sciences, University of Ottawa, 25 University Private, Ottawa, ON K1N 6X1, Canada

[2] Nutrition Department, Faculty of Medicine, University of Montréal, 2405 Côte Ste-Catherin Road, Montréal, QC H3T 1A8, Canada

[3] Faculté d'agronomie et de médecine vétérinaire, Université d'État d'Haiti, 1 rue Nationale, Damien, Port-au-Prince, Haiti

[4] Food and Agricultural Organization of the United Nations (FAO), Subregional Office for Eastern Africa, Addis Ababa, Ethiopia

Introduction

Haiti is known as the poorest country of the Americas with approximately 54 % of its population living on 1.90$ a day or less (World Bank, 2012). According to a national survey conducted in 2012, 64 % of Haitian households experience food deprivation (Cayemittes et al. 2013). Due to chronic insufficient access to food, among other factors, nutrient deficiencies and stunting are widespread (Ayoya et al. 2014; Cayemittes et al. 2013). The majority of households in rural areas depend on agriculture as their main source of livelihood but this sector is poorly productive. The low productivity of Haitian agriculture is attributable to many factors, which hamper domestic food production. These include a lack of infrastructure (roads, electricity, and irrigation) (Perez-Escamilla et al. 2009), limited access to food production inputs (fertile soil, water, fertilizer, equipment, and extension services) (Perez-Escamilla et al. 2009), ecological degradation (Baro, 2002), and unfavorable trade policies (Cohen, 2013). Moreover, in recent years, vulnerable Haitian households have been affected by multiple

shocks including the spike in global food commodity prices in 2006–08 (Iannotti & Robles, 2011), the 2010 earthquake (Kolbe et al. 2010), and several hurricanes which all further compromised households' access to sufficient food (United Nations Office for the Coordination of Humanitarians Affairs, 2012; Coordination national de la sécurité alimentaire d'Haiti (CNSA), 2011).

According to the Food and Agriculture Organization (1996), "food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life". As embodied in this definition, access to foods of sufficient nutritional quality and their consumption are pivotal in achieving food security. In developing countries, poor households typically have monotonous diets, which are mostly comprised of starchy staples with few fruit, vegetables or animal-based foods (Ruel, 2003). Haiti is no exception; a national survey conducted in 2012 revealed that fewer than a quarter of households (23 %) had high dietary diversity, defined as 11 food groups or more according to national cut-offs (CNSA, 2011). The same survey reported that 77 % of households had low (0–7 food groups) or moderate (8–10 food groups) dietary diversity (CNSA, 2011). Vulnerable sub-populations, such as infants seem to be especially affected by low dietary diversity (Heidkamp et al. 2013). According to the few studies that have documented food intake in the country, households infrequently consume nutrient-rich foods such as meat, fish, eggs, dairy, fruit, and vegetables (Dessalines, 2008; Parent et al. 2014).

Dietary diversity, the sum of food items or food groups consumed over a reference period, is a simple proxy measure of diet quality, increasingly used in low and middle-income countries (Ruel et al. 2013). This measure has been shown to be nutritionally relevant as it has been associated with energy and nutrient intake (Kennedy et al. 2007; Rose et al. 2008), nutrient adequacy (Hatløy et al., 1998; Steyn et al. 2006; Torheim et al. 2004), and with anthropometric measures of adults and children (Arimond & Ruel, 2004; Ruel et al. 2013). Poor dietary diversity and the resulting nutrient deficiencies have also been associated with many adverse health outcomes including poor growth (Arimond & Ruel, 2004; Heidkamp et al. 2013), cognitive impairment, reduced productivity, and increased mortality (Kant et al. 1995; Müller and Krawinkel, 2005).

Determinants of household diet quality are complex and include many interacting factors such as socio-economic status (Hatløy et al., 2000; Anzid et al. 2009; Savy et al. 2007), geography (Anzid et al. 2009; Hatløy et al., 2000), level of education (De Cock et al. 2013; Jones et al. 2014; Savy et al. 2005), household demographics (Jones et al. 2014; Rashid et al. 2011), cultural practices (Legwegoh & Hovorka, 2013), occupations (Savy et al.2007; Savy et al.2005), seasonal food availability (Savy et al. 2006), exposure to crises (Block et al. 2004; Dabalen & Paul, 2014; Thorne-Lyman et al. 2010), and food production practices (Jones et al. 2014). Household gender dynamics can also influence diet quality. Indeed, maternal education (Rashid et al. 2011) and nutritional knowledge (Block, 2007) as well as women's empowerment and control over resources (Bushamuka et al. 2005; Jones et al. 2014; Sraboni et al. 2014) have all been shown to improve diet quality within households.

To the best of our knowledge, there are no studies exploring the determinants of household dietary diversity in Haiti. The purpose of this study is therefore to assess the diet quality of rural Haitian households and to identify its socio-economic determinants among characteristics of households and individuals. The identification of these determinants could provide valuable information for local interventions.

Materials and methods

Study setting

The study was conducted in the Department of Grande Anse which is located in the south-western part of Haiti. This area covers 1911.9 km^2 and its estimated population is 446,901 of whom 77.9 % live in rural areas (Institut haïtien de statistique et d'informatique, 2012). The main economic activity of the region is agriculture which is mostly conducted on deforested and degraded hillside lands. In 2011, 81 % of households of this Department had been exposed to at least 3 shocks that potentially threatened their food security status (CNSA, 2011). Given the extreme vulnerability of the region, a Public Health Agriculture (PHA) intervention was initiated in order to reduce the rate of acute malnutrition among children and to strengthen population resilience to food insecurity. This multisectoral strategy included clinical care provided in nutritional rehabilitation centres managed by Médecins du Monde, improvements of sanitary conditions undertaken by the German Red Cross, and capacity building activities in food production, food preparation, and nutrition organized by the United Nation's Food and Agriculture Organization in partnership with the Haitian Ministry of Public and Population Health. Targeted households were mainly those in which a child between the ages of 1 and 5 years had been treated for acute malnutrition and also included households with vulnerable members such as elderly adults and pregnant or lactating women.

Data collection and sampling

A cross-sectional survey was conducted in August and September 2012, after the spring growing season (Sanou et al. unpublished). Data collected included demographic and socio-economic characteristics of households and respondents as well as information on their food production activities. The pre-coded questionnaire, initially written in French, was translated to Haitian Creole and was pre-tested with individuals outside the study area. The data collection was performed by a field

team of 12 interviewers and 3 supervisors who spoke both French and Haitian Creole.

In total, 529 households were randomly selected using a two stage sampling method. Since the data were initially collected to assess the impact of the PHA intervention, the first stage of sampling was determined by selecting the 7 targeted areas in the Department of Grande Anse which were defined as the region within a 5-h walk of 7 nutritional rehabilitation centres. These areas were: Abricot, Anse d'Hainault, Carrefour Charles, Chambellan, Grand Vincent, Moron, and Prévilé. At the second stage, a total of 255 households were randomly selected among a list of 630 intervention households. The number of households selected per area was representative of the geographical distribution of households who had benefited from the intervention. A total of 274 non-intervention households from the same areas were also sampled. The total number of households sampled per area varied from 12 households in Abricot to 134 in Moron. The respondents of the survey were female caregivers. Their informed consent was verbally obtained before their participation.

Household dietary diversity score

Household dietary diversity was assessed using a qualitative 24-h food group consumption questionnaire developed by the Food and Nutrition Technical Assistance (FANTA) Project (Swindale & Ohri-Vachaspati, 2005). This tool was adapted to reflect locally consumed foods. Respondents reported whether or not a member of the household had consumed foods from a given food group the day before the survey. Foods were categorized among the following 12 food groups: cereals, roots/tubers, fruits, vegetables, meats, eggs, fish/shellfish, nuts/pulses, milk/dairy products, oils/fats, sugar/sweets and spices/condiments/beverages. The Household Dietary Diversity Score (HDDS) was determined by summing the number of food groups consumed by households and therefore could vary between 0 and 12. Since there are no universal cut-offs for categorizing households according to their HDDS, the sample distribution was divided into HDDS tertiles which were characterized as low (0–5), moderate (6–7) and high (8–12) dietary diversity (Swindale & Ohri-Vachaspati, 2005).

Statistical analysis

Data were entered and analysed using SPSS Statistics 21, Armonk, NY, U.S. Frequencies, means, and standard deviations (SD) were used to describe sample characteristics. Differences in household and respondent characteristics between HDDS tertiles were assessed with Pearson Chi-square analyses and z-tests or one-way analysis of variance (ANOVA) coupled with Bonferroni post-hoc tests.

Multivariate linear regressions were conducted to identify determinants of HDDS, which was treated as a continuous variable. Independent variables were included in the regression model if there was a priori evidence from the literature that they could be independent predictors of individual or household dietary diversity. Some variables were not included simultaneously to avoid multi-collinearity. These variables included: practice of livestock rearing by a household member and respondent ownership of livestock; the number of meals consumed by adults and the number of meals consumed by children; household land ownership and respondents' access to land for personal use; and household size and the number of children or adults per household.

For the purpose of the regression analyses, variables not normally distributed were modified using square root or logarithmic transformation as appropriate. Three discrete variables, namely the number of meals consumed by adults and children as well as the number of children per household were transformed into categorical variables. Prior to the regression analyses, univariate and multivariate outliers exceeding three SDs were excluded to avoid their disproportional effects on the results (Tabachnick & Fidell, 2007). All categorical variables in the regression models were included as dummy variables.

Although many regression models were explored, only one model is presented for sake of brevity. Prior to this decision, we compared outcomes of several models which essentially included the same set of variables while interchanging those that could not be included simultaneously due to possible multi-collinearity as stated above. Results were roughly consistent across models. Absence of multi-collinearity between independent variables was assessed using a variance inflation factor test (values ranged from 1.083 to 2.405). Since we could not assume that data were missing at random (Tabachnick & Fidell, 2007), multi-imputation was not conducted and only complete cases were included in the regression analysis (n = 476). The significance level was set at α =0.05 for all analyses.

Selected variables

Variables included in the final model are: number of adults per household, respondent education attainment (none/primary/secondary or higher), household land ownership (no/yes), use of latrines by household members (no/yes), respondent's main occupation (none/agriculture/petty commerce/other), number of meals consumed by children the day before the survey (≤1 meal/2 meals/≥3 meal), respondent's perceived accessibility of the household's dwelling location (easy/moderate/difficult), and self-reported availability of sufficient resources to meet food needs at the time of the survey (no/yes). Independent variables such as respondent age and marital status (married/living with a partner/other) as well as household participation in the PHA intervention (no/yes) and access to borrowed land (no/yes) were included as relevant covariates. Models were adjusted for household size, number of children aged 5 years or less per household (≤1 child/2–3 children/4–6 children), number of meals consumed

by adults (≤1 meal/2 meals/≥3 meal), as well as respondents' access to land for their personal use (no/yes), and their ownership of livestock (no/yes). These variables were removed from the final model due to their minimal effect on results.

Ethical review

The protocol for this secondary analysis was approved by the University of Ottawa's research ethics committee (H05–13-09).

Results

Characteristics of participating households and respondents

Table 1 describes household and respondent characteristics. The household size varied from 2 to 20 members with a mean size of 7.4 (SD 2.59). Nearly all households had at least one member who practiced agriculture (96.7 %) and livestock rearing (83.1 %), whereas few had members who practiced fishing

Table 1 Characteristics of the sample households and survey respondents, Grande Anse, Haiti, August/September 2012 (maximum n = 529)

Sociodemographic characteristics	n	Mean or %	SD
Household			
Household size	527	7.35	2.59
Average numberof adults per household	528	2.76	1.28
Number of children under the age of 5 years per household	525	1.83	0.99
Accessibility of the dwelling location			
Easy	120	22.8	
Moderate	225	42.7	
Difficult	182	34.5	
Average number of meals consumed by adults per day	526	2.09	0.71
Average number of meals consumed by children per day	526	2.18	0.75
Land ownership (% yes)†	456	86.2	-
Access to borrowed land for agriculture (% yes)†	247	47.8	-
Practice of agriculture by a household member (% yes)†	503	96.7	-
Practice of livestock rearing by a household member (% yes)†	439	83.1	-
Practice of fishing by a household member (% yes)†	45	8.6	-
Fruit and vegetables produced by household (% yes)†	468	92.9	-
Recipient of the PHA intervention (% yes)†	255	48.2	-
Use of latrines as principal mean of defecation (% yes)†	279	53.1	-
Sufficient resources to meet current food needs (%yes)†	160	30.7	-
Respondent			
Average age (years)	516	36.27	12.99
Marital Status†			
Single	62	11.7	
Living with a partner	293	56.3	
Married	141	26.7	
Divorced / Separated / Widowed	28	5.3	
Last education level completed†			
None	205	38.8	
Primary	253	47.9	
Secondary and above	70	13.3	
Main Occupation†			
None	109	20.6	
Agriculture	214	40.5	
Petty commerce	180	34.0	
Other	26	4.9	
Access to a parcel of land for personal use (% yes)†	293	56.3	-
Ownership of livestock animals (% yes)†	229	44.0	-

† Values are also presented in percentages

(8.6 %). The majority of households (86.2 %) owned some land and nearly half (47.8 %) had access to borrowed land for agriculture. Most households (92.9 %) produced fruit and vegetables. About 31 % of households reported having sufficient resources to meet their food needs at the time of the survey.

The respondents' mean age was 36.3 (SD12.99). Respondents' main occupation was agriculture (40.5 %) or petty commerce (34.0 %) while 4.9 % had other occupations and 20.6 % reported no occupation. Most respondents had primary-level education (47.9 %), followed by those with none (38.8 %) and the remainder had secondary-level or higher (13.3 %). In terms of food production assets, 56.3 % of respondents had access to land for their personal use and 44.0 % possessed their own livestock.

Food group consumption

As presented in Table 2, food groups that were consumed the most included: oils/fats (93.5 %), condiments/spices/beverages (81.3 %), roots/tubers (78.4 %) and cereals (72.2 %). Animal-based foods such as eggs (12.3 %), milk/dairy products (18.2 %), and meats (26.5 %) were the least consumed. Among households who had consumed foods from the given food groups, households' own production was the main source for eggs (83.1 %), vegetables (75.1 %), fruit (74.4 %), and roots/tubers (67.6 %) whereas, foods from the remaining 8 groups were mainly acquired through purchasing.

HDDS and characteristics of HDDS tertiles

Mean HDDS was 6.3 (SD 2.27). Based on HDDS tertiles, 37.1 %, 33.6 %, and 29.3 % of households were categorized as having low (0–5), moderate (6–7) and high (8–12) dietary diversity, respectively. Table 3 and Table 4 present bivariate analyses comparing household and respondent characteristics as a function of HDDS tertiles. Households with low dietary diversity were less likely to report use of latrines ($p < .001$), land ownership ($p < .001$) and practice of livestock rearing by a household member ($p < .01$). Among respondents from these households, a significantly higher proportion reported no occupation ($p < .05$), had primary or no education ($p < .001$), and were less likely to have access to land for their personal use ($p < .05$) or to possess their own livestock ($p < .001$). The number of meals consumed by adults and children on the day before the survey were also significantly lower among households with low dietary diversity ($p < .001$). Household with high dietary diversity were more likely to report sufficient resources to meet their food needs ($p < .01$). Among respondents from these households, a greater proportion had secondary or higher education ($p < .001$) and participated in petty commerce as their main occupation ($p < .05$). There were also more adults in high dietary diversity households ($p < .05$).

Determinants of HDDS

Table 5 presents the results of a multivariate linear regression model exploring the determinants of HDDS in Haiti. Among household characteristics, the number of adults per household, land ownership, practice of livestock rearing, the number of meals consumed by children, use of latrines, and the accessibility of the dwelling's location perceived as difficult were all associated with higher HDDS. Among respondent characteristics, participation in petty commerce and practice of agriculture as main occupation in addition to increased education

Table 2 Percentage of households who had consumed foods from each food group and main sources of these foods consumed the day before the survey, Grande Anse, Haiti, August /September 2012

	Consumption		Main Source					
	(*n* 529)		Own production		Purchased		Other	
Food group	n	%	n	%	n	%	n	%
Oil and fats	493	93.5	51	10.4	428	87.2	12	2.4
Condiments, spices and beverages	429	81.3	67	15.7	348	81.3	13	3.0
Roots and tubers	414	78.4	280	67.6	118	28.5	16	3.9
Cereals	381	72.2	43	11.3	319	83.7	19	5.0
Vegetables	338	64.3	253	75.1	75	22.3	9	2.7
Sugar and sweets	301	56.9	10	3.3	282	93.7	9	3.0
Fruits	300	56.7	224	74.4	67	22.3	9	3.0
Nuts and pulses	199	37.7	57	28.6	124	62.3	18	9.0
Fish and shellfish	167	31.6	12	7.2	153	91.6	2	1.2
Meats	140	26.5	14	10.1	119	86.2	5	3.6
Milk and dairy products	96	18.2	21	21.9	67	69.8	8	1.5
Eggs	65	12.3	54	83.1	11	16.9	0	0

Table 3 Comparison of household characteristics as a function of HDDS tertiles, Grande Anse, Haiti, August/September 2012 (*n* 529)

	Low diversity		Moderate diversity		High diversity		F-stat	X^2
	n	Mean (SD) or %	n	Mean (SD) or %	n	Mean (SD) or %		
Household characteristics								
Number of members‡	192	7.03 (2.59)	173	7.41 (2.51)	151	7.61 (2.51)	2.31	-
Number of adults‡	192	2.60 (1.01) [a]	174	2.74 (1.39)	151	2.95 (1.298) [a]	3.26*	-
Number of children under 5 years‡	190	1.87 (1.01)	173	1.83 (1.02)	151	1.82 (.953)	0.14	-
Accessibility of the dwelling location§								
Easy	50	26.0	34	19.7	33	21.9	3.3	
Moderate	81	42.2	71	41.0	66	43.7	-	
Difficult	61	31.8	68	39.3	52	34.4	-	
Use of latrine by HH† members (% yes)§	72	37.9 [a]	96	55.5 [a]	104	68.4 [a]	-	32.3 ***
Recipient of the PHA† intervention (% yes)§	94	49.0	89	51.1	69	45.4	-	1.1
Ownership of land (% yes)§	150	78.1 [a,b]	155	89.1 [a]	141	92.8[b]	-	17.1***
Access to borrowed land for agriculture (% yes)§	91	47.6	80	47.6	70	47.3	-	0.01
Practice of livestock rearing by a HH member (% yes)§	147	76.6 [a]	146	84.4	137	90.1 [a]	-	11.4**
Sufficient food stocks or resources to meet food needs (%yes)§	44	23.4 [a]	50	29.1 [b]	61	40.4 [a, b]	-	11.4**
Number of meals consumed by adults‡	190	1.78 (.69) [a, b]	173	2.20 (.70) [a]	152	2.32 (.61) [b]	29.64***	-
Number of meals consumed by children‡	190	1.88(.74) [a, b]	173	2.27 (.71) [a]	152	2.18 (.68) [b]	28.96***	-

† HH: household; PHA: Public health agriculture

‡ Values in mean (SD) and results of one-way ANOVA test of significance and Bonferroni post-hoc test are presented

§ Values in % and results of Pearson's Chi-square are presented

‡§ Within rows, values marked with the same superscript denote statistically significant differences between dietary diversity categories $P < 0.05$

*P < 0.05 ** P < 0.01 ***P < 0.001

attainment were also significant positive determinants of HDDS. This model ($F(19, 456) = 10.709$, $p = .000$) accounted for 30.9 % of the HDDS variance.

According to standardized beta coefficients, the relative importance of variables in explaining the HDDS variance in descending order is: consumption of at least 3 meals a day by children ($\beta = .408$, p = .000), consumption of 2 meals a day by children ($\beta = .243$, p = .000), respondent's attainment of secondary-level education or higher ($\beta = .232$, p = .000), respondent's participation in petty commerce ($\beta = .149$, $p = .006$), use of latrines ($\beta = .142$, $p = .001$), respondent's attainment of primary-level education ($\beta = .135$; $p = .004$), household land ownership ($\beta = .124$, $p = .003$), respondent's practice of agriculture ($\beta = .114$, $p = .040$), accessibility of the dwelling's location perceived as difficult ($\beta = .112$, $p = .031$), number of adults per household ($\beta = .105$, $p = .011$), and practice of livestock rearing ($\beta = .093$, $p = .028$).

Although the number of meals consumed by adults was a significant determinant (data not shown) the number of meals consumed by children was more strongly associated with HDDS and was therefore preferred in the final model. Results presented here were roughly consistent across models explored with two exceptions — accessibility of the dwelling's location perceived as difficult and women's practice of agriculture as main occupation were not significant predictors of HDDS in some models (data not shown).

Discussion

This study assessed household diet quality and identified determinants of HDDS among a sample of rural Haitian households living in a highly vulnerable region. Most households consumed starchy staples, whereas few consumed animal-based foods. Purchasing and households' own agricultural production were the two main sources of foods consumed the day before the survey. The predominant source of foods consumed varied across food groups. Interestingly, determinants of household dietary diversity were multidimensional and concurrently associated with household- and individual-level factors.

Table 4 Comparison of respondent characteristics as a function of HDDS tertiles, Grande Anse, Haiti, August/September 2012 (*n* 529)

	Low diversity		Moderate diversity		High diversity		F-stat	X^2
	n	Mean (SD) or %	n	Mean (SD) or %	n	Mean (SD) or %		
Age (years)‡	184	35.8 (12.9)	171	37.3 (13.1)	151	36.1 (13.2)	0.68	.657
Marital Status§								
Living with a partner	116	60.4	101	58.0	75	49.3		5.96
Married	44	22.9	49	28.2	46	30.3		
Single/Divorced/Separated/Widowed	32	16.7	24	13.8	31	20.4		
Education attainment§								
None	92	47.9 [a]	72	41.6 [b]	39	25.7 [a, b]	-	33.4***
Primary	85	44.3	86	49.7	76	50.0	-	-
Secondary or higher	15	7.8 [a]	15	8.7 [b]	37	24.3 [a, b]	-	-
Main Occupation§								
None	52	27.1 [a, b]	31	17.8 [a]	23	15.1 [b]	-	16.0*
Agriculture	77	40.1	75	43.1	57	37.5	-	-
Commerce	53	27.6 [a]	64	36.8	61	40.1 [a]	-	-
Other	10	5.2	4	2.3 [a]	11	7.2 [a]	-	-
Ownership of a parcel of land (% yes)§	91	47.6 [a]	107	63.7 [a]	88	58.3	-	9.8*
Ownership of livestock (% yes)§	60	31.9 [a, b]	85	49.7 [a]	78	52.0 [b]	-	17.3***

‡ Values in mean (SD) and to results of one-way ANOVA test of significance and Bonferroni post-hoc test are presented

§ Values in % and results of Pearson's Chi-square are presented

‡§ Within rows, values marked with different superscripts denote statistically significant differences between dietary diversity categories $P < 0.05$

*$P < 0.05$ ** $P < 0.01$ ***$P < 0.001$

The overall diet quality of participating households was poor. Most households consumed staple foods such as oil/fats, condiments/beverages/spices, roots/tubers and cereals, whereas few households consumed animal-based foods, known to be particularly rich in nutrients. These dietary patterns are consistent with other studies conducted in Haiti (Dessalines, 2008; Parent et al. 2014; Spray et al. 2013).

HDDS in our sample is low compared to a recent national survey. In May/June 2011, only 14 % of households in the Department of Grand Anse had low dietary diversity (CNSA, 2011). In our study, 70.7 % of households would be categorized as such according to the national HDDS cutoffs. This difference may be partly due to the characteristics of our surveyed population which mostly consisted of households with children of 1 to 5 years of age. In 2012, Haiti was also affected by drought and tropical storms which destroyed many crops including maize, sorghum, rice, pulses, and bananas (CNSA, 2012). These crop losses coincided with increases in imported food prices (CNSA, 2012). The reduction of local food availability compounded with a decrease in purchasing power may therefore explain the lower dietary diversity documented in the current study compared to the national data from 2011.

As aforementioned, the consumption of animal-based foods, including meat/organs, fish, dairy, and eggs, was also low. In Haiti, low consumption of these nutrient-dense foods has been attributed to their prohibitive costs, lack of supply in local markets, ecological constraints hindering animal production, and households' inability to store these foods (Loechl et al. 2005; Menon et al. 2002). Since the vast majority of households who had consumed eggs had acquired them through their own production, support for chicken rearing may improve consumption of animal-based foods. Indeed, other studies have shown that agricultural interventions that include small animal husbandry can improve diet quality through increased consumption of eggs and milk (Girard et al. 2012).

More than a third of households had not consumed vegetables and fruit the day before the survey despite the vast majority of them producing these foods. This suggests that increased awareness of the benefits of consuming vegetables and fruit may be warranted to improve household diet quality in Haiti. Indeed, some field-based programmes in the country have reported that certain fruit varieties and leafy green vegetables widely available are not consumed due to cultural beliefs and preferences (Heidkamp et al. 2013). This emphasises the importance of including dietary education or a behavior change communication strategy in interventions aiming to increase vegetable and fruit consumption.

Table 5 Results of a multivariate linear regression analysis for selected determinant variables of household dietary diversity score, complete cases, Grande Anse, Haiti, August–September 2012 (*n* 476)

Variable	*β*	Standardized *β*	95 % CI	P
Constant	1.092		-1.306 ; 3.490	.371
Number of adults in HH†	1.412	.105	.326; 2.497	.011
Land ownership	.835	.124	.293 ; 1.376	.003
Access to borrowed land	.141	.031	-.217 ; .498	.440
Practice of livestock rearing by a HH member	.580	.093	.063 ; 1.098	.028
Use of latrine by HH members	.639	.142	.277 ; 1.002	.001
Perceived accessibility of the dwelling location				
Moderate	-.042	-.009	-.504 ; .419	.857
Difficult	.526	.112	.048 ; 1.003	.031
Meals consumed by children				
2 meals	1.096	.243	.575 ; 1.617	.000
≥ 3meals	1.994	.408	1.414 ; 2.574	.000
Recipient of the PHA† intervention	.073	.016	-.281 ; .426	.685
Sufficient food stocks or resources to meet food needs	.307	.063	-.092 ; .707	.131
Age of respondent	.334	.022	-1.083 ; 1.751	.644
Respondent's educational level				
Primary level	.607	.135	.199 ; 1.014	.004
Secondary level or higher	1.509	.232	.897 ; 2.121	.000
Respondent's main occupation				
Agriculture	.520	.114	.024 ; 1.016	.040
Commerce	.705	.149	.198 ; 1.211	.006
Other	.442	.044	-.424 ; 1.307	.316
Respondent's marital status				
Married	.015	.003	-.427 ; .456	.948
Single / Divorced / Separated / Widowed	.423	.069	-.098 ; .926	.098
R^2		.309		
R^2ajusted		.280		

† HH: household ; PHA: Public health agriculture

Coding for independent variables: Land ownership, access to borrowed land, practice of livestock rearing by a household member, recipient of the PHA intervention and sufficient resources to meet food needs coded as no = 0 and yes = 1; Number of adults in the household and respondent's age are continuous. Accessibility of the dwelling location, number of meals consumed by children, respondent's education level, respondent's main occupation, and respondent's marital status are categorical variables and are coded as dummy variables. In respective order, comparison groups for these categorical dummy variables are: easy accessibility, ≤1 meal, no education, no occupation and living with a partner

Coding for dependant variable: The household dietary diversity score ranges from 0 to 12 food groups

In our sample, determinants of household diet quality are multidimensional and associated with various factors including socioeconomic status (use of latrine, education attainment, land ownership, the number of meals consumed), household demographics (number of adults per household), rural development (practice of livestock rearing), gender (petty commerce and agriculture carried out by women), as well as physical environment (accessibility of the dwelling location). Moreover, household dietary diversity is concurrently affected by household- and individual-level factors. The multifactorial nature of diet quality highlights the need for multisectoral approaches, such as the PHA intervention, in addressing the issue.

Among household-level determinants, socio-economic characteristics such as land ownership, use of latrines, and the number of meals consumed by children the day before the survey were all positive determinants of HDDS. These findings are consistent with other studies. For instance, asset possession and access to improved sanitary infrastructure were associated with the dietary diversity of mothers of young children in Burkina Faso (Savy et al. 2007; Savy et al. 2006). The number of meals consumed by adults and children, considered to be proxy indicators for economic access to food, has also been shown to be correlated with HDDS in Uganda and Burkina Faso (Kennedy et al. 2010).

Although a large proportion of sampled households had a member practicing livestock rearing and despite this practice being positively associated with HDDS, it appears that this activity may not directly lead to increased household consumption of animal-based foods (with the exception of eggs). Since most households who consumed these foods acquired them through purchasing, it is possible that households prefer to sell their livestock rather than use them for food. Indeed, according to Baro (2002), livestock in Haiti is used as a durable asset sold to finance other activities or to address emergency situations. Although livestock rearing may not directly improve diet quality, it constitutes an important economic asset which could improve household food security.

Previously, HDDS has been associated with household size in countries such as Malawi and Bangladesh (Thorne-Lyman et al. 2010; Jones et al. 2014). According to our findings, the number of adults per household seemed to be a positive determinant of HDDS, whereas household size was not. The increased number of adults per household may improve dietary diversity through increased availability of labour and diversity of income sources. More research is needed to replicate this finding before confident conclusion can be drawn.

Surprisingly, difficult accessibility of the dwelling location was positively associated with HDDS. These findings contradict earlier studies, which have found that dietary diversity is typically higher in more accessible settings such as urban areas versus rural ones (Hatløy et al., 2000). On the other hand, households in isolated areas may be more dependent on their own food production rather than the cash economy and may have greater access to seasonal or wild foods (Anzid et al. 2009). When conducting further analyses, we found that a significantly higher proportion of households who perceived their dwelling as difficult to access depended on their own food production for vegetables, pulses, and fruit versus those who perceived their dwelling to be more accessible (data not shown). Increased reliance on domestic food production in isolated locations may explain the relationship between dwelling accessibility and HDDS. Given that our study was also conducted during a period of acute food insecurity, these households' increased reliance on their own food production may have buffered the effects of higher food prices on their dietary patterns. It should be noted that the significant association between accessibility of the dwelling location and dietary diversity was not consistent in all tested models. Further investigations are warranted to confirm the relationship between dietary diversity and accessibility of the dwelling location.

Among individual-level determinants, level of education and occupation of respondents were both positively associated with HDDS. Women's education level has been previously associated with increased dietary diversity (Torheim et al. 2004) but this relationship is inconsistent in some contexts (Savy et al. 2007; Savy et al. 2006). Our study found that respondents with primary or secondary level education had higher HDDS compared to those without any formal education. In Haiti, maternal education had been identified as a compensating factor for the negative effects of food insecurity on the dietary diversity of infants (Ruel et al. 2004). However, a recent analysis of the country's 2005–06 Demographic and Health survey found that maternal education was not significantly associated with infants meeting the minimum dietary diversity recommendation of the World Health Organization (Heidkamp et al. 2013). Unlike this study, our results suggest that women's education may be an important influential factor of dietary diversity at the household level.

Respondent participation in petty commerce was also a significant determinant of HDDS. This is in accordance with Savy et al. (2005) who observed a positive relationship between women's generation of commercial income and dietary diversity in rural villages of Burkina Faso. Practice of petty commerce by women may provide additional income to households as well as give them more autonomy or access to cash for purchasing foods. In Haiti, women are very engaged in economic activities, albeit more so in the informal sector (Gardella, 2006). They are exclusively responsible for selling foods in domestic markets and typically have control over the income generated from this activity (Gardella, 2006). Despite this autonomy, gender inequality is still very much a reality in the country (Padgett & Warneche, 2011).

Women's empowerment through participation in income generating activities and greater control over household resources has indeed been identified as a gateway to improving household food security (World Bank, 2007). Support for homestead food production by women in particular improves dietary diversity, increases fruit, vegetable, and animal-based food consumption as well as increasing household income (Bushamuka et al. 2005; Girard et al. 2012). Although a higher proportion of women from the moderate and high dietary diversity households possessed their own livestock, this was not a determinant of HDDS in our multivariate analysis, nor was respondents' access to land for personal use. Factors such as lack of time, technical assistance or knowledge of the health benefits of certain foods may be impeding the effective utilization of these productive assets by Haitian women and merits further investigation.

Our study is the first to explore determinants of HDDS in Haiti. It has provided important insights into some contextual factors influencing diet quality in the Department of Grande Anse. However, these findings should be interpreted with caution in line with the limitations of the study. Regarding the dietary diversity measure, there are still some outstanding issues related to the appropriate number of food groups that should be used and whether portion sizes or consumption frequency should be taken into account (Ruel, 2003). In Haiti, for instance, meat and seafood are often used in small quantities to flavour dishes

(Heidkamp et al. 2013). Without quantitative information, the reported consumption of these foods or others may therefore be insufficient in determining whether a household's general access and consumption of a given food group is adequate. Since HDDS includes food groups of low nutritional quality, such as fat/oil, condiments/beverages/spices and sugar/sweets, households' diet quality may be somewhat exaggerated by the inclusion of these food groups in the score. Also, given the simplicity of the HDDS indicator, it is assumed that households with the same scores have equivalent diet quality when in fact the combination of food groups consumed by households may be different. Furthermore, HDDS does not consider intra-household dynamics and therefore does not take into account the possible inequity in food distribution among household members. Many studies have shown the association between dietary diversity and nutrient adequacy among individuals; however, there is a paucity of studies demonstrating its relationship with food consumption at the household-level (Hoddinott & Yohannes, 2002; Rose & Tschirley 2003). More studies are needed to validate dietary diversity as an indicator of household diet quality. In the absence of more robust food consumption data, our study nonetheless provides valuable insight into the quality of foods consumed by rural Haitian households and possible determinants of diet quality. Future investigations in Haiti should also include qualitative research to confirm and contextualize quantitative results such as those presented in this article.

No causal inference can be made due to the study's cross-sectional design. In addition, our results cannot be generalized to the broader Haitian context given the particularity of the study population. The exclusion of incomplete cases in the multivariate regression models may have also biased our results. Since the data were initially collected for the programmatic assessment of the PHA intervention and not for this research, some relevant variables could not be accounted for in the model (e.g. women's participation in decision making), which may misestimate the association between potential determinants and HDDS.

Our findings suggested that household diet quality is influenced by multidimensional factors such as socioeconomic status, household demographics, rural development, gender, and physical environment which should all be considered in intervention planning in the region. Household- and individual-level factors should also be taken into account with particular attention to women's education and occupations. Potential pathways to improve household diet quality and food security in the Department of Grande Anse should embrace multisectoral and multilevel perspectives and include support to livestock rearing in addition to enhancing women's education and participation in petty commerce, among other income generating activities. Our study design does not allow an in depth assessment of the potential role of women empowerment in achieving food security and improving household dietary diversity. Further investigation is needed to better assess the potential impact of women's use and control of productive assets such as land and livestock on household diet quality.

Acknowledgments The authors are grateful for the participating households and would also like to acknowledge the contribution of local collaborators as well as the efforts of the field team who participated in the data collection. Special thanks to Akoï Koivogui, Bernard Arcens, Jean Pierre Foschia, Adam Yao, Marie Petuelle Elisme, Emmnuella Blain, Ismael Ngnie Teta, Papa Moussa Ndoye, Jean Ernst Saint Fleur and Patrick Boily.

Author's contributions D.S., M.B., and Y.P. designed the study. D.S. and Y.P. coordinated and oversaw the data collection. E.P. formulated the research questions. E.P. and R.B. planned and carried out the data analysis. E.P., D.S., M.B. and R.B. interpreted the findings. E.P. wrote the first draft of the manuscript. All co-authors reviewed and contributed to the manuscript.

Compliance with ethical standards

Funding The data collection was funded by the Food and Agriculture Organization through an ECHO grant. This secondary data analysis has not received any specific grant from any funding agency, commercial or non-profit organization.

Conflicts of interest The authors declare that they have no conflict of interest. The article is original work and has not been submitted for publication elsewhere.

References

Anzid, K., Elhamdani, F. Z., Baali, A., Boétsch, G., Levy-Desroches, S., Lôpez, P. M., et al. (2009). The effect of socio-economic status and area of residence on household food variety in Morocco. *Annals of Human Biology, 36*(6), 727–749.

Arimond, M., & Ruel, M. T. (2004). Dietary diversity is associated with child nutritional status: evidence from 11 demographic and health surveys. *Journal of Nutrition, 134*(10), 2579–2585.

Ayoya, M. A., Heidkamp, R., Ngnie-Teta, I., Mamadoultaibou, A., Daniel, E. F., Durandisse, E. B., et al. (2014). Précis of nutrition of children and women in Haiti: analyses of data from 1995 to 2012. *Annals of the New York Academy of Sciences, 1309*, 37–62.

Baro, M. (2002). Food insecurity and livelihood systems in Northeast Haiti. *Journal of Political Ecology, 9*, 1–33.

Block, S. A. (2007). Maternal nutrition knowledge versus schooling as determinants of child micronutrient status. *Oxford Economic Paper, 59*, 330–353.

Block, S. A., Kiess, L., Webb, P., Kosen, S., Moench-Pfanner, R., Bloem, M. W., et al. (2004). Macro shocks and micro outcomes: child nutrition during Indonesia's crisis. *Economics & Human Biology, 21*(2), 21–44.

Bushamuka, V. N., de Pee, S., Talukder, A., Kiess, L., Panagides, D., Taher, A., et al. (2005). Impact of a homestead gardening program on household food security and empowerment of women in Bangladesh. Food. *Nutrition Bulletin, 26*(1), 17–25.

Cayemittes, M., Busanga, M., Bizimana, J., Barrère, B., Sévère, B., Cayemmittes, V. et al. (2013). Enquête Mortalité, Morbidité et Utilisation des Services EMMUS-V Haïti 2012. Pétion-Ville: Institut Haïtien pour l'Enfance http://dhsprogram.com/pubs/pdf/FR273/FR273.pdf. Accessed November 2015.

Cohen, M. J. (2013). Diri Nasyonal ou Diri Miami? Food, agriculture and US-Haiti relations. *Food Security, 5*(4), 597–606.

Coordination nationale de la sécurité alimentaire (2011). Enquête nationale de la sécurité alimentaire. http://www.cnsa509.org/Web/Etudes/Rapport%20final%20enquete%20 nationale (ENSA).pdf. Accessed November 2015.

Coordination nationale de la sécurité alimentaire. (2012). Haiti: Perspective sur la sécurité alimentaire, Octobre 2012 à Mars 2013. http://www.cnsa509.org/Web/Bulletin/HT_OL_2012_11 _version_ STV%20(2).pdf. Accessed November 2015.

Dabalen, A. L., & Paul, S. (2014). Effect of conflict on dietary diversity: evidence from Côte d'Ivoire. *World Development, 58*, 143–158.

De Cock, N., D'Haese, M., Vink, N., van Rooyen, C. J., Schöfeldt, H. C., & D'Haese, L. (2013). Food security in rural areas of Limpopo province, South Africa. *Food Security, 5*(2), 269–282.

Dessalines, M. (2008). The role of sweet potatoes in the diet and nutrition of rural Haitian families. MSc. Thesis, University of Connecticut.

Food and Agriculture Organization of the United Nations (1996). *Rome declaration on world food security*. Rome: FAO.

Gardella, A. (2006). Gender Assessment for USAID/Haiti Country Strategy Statement Port-au-Prince, USAID Haiti, p. 29.

Girard, A. W., Self, J. L., McAuliffe, C., & Olude, O. (2012). The effects of household food production strategies on the health and nutrition outcomes of women and young children: a systematic review. *Paediatric Perinatal Epidemiology, 26*(Suppl. 1), 205–222.

Hatløy, A., Torheim, L. E., & Oshaug, A. (1998). Food variety - a good indicator of nutritional adequacy of the diet? A case study from an urban area in Mali, West Africa. *European Journal of Clinical Nutrition, 52*(12), 891–898.

Hatløy, A., Hallund, J., Diarra, M. M., & Oshaug, A. (2000). Food variety, socioeconomic status and nutritional status in urban and rural areas in Koutiala (Mali). *Public Health Nutrition, 3*(1), 57–65.

Heidkamp, R. A., Ayoya, M. A., Teta, I. N., Stoltzfus, R. J., & Marhone, J. P. (2013). Complementary feeding practices and child growth outcomes in Haiti: an analysis of data from demographic and health surveys. *Maternal & Child Nutrition, 11*(4), 815–828.

Hoddinott, J., & Yohannes, Y. (2002). *Dietary diversity as a food security inidcator*. Washington, DC: Food and Nutrition Technical Assistance Project, USAID http://www.fantaproject.org/sites/default/files/resources/Dietary Diversity-HH- FS-Indicator- 2002.pdf. Accessed May 2015.

Iannotti, L., & Robles, M. (2011). Negative impact on calorie intake associated with the 2006-08 food price crisis in Latin America. *Food and Nutrition Bulletin, 32*(2), 112–123.

Institut haïtien de statistique et d'informatique. (2012). Population totale, population de 18 ans et plus et densité estimés en 2012. http://www.ihsi.ht/pdf/projection/DOC_POPTLE18_MEN EST2012.pdf. Accessed November 2015.

Jones, A. D., Shrinivas, A., & Bezner-Kerr, R. (2014). Farm production diversity is associated with greater household dietary diversity in Malawi: findings from nationally representative data. *Food Policy, 46*, 1–12.

Kant, A. K., Schatzkin, A., & Ziegler, R. G. (1995). Dietary diversity and subsequent cause-specific mortality in the NHANES I epidemiologic follow-up study. *The Journal of American College of Nutrition, 14*(3), 233–238.

Kennedy, G. L., Pedro, M. R., Seghieri, C., Nantel, G., & Brouwer, I. (2007). Dietary diversity score is a useful indicator of micronutrient intake in non-breast-feeding Filipino children. *Journal of Nutrition, 137*(2), 472–477.

Kennedy, G., Berardo, A., Papavero, C., Horjus, P., Ballard, T., Dop, M., et al. (2010). Proxy measures of household food consumption for food security assessment and surveillance: comparison of the household dietary diversity and food consumption scores. *Public Health Nutrition, 13*(12), 2010–2018.

Kolbe, A. R., Hutson, R. A., Shannon, H., Trzcinski, E., Miles, B., Levitz, N., et al. (2010). Mortality, crime and access to basic needs before and after the Haiti earthquake: a random survey of port-au-prince households. *Medicine, Conflict, and Survival, 26*(4), 281–297.

Legwegoh, A. F., & Hovorka, A. J. (2013). Assessing food insecurity in Botswana: the case of Gaborone. *Development in Practice, 23*(3), 346–358.

Loechl, C., Menon, P., Ruel, M. T., & Pelto, G. (2005). *A Qualitatative study of the patterns of infant feeding and Care in the Hinche Area of plateau central, Haiti*. Washington, DC: FANTA Project, Academy for Educational Development.

Menon, P., Loechl, C., Pelto, G., & Ruel, M. T. (2002). *Development of a behavior change communication program to prevent malnutrition in the central plateau of Haiti: results and challenges from a formative research study*. Washington, DC: FANTA Project, Academy for Educational Development.

Müller, O., & Krawinkel, M. (2005). Malnutrition and health in developing countries. *Canadian Medical Association Journal, 173*(3), 279–286.

Padgett, A., & Warneche, T. (2011). Diamonds in the rubble: the women of Haiti. *Journal of Economic Issues, 45*(3), 527–557.

Parent, J., Dallmann, D., Garcia, M., & Melgar-Quinonez, H. (2014). Food security status and dietary intake among small farming families in Haiti. *The Journal of the Federation of American Societies for Experimental Biology, 28*(1 Suppl), A805.6.

Pérez-Escamilla, R., Dessalines, M., Finnigan, M., Panchón, H., Hromi-Fiedler, A., & Gupta, N. (2009). Household food insecurity is associated with childhood malaria in rural Haiti. *Journal of Nutrition, 139*, 2132–2138.

Rashid, D., Smith, L., & Rahman, T. (2011). Determinants of dietary quality: evidence from Bangladesh. *World Development, 39*(12), 2221–2231.

Rose, D., & Tschirley, D. (2003). Predicting dietary intakes with simple food recall information: a case study from rural Mozambique. *European Journal of Clinical Nutrition, 57*(10), 1212–1221.

Rose, D., Chotard, S., Oliveira, L., Mock, N., & Libombo, M. (2008). A comparative evaluation of dietary indicators used in food consumption assessments of at-risk populations. *Food and Nutrition Bulletin, 29*(2), 113–122.

Ruel, M. T. (2003). Operationalizing dietary diversity: a review of measurement issues and research priorities. *Journal of Nutrition, 133*(11 Suppl 2), 3911S–3926S.

Ruel, M. T., Menon, P., Arimond, M., & Frogillo, E. A. (2004). Food insecurity: an overwhelming constraint for child dietary diversity and growth in Haiti. *The Journal of the Federation of American Societies for Experimental Biology, 18*(4), A104.

Ruel, M. T., Harris, J., & Cunningham, K. (2013). Diet quality an evidence-based approach volume 2. In V. Preedy, L. Hunter, & V. Patel (Eds.), *Diet quality in developing countries* (pp. 239–261). New York: Humana Press.

Savy, M., Martin-Prével, Y., Sawadogo, P., Kameli, Y., & Delpeuch, F. (2005). Use of variety/diversity scores for diet quality measurement: relation with nutritional status of women in a rural area in Burkina Faso. *European Journal of Clinical Nutrition, 59*(5), 703–716.

Savy, M., Martin-Prével, Y., Traissac, P., Eymard-Duvermay, S., & Delpeuch, F. (2006). Dietary diversity scores and nutritional status of women change during the seasonal food shortage in rural Burkina Faso. *Journal of Nutrition, 136*(10), 2625–2632.

Savy, M., Martin-Prével, Y., Traissac, P., & Delpeuch, F. (2007). Measuring dietary diversity in rural Burkina Faso: comparison of a 1-day and a 3-day dietary recall. *Public Health Nutrition, 10*(1), 71–78.

Spray, A. L., Eddy, B., Hipp, J. A., & Iannotti, L. (2013). Spatial analysis of undernutrition of children in Léogâne commune, Haiti. *Food Nutrition Bulletin, 34*(4), 444–461.

Sraboni, E., Malapit, H. J., Quisumbing, A. R., & Ahmed, A. U. (2014). Women's empowerment in agriculture: what role for food security in Bangladesh? *World Development, 61*, 11–52.

Steyn, N. P., Nel, J. H., Nantel, G., Kennedy, G., & Labadarios, D. (2006). Food variety and dietary diversity scores in children: are they good indicators of dietary adequacy? *Public Health Nutrition, 9*(5), 644–650.

Swindale, A., & Ohri-Vachaspati, P. (2005). *Measuring household food consumption: a technical guide 2005*. Washington, DC: FANTA Project, Academy for Educational Development.

Tabachnick, B., & Fidell, L. (2007). *Using multivariate statistics* (5th ed.). Boston: Pearson Education Inc.

Thorne-Lyman, A. L., Valpiani, N., Sun, K., Semba, R. D., Klotz, C. L., Kreamer, K., et al. (2010). Household dietary diversity and food expenditures are closely linked in rural Bangladesh, increasing the risk of malnutrition due to the financial crisis. *Journal of Nutrition, 140*(1), 182S–188S.

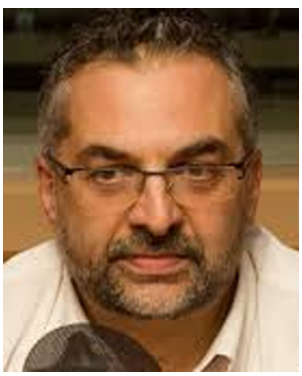
Torheim, L. E., Ouattara, F., Diarra, M. M., Thiam, F. D., Bariko, I., et al. (2004). Nutrient adequacy and dietary diversity in rural Mali: association and determinants. *European Journal of Clinical Nutrition, 58*(4), 594–604.

United Nations Office for the Coordination of Humanitarian Affairs – Haiti. (2012). Haiti: Emergency Appeal Hurrican Sandy, http://www.fao.org/fileadmin/templates/tc/tce/pdf/ Emergency _Appeal_Hurricane_Sandy_Haiti.pdf. Accessed November 2015.

World Bank.(2007) From Agriculture to Nutrition: Pathways, Synergies and Outcomes. Washington, DC., http://siteresources.worldbank.org/INTARD/825826-1111134598204/21608 903/January2008 Final.pdf. Accessed January 2016

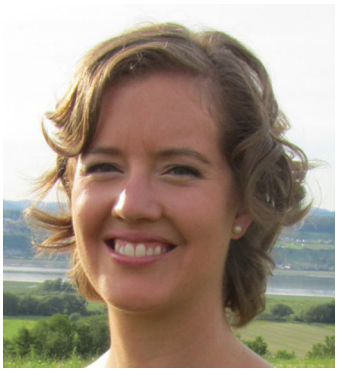
World Bank. (2012). Haiti, Country Indicators. http://povertydata.worldbank.org/poverty/country /HTI. Accessed November 2015.

Elise Pauzé completed her M. Sc. in Interdisciplinary Health Sciences in 2015 at the University of Ottawa. She has a bachelor's degree in nutrition sciences and is a registered dietitian. Her master's dissertation examined the determinants of dietary diversity and food access among Haitian households in the Department of Grand'Anse.



Malek Batal is an Associate Professor at the Nutrition Department of the Faculty of Medicine of the University of Montreal. He is also the Director of TRANSNUT, a WHO Collaborating Centre on Nutrition Changes and Development. His research focuses on environmental, social, economic, and cultural determinants of dietary choices and their relationship to the health of individuals in several populations, including First Nations in Canada, Francophones living in a minority language situation and Lebanese living in rural areas. He is currently leading a project on child and maternal health in the Department of Grand'Anse, Haiti.

Yvens Philizaire is an Agronomy Engineer with a diploma in Food Science and Technology of the Faculty of Agronomy and Veterinary Medicine (FAMV) of the State University of Haiti (UEH) and has a master's degree in Human nutrition of the Institute of Research for Development (IRD) of Montpellier II University (France). In 2011, he did a specialization course in dairy technology and processing at INRA (Rennes, France). Since 2009 he has held the position of Professor-Researcher at FAMV where he teaches nutrition, dairy technology and organizes practical workshops with his students.



Rosanne Blanchet is a dietitian currently doing a PhD in population health at the University of Ottawa. For several years, she has been interested in the nutrition transition, its determinants and its impacts on nutritional status and obesity. Her current research focuses on determinants of nutritional health among school-aged immigrant children of African and Caribbean descent. Her work is supported by doctoral awards from the Consortium National de Formation en Santé – volet Université d'Ottawa and the Fonds de Recherche Québec-Santé.

Dia Sanou is a certified Public Health Nutritionist. He is currently the Nutrition advisor for FAO subregional office for Eastern Africa and liaison office to Africa Union in Addis Ababa, Ethiopia. He has over 15 years experience in global nutrition and has collaborated with many international organizations, government agencies and academic institutions in Burkina Faso, Canada, Haiti and Mali. He specializes in nutrition policy, multisectoral programming, capacity building, and operations research. He has authored several peer-reviewed articles and he is the Co-Chief Editor of Africa Nutrition Matters, the Newsletter of the African Nutrition Society.