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Exploring the new indicator Minimum Dietary Diversity-Women

Results from Burkina Faso

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Abstract

Improving the quality of women’s diet is the best way to stop the intergenerational cycle of malnutrition. The ‘minimum dietary diversity-women’ is a global indicator recently endorsed to monitor nutrition-sensitive actions and programmes aimed at improving the diet of women of reproductive age. This report explores the potential use of the indicator for programmatic action and gauges how the indicator relates to other dimensions and how sensitive it is to changes in both urban and rural Burkina Faso.

1. Introduction

Maternal micronutrient malnutrition is a widespread nutrition challenge faced by women living in resource-poor settings, the consequences of which affect not only the health and survival of women but also that of their children, notably through intrauterine growth retardation (Allen, 2005 and Bartley et al., 2005).

One of the main factors responsible for this type of malnutrition is the poor quality of women's diets as they lack dietary diversity. There is ample evidence from developed countries that dietary diversity is indeed strongly associated with nutrient adequacy (Ruel, 2003), and the growing evidence from developing countries supports this association (Arimond et al., 2010 and Mirmiran et al., 2004 and 2006).

In resource-poor environments across the globe, low-quality monotonous diets are the norm. When grain or tuber-based staple foods dominate and diets lack vegetables, fruits and animal-source foods, the risk for a range of micronutrient deficiencies is high. Women of reproductive age (15-49 years old) are particularly vulnerable because of their greater micronutrient needs (Torheim et al., 2010).

By improving women's diets we can thus not only improve their health and ability to work and care for their families, but also have a positive effect on pregnancy outcomes and the health and nutrition of infants and young children, falling within the 1 000-day window of opportunity.

Although in the past decades there had been many calls of attention to the quality of women's diets, with a specific focus on micronutrient adequacy, little programmatic action had been taken. Among other reasons, this was due to a scarcity of data on women dietary patterns and micronutrient deficiencies as well as to a lack of valid indicators.

In 2005, the Women's Dietary Diversity Project (WDDP) was launched to fill this 'data and indicators gap'. The first phase of the project (WDDP-I) was funded by the United States Agency for International Development (USAID) through the Food and Nutrition Technical Assistance project (FANTA) and was coordinated by the International Food Policy Research Institute (IFPRI), with the specific objective of identifying a set of simple food group indicators (FGIs) of dietary diversity to reflect the micronutrient adequacy of women's diets. They used altogether five datasets from Africa and Asia (urban populations for Burkina Faso, Mali and Philippines and rural populations for Mozambique and Bangladesh) (Arimond et al., 2011).

The project produced a number of quasi-continuous food groups indicators (FGIs) based in the counting of food groups (FG) consumed in a given period of time (see Table A1-1 in the appendix). The 9-point FG score (FGI-9) has been the most popular as it is used by the Food and Agriculture Organisation (FAO) and USAID.

However, the project failed to propose a single indicator or to provide thresholds for any of the FGIs to proxy micronutrient adequacy across all contexts. Therefore, the FAO guidelines on assessing individual dietary diversity for women were to report results by the mean population score (FAO, 2013).

These were important limitations in the use of the indicators for advocacy or programmatic actions, and there was a call for a dichotomous indicator for use across all contexts similar to the 'minimum dietary diversity-children' indicator being used for infants and young children.

As a result, the Nutrition Division of the FAO started the second phase of the project (WDDP-II) in 2012 with funds from the European Union-funded programme on improved global governance for hunger reduction. The analytical component was led by the Institut de Recherche pour le Développement (IRD) and its objectives were to explore the contribution of additional data to the analysis and investigate whether a standard cut-off could be identified to formulate a valid dichotomous women's dietary diversity indicator. They added four datasets (three rural datasets for Bangladesh, Burkina Faso and Uganda and one rural/urban for Uganda) to the five already used in the WDDP-I (Martin-Prével et al., 2015).

The project yielded two candidate dichotomous indicators: one based on the FGI-9 used by FAO and USAID, and a dichotomous indicator based on a 10-point food group score.

On July 2014, FAO and FANTA facilitated a technical meeting with participants from academia, international research institutes, United Nations (UN) and donor agencies in order to select one of the two as the best proxy indicator for global use in assessing the micronutrient adequacy of women's diets. They selected the 10-point food group score as the new indicator for MDD-W.

The MDD-W is defined as the consumption of at least five out of 10 FGs over the previous 24 hours. The interpretation is that women consuming foods from five or more of the selected 10 FGs have a greater likelihood of meeting their micronutrient needs.

It is important to emphasise that the MMD-W is measured at individual level, but inferences are made about dietary adequacy of populations. It is not appropriate for individual dietary assessment or screening and it does not reflect all dimensions for dietary quality. For instance, it cannot reflect appropriate quantity or balance and/or moderation in consumption.

The next steps proposed after the agreement on the indicator were the design of a users' manual on the MDD-W to be developed by FAO and partners (to be released soon) and the proposal of a research agenda covering different topics (FAO, 2014).

Two of the areas to be covered are how the new indicator relates to other dimensions and factors and how sensitive it is to changes. Understanding these aspects will be useful for building an advocacy discourse and for having a first approximation of its potential use for monitoring progress of nutrition-sensitive interventions and programmes. The latter will be even more important if the MDD-W is formally endorsed as one the indicators of the second Sustainable Development Goal (SDG).

The present study addresses those two areas by trying to answer the following research questions.

1. What is the relationship between the MDD-W indicator and other dimensions like socioeconomic status, food security (FS), nutritional status, education, etc.?

2. How sensitive is the indicator to changes (whether related to a programme or not)?

2. Data and methods

2.1 Data

The first challenge we faced when approaching this research was the scarcity and the limited accessibility to datasets that a) would collect information on women's diets in resource-poor settings, and b) would contain information that was detailed enough to allow for analysis.

As it has previously been mentioned, there is limited information on women's diets, especially from resource-poor settings. Before the 1 000-days approach was conceived in 2008, dietary surveys focused on the diet adequacy of infants and children rather than on that of the mothers or women of reproductive age (WRA).

Furthermore, as the new indicator is based on the FGI-10 and not on the FGI-9 that has been commonly used (see Table 1), the scarce data on women's diets that were collected through surveys did not fulfil the FG disaggregation needed for the construction of the MDD-W.

***Table 1*:** Food group disaggregation for FGI-9 and FGI-10

FGI-9R		FGI-10	
1	All starchy staples	**1**	All starchy staples
2	All legumes and nuts	**2**	Beans and peas
		3	Nuts and seeds
3	All dairy	**4**	All dairy
4	Organ meat	**5**	Flesh foods (including organ meat and miscellaneous small animal protein)
5	Flesh foods and miscellaneous small animal protein		
6	Eggs	**6**	Eggs
7	Vitamin A-rich dark green leafy vegetables	**7**	Vitamin A-rich dark green leafy vegetables
8	Other vitamin A-rich vegetables and fruits	**8**	Other vitamin A-rich vegetables and fruits
9	Other fruits and vegetables	**9**	Other vegetables
		10	Other fruits

If the survey collects the information according to the FGI-9 (or any of the FGIs proposed by the WDDP-I), then the food groups of 'all legumes and nuts' and of 'other fruits and vegetables' are usually collected in an aggregated way, with no possibility of disaggregation to construct the FGI-10.

Therefore, we dedicated an important part of the investigation to the search of datasets appropriate to conduct the analysis.

2.1.1 Review of potential data sources

We employed the following different methods to identify and access datasets with the appropriate information and format.

- ✓ **Public dataset repositories:** we reviewed public datasets from institutions conducting FS and nutrition surveys.
    - o *ORC Macro International* carries out periodical demographic and health surveys (DHS) at country level. Dietary information on women was collected only in the

fifth round (2003-2008), but the FG disaggregation is not valid for calculating the MDD-W.
    - *Unicef* conducts multiple clusters indicators surveys (MICS) focused on children and their mothers, but no information is collected on diet.
    - *World Bank* performs regular and panel living standards measurement studies (LSMS) surveys, but the diet information is collected only at household level and not at individual level.
    - *Feed the future nutrition innovation laboratories* carry out baseline surveys in their area of intervention. They collect women's diets, but in the surveys they have published so far, the groups' disaggregation does not allow for the construction of the MDD-W.
    - The *International Food Policy Research Institute* (IFPRI) hosts a household and community database repository coming from different surveys. We reviewed all databases containing *food consumption* as a key term in the description of the project and compiled the results of this search in Table A2-1 (see Appendix 2).

- ✓ **Review of EU-funded projects:** we reviewed the EU-funded projects in the development and the humanitarian aid sectors using the 'EU Aid Explorer' tool ([1]) with the aim of identifying projects yielding databases that could be of use for the analysis. However, the information included for the projects in this database does not allow for this type of identification.

- ✓ **Literature review:** we searched in Medline using the MesH terms *women* AND *diet* OR *food* in order to identify studies based on datasets with information on women's diets. We discarded the majority of the studies by the title based on context of study (e.g. carried out in developed countries), population group targeted (e.g. pregnant, post-menopausal women) or condition (disease, e.g. HIV-infected).

  The search yielded a study conducted in a small area in Ethiopia, the studies conducted by the IRD in Burkina Faso, a national study conducted by Hellen Keller International in Cameroon and the global studies conducted by the Global Nutrition and Policy consortium.

- ✓ **Personal contacts with public and/or private organisations** hosting diet and nutrition databases.
    - *World Health Organisation* (WHO): the nutrition department hosts databases on diet but contain only summary indicators from surveys and not the raw datasets. However, as they have collaborated with national governments on the undertaking of women's diets surveys, they were keen to facilitate the access to the corresponding datasets, specifically in Zimbabwe, Namibia and South Africa. The process is slow and has not yielded any up-to-date results.
    - *FAO*: the nutrition assessment and scientific advice group at FAO holds datasets on women's diets, though these are used to construct the WDPP indicators, including the MDD-W. We discarded the use of those datasets but may reconsider due to the scarcity of data on diets.
    - *Hellen Keller International*: the surveys conducted up until 2015 collected the information in the aggregated form for use with FGI-9 and could therefore not be used in this study.
    - *Global Nutrition and Policy Consortium*: Tufts University is the home of the global dietary database, an initiative that aims to characterise diet around the world in collaboration with the FAO and WHO Global Individual Food Consumption Data Tool (FAO/WHO GIFT). The group at FAO involved in the initiative is the nutrition assessment group and at WHO it is the food safety unit.

([1]) The EU Aid Explorer tool is available at https://euaidexplorer.ec.europa.eu/

The consortium could not give access to the database, as they do not yet have the data-sharing policy streamlined.

- *Feed the Future Nutrition Innovation Laboratories*: a USAID initiative based at Tufts University with the aim to assess how integrated interventions of agriculture, nutrition and health can achieve large-scale improvements in maternal and child nutrition in Asia and Africa. The following two potential datasets were identified.
  - Nepal dataset: we reviewed the preliminary report to discover that data had been collected on a weekly basis, which is not appropriate for our study.
  - Uganda panel dataset (October-December 2012): data were collected by 24-hour dietary recall in the appropriate format. The description of the survey indicates that the dataset may be appropriate for our analysis. However, the raw data are not yet accessible for potential analysis.
- *Institut de Recherche pour le Développement*: two IRD projects carried out in Burkina Faso (one rural and one urban) collected data that fulfil the requirements of our analysis. The rural dataset was one of the datasets incorporated into the WDDP-II (Martin-Prével, 2015).

As a result of this screening exercise, two datasets hosted at IRD emerged from Burkina Faso: one that collected information from two urban settings (Ouagadougou and Bobo-Dioulasso) in three consecutive years (2009, 2010 and 2011) and one conducted in two rural provinces (Sanguie and Sourou) in two seasons (lean and post-harvest) of the same year, 2010. The JRC signed a data-sharing agreement with the IRD; these are the datasets analysed in this report.

We set the following research questions for the analysis of these Burkina Faso datasets:

1. What is the proportion of women achieving a minimum dietary diversity in each of the settings and time periods/seasons studied? What are the FGs contributing to MDD-W in each of the settings by time period/season? Are there differences between settings and/or time periods/seasons? **(RQ1)**

2. What are the factors associated with the MDD-W in each of the settings and time periods/seasons? **(RQ2)**

3. How does the MDD-W correlate with other FS indicators at household level, like the Household Food Insecurity Access Scale (HFIAS) and others? **(RQ3)**

4. How does the MDD-W correlate with the nutritional status of women in the rural samples? **(RQ4)**

2.1.2 Description of the Burkina Faso datasets

2.1.2.1 Urban data

The urban datasets are part of an IRD project on Food and Nutrition Vulnerability on Urban Environment conducted in the cities of Ouagadougou and Bobo-Dioulasso in Burkina Faso from 2009 to 2011 (Becquey and Martin-Prével, 2008 and Kameli et al. 2011).

Ouagadougou is the capital and largest city of Burkina Faso and Bobo-Dioulasso is the second largest, with populations of around 1.5 million and 500 000 inhabitants, respectively (Institut National de la Statistique et de la Démographie, Burkina Faso, 2015) ([2]).

The sampling was done by multistage cluster sampling in both cities and during each year of the study. Information was collected on household sociodemographic and economic

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([2]) The latest available population figures are from the 2006 census, and at the time of the survey they were most probably higher given that Burkina Faso experienced a rapid urbanisation process (Boyer and Delaunay, 2009).

characteristics as well as questions on consumption in relation to vulnerability, food insecurity and dietary diversity, among others.

The dietary diversity data were obtained through a 24 hour qualitative recall, that was addressed preferably to mothers of children under 5 years, then in second place to adult women and, if neither was present in the house, to men (Kamely et al., 2011). For the purpose of the analysis, we kept only the registries that had dietary information completed for WRA. See the resulting sample sizes in Table 2.

Table 2: Urban sampling sizes used in the analysis

Year	**Ouagadougou (N*)**	**Bobo-Dioulasso (N*)**
2009	2 055	1 988
2010	1 957	2 207
2011	2 259	2 272

*N=Number of women interviewed

The data were collected in Ouagadougou at the start of the lean season ([3]) (July 2009, June 2010 and July 2011) and in Bobo-Dioulasso in the post-harvest period (December 2009, November 2010 and October 2011) (Vernay, 2012).

2.1.2.2 Rural data

The rural dataset is the product of a survey on food consumption and iron status carried out in two rural provinces of Burkina Faso: the Sourou province in the northwestern region of the Boucle du Mouhoun and the Sanguie province in the western region of the Centre Ouest. It was part of a project of the IRD, the Institute of Research in Health Sciences of Burkina Faso and HarvestPlus. The main objective of this study was to provide reliable information on micronutrient deficiencies and quantitative estimates of the intakes of sorghum and some key nutrients among women and preschool children.

The sampling procedure was a multistage cluster selection process of 240 households in both provinces and the target population consisted of women and preschool children. The same households were surveyed twice in 2010. The first round took place during July-August (lean season) and the second in November-December (post-harvest season). The data from the second round were included in the WDDP-II project (Martin-Prével et al., 2013).

Information was collected on household general characteristics, dietary intake and anthropometric measures, among others. The dietary data were obtained by quantitative 24-hour recalls (Martin-Prével et al., 2013).

2.2 Methods

2.2.1 Variables

Several categorical variables were calculated regarding dietary diversity, household characteristics and FS information, as described below.

Dietary Diversity Score

The Dietary Diversity Score (DDS) was calculated as the number of different food groups consumed by the women the day before out of the list of 10 FGs recommended for the calculation of the MDD-W. It ranges from 0 to 10.

([3]) Even in urban settings, food insecurity and micronutrient intake follow seasonality of the agricultural production (Becquey et al., 2012).

For the urban samples, we obtained the list of 10 FGs by regrouping the 21 FGs collected by the qualitative questionnaire (see Table A2-2 in the appendix).

For the rural samples, the researchers of the original survey had aggregated the 24-hour recall quantitative information into 27 FGs, which we reassembled in the list of 10 FGs (see Table A2-3 in the appendix).

Minimum Dietary Diversity-Women

We calculated the MDD-W as a dichotomous variable that we computed as 1 if the women had a DDS equal to or higher than 5, and as 0 if they had a DDS below 5 (see previous DDS definition).

Household Socioeconomic scores

We used the household socioeconomic scores (SES) included in the databases that had been calculated by the researchers of the original studies as follows.

In the urban samples, the SES was calculated by factorial multiple-correspondence analysis based on the following variables: the quality of housing materials (roof, walls and floor); the main source of energy used for cooking; types of latrines and showers; types of cuisine; the drainage system of household waste; the main source of drinking water; the lighting; the household density (in classes); the number of electrical equipment (in classes); the numbers of mobile phones and mopeds by people (in classes); and the possession of car and furniture.

In the rural samples, the SES was computed using a multiple-correspondence analysis based on the variables: household assets (cart, animals, moped, mobile phones and petrol lamp); secondary income in the household; quality of housing materials (roof, soil and walls); access to safe water; and latrines.

The tertiles of the SES were calculated to categorise the population into low, middle and high socioeconomic categories.

Youth and Dependency ratios

The youth ratio was calculated as the number of household members under the age of 15 divided by the number of persons above the age of 15.

The dependency ratio was calculated as the number of people contributing to a household's income divided by the number of people in the household not contributing.

Tertiles of the youth ratio and the dependency ratio were calculated to categorise the population in the low, middle or high range of each.

Household Food security indicators

The HFIAS is a measure of food insecurity developed by FANTA. It records household reactions and response to food access problems faced during a recall period of 30 days. It aims to capture the severity of food insecurity faced by households due to lack of or limited resources to access food. It is composed of nine questions and each question has four response options: 'never', 'rarely', 'sometimes' and 'often', which are coded 0, 1, 2 and 3 in order of increasing frequency. Responses to these nine questions are summed up to make a food insecurity score, with a maximum score of 27 indicating most food-insecure households (Coates et al., 2007).

The Household Hunger Scale (HHS) is a food-deprivation scale based on the idea that the experience of household food deprivation causes predictable reactions that can be captured by a survey. It has its origins in the HFIAS and is constructed based on the three occurrence questions indicating the most severe level of food insecurity. The frequency of occurrence is reduced to two responses: 'rarely or sometimes' and 'often'. The score ranges from 0 to 6, which indicates the maximum score for food-insecure households (Ballard T et al., 2011).

The Coping Strategies Index (CSI) is an indicator of household food insecurity that is based on a series of questions about how the household manages to cope with a shortfall in food for consumption. It is context-specific (Maxwell, 2008). The comparative (reduced) CSI is a subset of the context-specific CSI but is calculated using a specific set of behaviours with a universal battery of severity weightings for each behaviour. Thus, the reduced CSI uses a standard set of five individual coping behaviours that can be employed by any household anywhere. Researchers of the original urban study calculated the reduced CSI based on these five questions, in relation to the previous month, with a resulting scale that ranged from 0 to 28 points (see Kameli et al. 2011 for further details). The CSI was not collected in the rural surveys.

Women nutritional status

We used a woman's anthropometric status as proxy of her nutritional status. The anthropometric status of women was assessed through the Body Mass Index (BMI: weight in kg/height in m²) and international thresholds were used to define underweight (< 18.5 kg/m²) and overweight (≥ 25 kg/m²).

2.2.2 Statistical analysis

Here we describe the analytical methods following the research questions outlined in the introduction. All statistical analyses were performed using Stata (special edition) version 13.1.

RQ1: MDD-W and food groups consumption

Minimum Dietary Diversity-Women

We calculated the proportion of WRA with MDD-W separately for the two urban settings (Ouagadougou and Bobo-Dioulasso) in both survey years as well as for the two rural settings (Sanguie and Sourou) in each of the seasons surveyed.

The results from the urban and the rural surveys were not comparable as they had collected the dietary information using different methods (qualitative in the urban survey and quantitative in the rural) and there is evidence, specifically from Burkina Faso, showing that results may differ substantially (Martin-Prével et al, 2010).

Therefore, we compared the proportions between the urban settings in both years and between the rural settings in each of the seasons by using Pearson's Chi Square tests (χ^2).

In order to compare the differences between years for each urban setting we applied logistic regressions in which the dependent variable was the MDD-W and the main independent variable was the year of the survey. We introduced household characteristics that differed significantly between the different years for each setting as possible confounders.

As in the rural area, the two rounds of the survey were done in the same households where household characteristics did not differ, allowing us to apply a χ^2 test to compare the average proportion of women reaching the minimum dietary diversity between seasons.

Food group consumption

We calculated the percentages of each of the 10 FGs consumed the day before and represented them both by setting and by period of study along with the mean of the DDS.

The percentages of the different food groups consumed was also calculated for each DDS category, and the DDS categories with less than 20 records (DDS=1, DDS=8 and DDS=9 were discarded in the urban analysis and DDS=7 in the rural ones) were omitted in the representation.

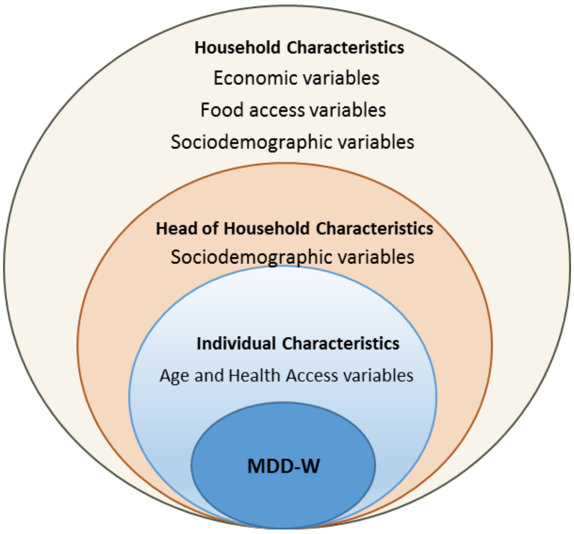
In the urban samples, there were no substantial differences between years in relation to the food group distribution according to FG, and therefore the data of the 3 years were pooled for Ouagadougou and Bobo-Dioulasso.

In the rural samples, however, there were significant differences between seasons in relation to FG distribution and DDS, and we therefore present the results separately.

RQ2: MDD-W associated factors

We independently assessed the MDD-W-associated factors in each of the settings and times of study following our own conceptual framework presented in Figure 1.

Figure 1: Conceptual framework for the assessment of MDD-W-associated factors



We grouped the variables in three dimensions. The first includes variables directly related to women, including biological (age), and health service access (post-natal care, vitamin A supplementation, iron supplementation and bed net ownership). The second group encompasses characteristics of the head of the household (age, gender, religion, marital status, occupation and level of studies). The third group captures household general characteristics. The variables were introduced in the model in this order: sociodemographic variables (youth and dependency ratio), food access-related variables (food stocks, livestock ownership, urban garden or agricultural production and time to closest place to purchase food, etc.) and socioeconomic variables (socioeconomic score, type of income, household assets, agricultural assets, etc.).

Depending on the survey (urban or rural), the variables included in each dimension vary. For instance, the urban survey did not collect information on access to health services and the information collected for the head of the household differed between rural and urban surveys.

The household SES were constructed differently for the rural and urban surveys, as has already been described in this section. Furthermore, in the rural surveys we tested the association with particular household assets independently from the household socioeconomic score as we considered they could have an impact on the diet, irrespective of their role as wealth contributors. We tested for correlations among all independent variables and closely explored variables in each dimension to select the best suited for each analysis.

As a first step, we carried out bivariate logistic regression analyses with MDD-W as the dependent variable and the covariates according to the conceptual framework (see details in Tables A2-4 and A2-5 in the appendix). After exploration and initial selection of variables in each dimension, all variables associated with MDD-W at the p value (p) below 0.10 were included in the multivariable analysis.

We built six logistic regression models (one for each setting and period of study) by using a manual stepwise forward procedure. P-values less than or equal to 0.05 were considered statistically significant, and we computed the adjusted odds ratio (aOR) with the 95 % confidence intervals (95 % CI) for each model.

RQ3: Food security indicators and MDD-W

The approach to this research question was slightly different for the rural and urban samples.

For the urban samples, we first pooled the data within cities, thus pooling the 3-year samples for Ouagadougou and the 3-year samples for Bobo-Dioulasso. In each of these pooled samples we carried out an ordinary least square (OLS) model (one for each of the FS indicators as dependent variables) and introduced the interaction term (MDD-W*year) as covariate. The interaction terms were significant at the level of $p < 0.20$ in Ouagadougou for the HFIAS indicator and in Bobo-Dioulasso for the HHS and CSI indicators (see Tables A2-6 and A2-7 in the appendix). Thus, for the sake of consistency, we performed the analysis separately for each year both in Ouagadougou and in Bobo-Dioulasso.

Subsequently, we applied a series of OLS regressions with each of the FS indicators as dependent variables, specified under two broad regimes. The first (model 1-without controls) includes only the MDD-W as independent variable. In the second (model 2-with controls) we controlled for potential confounders: characteristics of the head of household (age, gender and level of studies) and the socioeconomic score.

Furthermore, in each of the scenarios (cities and year of survey) we tested the interaction term (MDD-W*SES) to find that it was significant for all urban scenarios, and thus we stratified the analysis according to the SES in order to tease potential heterogeneities in the relationships across the distribution of the socioeconomic score.

In the rural samples we pooled the data for the two provinces and seasons and carried out a random effect regression, introducing the interaction terms MDD-W*province and MDD-W*season to take into account for the panel nature of the data. The interaction term MDD-W*province was highly significant (see Table A2-8 in the appendix), and we decided to perform analyses separately for each rural scenario.

We then conducted OLS regressions for each province and season under the two broad regimes applied to the urban samples. The model 2-with controls included household conditions (floor); possession of sheep, cart or plough; and the socioeconomic score as potential confounders.

We also tested for the interaction term (MDD-W*SES) in the rural models but it was only significant for HFIAS in the lean season of Sanguie and, therefore, we limited the stratification to that sample and indicator.

RQ4: nutritional status and MDD-W

Information on nutritional status for all women was collected only in the rural surveys.

We pooled all rural data and compared mean BMI values among women consuming five or more FG and women consuming less than five FG using Student's *t* test. Mean BMI values for each province and season are represented in a box plot.

With the pooled data we constructed three regression models (OLS, random effect and fixed effect) with BMI as the dependent variable and MDD-W, season, province and the interaction terms MDD-W*season, and MDD-W*province as explanatory variables. The random effect and the fixed effect models take into account the panel structure of the data by allowing a time-invariant mother effect.

3. Results

3.1 Urban samples

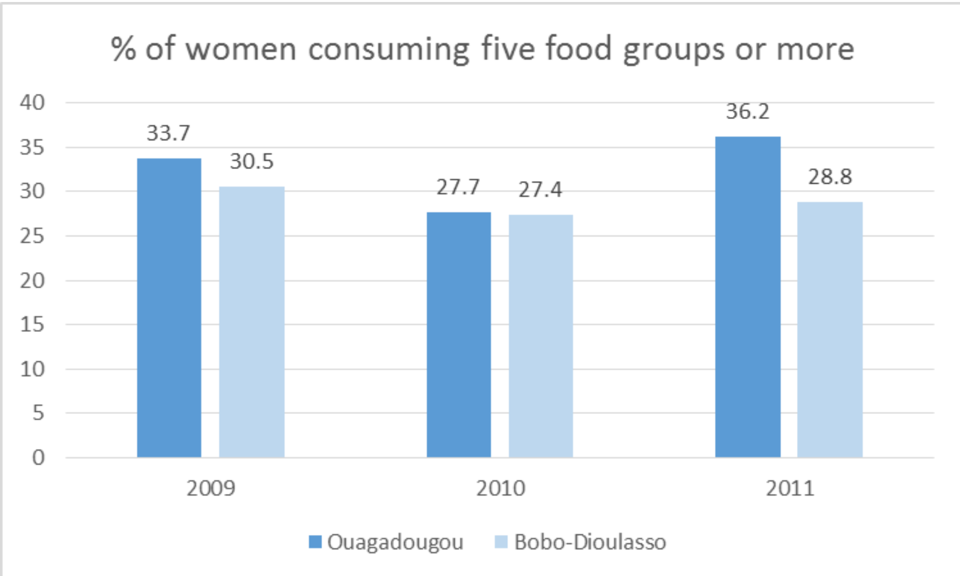
The sample characteristics differed by city and by year of study as described in Table A3-1 in the appendix.

3.1.1 MDD-W and food group consumption in the urban samples

The results show that the proportion of women attaining the MDD was different for each city and in each year studied (see Figure 2).

The MDD-W was low in all the samples studied, with less than four in 10 women consuming five or more FGs. The low values in 2009 could be a result of the rise in food prices in 2008, which remained high even after the crisis. This type of crisis may especially affect urban households, as they depend on the market for food provisioning, and see their purchasing power reduced. However, we would need data prior to 2008 to test this hypothesis. In 2010, there was a food security crisis in the Sahel due to poor rainfall, which may be related to the low dietary diversity recorded in June-July 2010.

Figure 2: Percentage of women attaining MDD-W in Ouagadougou and Bobo-Dioulasso,2009-2011



The fact that MDD-W was lower in Bobo-Dioulasso compared to Ouagadougou may be reflecting differences in the cities' characteristics, as Ouagadougou is a larger city and may offer a wider range of food products in its markets. However, the difference observed may be even more significant if the data were to be collected at the same time of the year. In this study, the information was collected in Bobo-Dioulasso in the post-harvest (PH) season and in Ouagadougou in the lean season, and an increase in overall micronutrient adequacy from the lean to the PH season has already been reported among urban women in Burkina Faso (Becquey, 2012).

Fluctuations in MDD-W were stronger in Ouagadougou than in Bobo-Dioulasso. In 2010, women in Ouagadougou were 20-30 % less likely than in adjacent years to obtain MDD-W, whereas in Bobo-Dioulasso the likelihood was 20 % lower compared to 2009, but there was no significant difference from 2011 (see Table A3-2 in the appendix). This can be associated with the fact that Bobo-Dioulasso is a smaller city closer to the rural world and therefore is less dependent on the market, or that Bobo-Dioulasso did not suffer major FS shocks during the observation period. Furthermore, the stark deterioration for Ouagadougou dietary diversity in 2010 has previously been associated with the floods that occurred in Burkina Faso in September 2009. More than 44 % of the Ouagadougou sample households were affected and showed a dietary diversity significantly lower than the unaffected ones (Vernay, 2012). In Ouagadougou, the mean DDS ranged from 3.8 in 2009 to 4.1 in 2011 and in Bobo-Dioulasso from 3.7 in 2010 to 3.9 in 2009. The FG more frequently consumed in both cities was the starchy staples, vitamin A-rich leafy vegetables and other vegetables, while eggs, dairy and other fruits were consumed the least. In 2009 the consumption of flesh foods was higher than in subsequent years for both cities, and higher in Bobo-Dioulasso overall. Other key differences between the two cities were that the FG consumption of beans and peas and of nuts and seeds was lower in Bobo-Dioulasso overall and that the vitamin A-rich leafy vegetables and fruits increased in Ouagadougou from year to year but decreased in Bobo-Dioulasso (Figures 3 and 4).

Figure 3: Mean DDS and food group consumption in Ouagadougou, 2009-2011

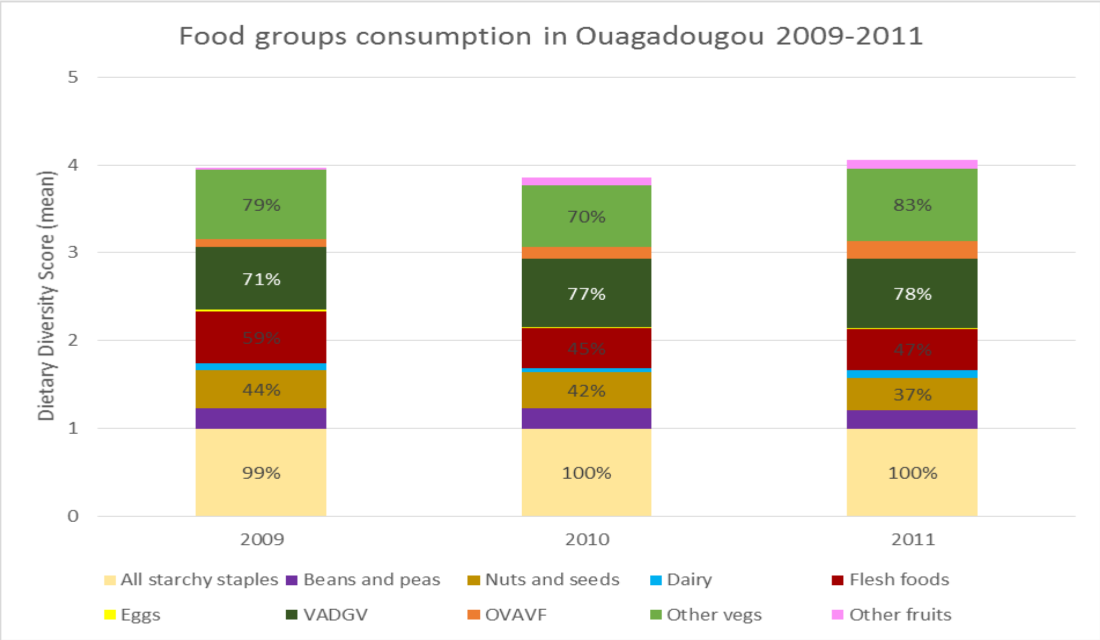
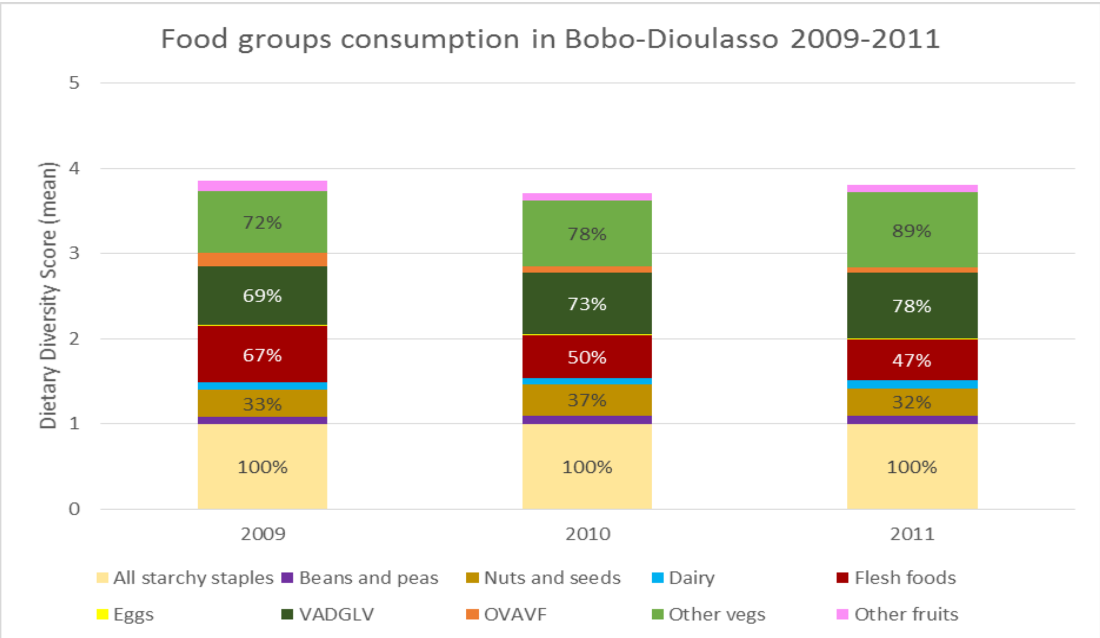


Figure 4: Mean DDS and food group consumption in Bobo-Dioulasso, 2009-2011



Part of these differences can be resulting from the different times of year when data were collected. For instance, November is not a favourable month for mango consumption, which can affect the low vitamin A-rich vegetables and fruits recorded for Bobo-Dioulasso in 2010 and 2011.

Figure 5: Percentage of food group consumption by dietary diversity scores in Ouagadougou, 2009-2011

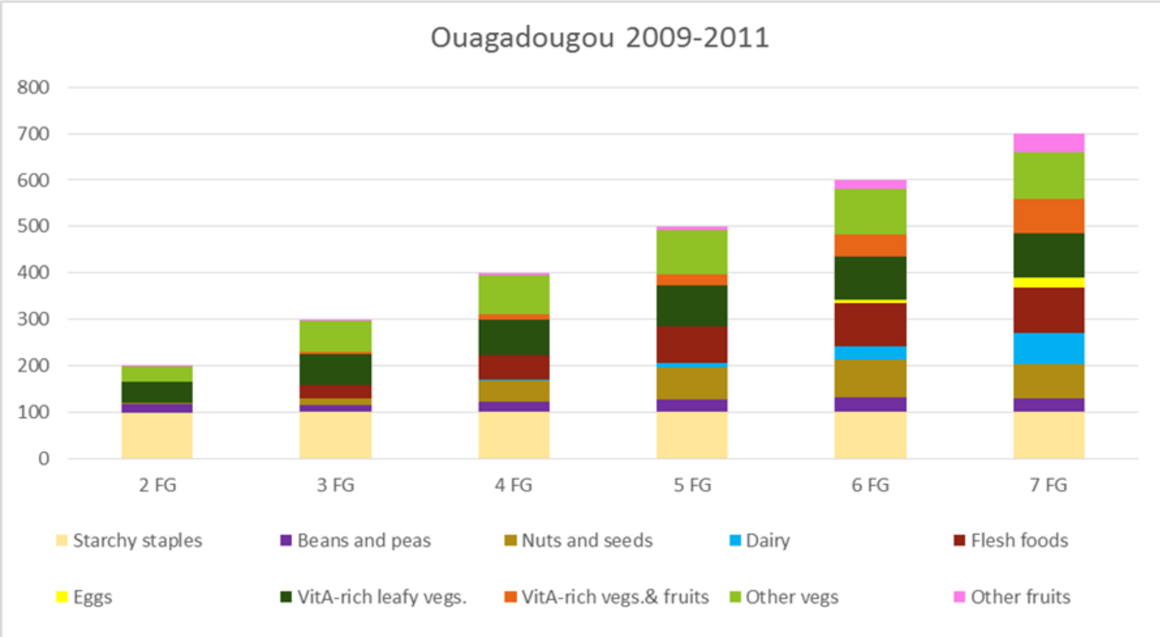
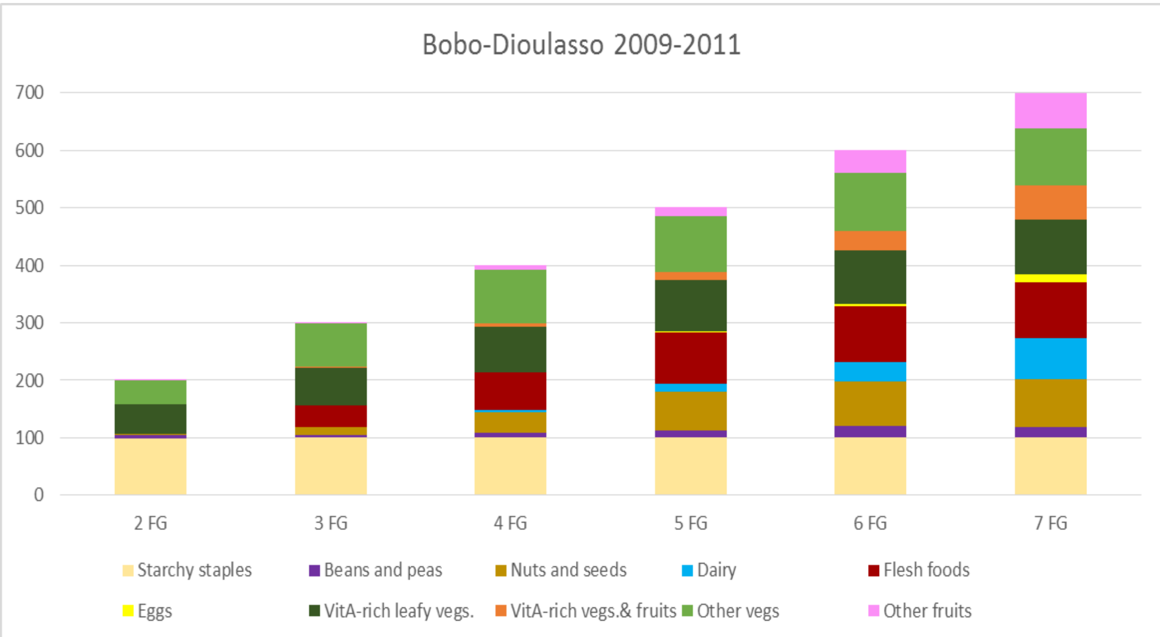


Figure 6: Percentage of food group consumption by dietary diversity scores in Bobo-Dioulasso, 2009-2011



By observing Figures 5 and 6, we can see that in both cities the FGs that are more likely to be added in the shift from the four FG category to the five FG category and above (MDD-W) are the animal source foods (dairy and flesh foods), nuts and seeds, vitamin A-rich vegetables and fruits, and other fruits.

3.1.2 Factors associated with MDD-W in the urban samples

In Tables 3 and 4, we present the results of the multivariable logistic regression with MDD-W as dependent variable in Ouagadougou and Bobo-Dioulasso, respectively.

Table 3: MDD-W-associated factors in Ouagadougou, 2009-2011

	OUAGADOUGOU					
	2009		2010		2011	
Covariate	MDDW %	aOR (CI 95%)	MDDW %	aOR (CI 95%)	MDDW %	aOR
Woman's age						
15-25 years			31.1	ref		
26-35 years			26.7	0.8(0.6-1.0)		
36-49 years			25.3	0.7(0.5-0.9)		
				0.009		
Sex head of household						
Male	34.4	ref				
Female	27.7	0.7 (0.5-0.9)				
p		0.04				
Household youth ratio score						
Low	39.3	ref				
Middle	38.3	1.1 (0.8-1.4)				
High	26.0	0.8 (0.6-0.9)				
p		0.01				
Household food stocks						
None	23.4	ref	17.4	ref	24.3	ref
Little (food for 2 days at least)	28.1	1.4(1.0-1.9)	22.1	1.3 (1.0-1.8)	37.0	1.6 (1.1-2.4)
At least 5 kg of cereals	34.0	1.2 (0.9-1.6)	31.3	1.7 (1.3-2.2)	33.8	1.2 (0.9-1.5)
At least 20 kg of cereals	48.4	1.8 (1.4-2.3)	53.0	2.0 (1.9-3.8)	50.8	1.6 (1.2-2.0)
p		0.0002		<0.0001		0.005
Chicken						
No	34.5	ref			32.3	ref
Yes	25.5	0.6(0.4-0.9)			31.2	0.8 (0.6-1.0)
p		0.004				0.01
Vegetable garden						
No	19.2	ref				
Yes	36.2	0.6 (0.5-0.9)				
p		0.004				
Transport time to food purchasing						
Less than 20 minutos	29.8	ref				**
20 minutes or more	58.1	2.8 (2.1-3.7)				
p		<0.0001				
Socioeconomic score						
Low	20.6	ref	16.5	ref	20.7	ref
Middle	27.8	1.3 (0.9-1.7)	24.1	1.45 (1.1-1.9)	27.5	1.3 (1.0-1.7)
High	52.2	3.0 (2.3-3.9)	50.3	3.4 (2.6-4.6)	55.5	3.3 (2.5-4.4)
p		<0.0001		<0.0001		<0.0001
Pseudo R2(2009)=0.11 Pseudo R2(2010)=0.09 Pseudo R2(2011)=0.08						

In Ouagadougou, the household socioeconomic status and the food stocks available were consistently correlated with the MDD-W over the 3 years. Women living in high SES households were around three times more likely to be consuming five FG or more than women from low socioeconomic households. In addition, living in a household with at least 20 kg of cereals as food stock increased the likelihood of reaching MDD-W between 1.6-2 times. The increasing level of education of the head of the household was also consistently associated with a higher likelihood of reaching MDD-W, although only significantly at the bivariate analysis.

The female-headed households showed a lower proportion of women with MDD-W (28 % versus 34 % of male-headed households), but only in 2009, which may be reflecting a higher vulnerability of these types of households to the contemporary price crisis that had occurred the previous year.

The youth ratio was only associated with MDD-W in 2009, showing that women living in households with a higher proportion of children per adult were less likely to be consuming five FG or more. Other studies have shown that the household demographic distribution in Burkina Faso changed over the 2009-2011 period towards smaller families.

In the year 2009, there was a group of variables related to food access that showed a negative association with MDD-W. Women living in households that have chickens, an urban parcel or are located close to a food-purchasing place (less than 20 minutes away from the household) were less likely to be consuming five FG or more. Although these variables may be associated with a higher dietary adequacy in other urban contexts, we consider that in the samples studied they are characterising the peri-urban subpopulations of Ouagadougou. The urban population of Ouagadougou increased dramatically after the 2008 food price crisis, resulting in the emergence of peri-urban areas without proper constructions or public service provisions, in which a high concentration of impoverished populations live (May, 2006). A previous analysis of this same sample has shown that the dietary diversity of the households located in these peri-urban areas was significantly lower (Kameli et al., 2010). A descriptive analysis of our data showed that the proportion of peri-urban households that have chickens, urban parcels or are located close to a food-purchasing place was significantly higher than the proportion of urban households with these same characteristics.

Table 4: MDD-W-associated factors in Bobo-Dioulasso, 2009-2011

	BOBO-DIOULASSO					
	2009		2010		2011	
Covariate	MDDW %	aOR (CI 95%)	MDDW %	aOR (CI 95%)	MDDW %	aOR (CI 95%)
Age respondent						
15-25 years					34.5	ref
26-35 years					26.6	0.7 (0.6-0.9)
36-49 years					26.2	0.7 (0.6-0.9)
p						0.006
Head of household education status						
None	26.4	ref	20.7	ref		
Primary school	26.7	0.9 (0.7-1.1)	28.9	1.2(1.9-1.6)		
Secondary school and above	48.1	1.4 (1.1-1.8)	43.0	1.5(1.2-1.9)		
p		0.01		0.005		
Household youth ratio score						
Low				ref	35.6	ref
Middle				0.91 (0.7-1.1)	26.6	0.7 (0.6-0.9)
High				0.67 (0.5-0.9)	21.8	0.7 (0.5-0.9)
p				0.02		0.005
Household food stocks						
None	26.0	ref				**
Little (food for 2 days at least)	23.2	0.8 (0.5-1.1)				
At least 5 kg of cereals	29.0	1.0 (0.8-1.4)				
At least 20 kg of cereals	39.8	1.5 (1.1-1.9)				
p		0.002				
Socioeconomic score						
Low	16.0	ref	11.4	ref	15.6	ref
Middle	26.8	1.9 (1.5-2.6)	22.6	2.1 (1.6-2.9)	21.0	1.3 (1.0-1.8)
High	48.9	4.3 (3.2-5.6)	45.1	5.2 (4.0-6.9)	42.5	3.4 (2.6-4.4)
p		<0.0001		<0.0001		<0.0001

Pseudo R2(2009)=0.08 Pseudo R2(2010)=0.10 Pseudo R2(2011)=0.07

In Bobo-Dioulasso, the factors that were consistently associated with MDD-W over the 3 years were the socioeconomic score and the level of education of the head of the household. Women living in households falling in the high tertile of the socioeconomic score were three to five times more likely to consume five FG or more. In addition, the higher the education of the head of the household, the more likely the women were to reach MDD-W in 2009 and in 2010. Results from 2011 show the same trend, although the association lost significance when introduced in the multivariable model.

The food stocks were only significantly associated with MDD-W in 2009. The association was not significant in the final model of 2010 and there were no data for this variable in 2011. The difference with Ouagadougou results may partly be explained by the proximity of the city of Bobo-Dioulasso to the rural world, which makes the population less dependent on food stocks and markets.

Finally, in the years 2010 and 2011, the household youth ratio was negatively associated with the consumption of five FG or more by the women. The higher the proportion of children in relation to adults, the less likely the women were to reach MDD-W, suggesting a preferential food allocation to children.

3.1.3 MDD-W and other food security indicators in the urban samples

The analysis of the relationship between different food security indicators (HFIAS, HHS and CSI) and MDD-W shows that there is a strong correlation between these measures of food insecurity and the MDD-W indicator, and that the associations may be modified by the socioeconomic status of the households.

Table 5: Mean difference in HFIAS between MDD-W=0 and MDD-W=1, Ouagadougou and Bobo-Dioulasso, 2009-2011

	Model 1 -without controls											
	OLS			Low SES			Medium SES			High SES		
Survey	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p
Ouaga 2009	-3.45	0.293	<0.001	-1.77	0.541	0.001	-1.32	0.481	0.006	-1.63	0.395	<0.0001
Ouaga 2010	-4.22	0.326	<0.001	-1.03	0.523	0.05	-0.6	0.575	0.294	-4.2	0.487	<0.0001
Ouaga 2011	-4.38	0.305	<0.001	-0.96	0.578	0.096	-2.11	0.533	0.001	-1.96	0.36	<0.0001
Bobo 2009	-3.69	0.327	<0.0001	-2.34	0.688	0.001	-0.955	0.531	0.07	-2.79	0.486	<0.0001
Bobo 2010	-3.75	0.322	<0.0001	-3.63	0.748	<0.0001	-1.71	0.593	0.004	-1.39	0.385	<0.0001
Bobo 2011	-4.19	0.29	<0.0001	-1.41	0.673	<0.0001	-3.38	0.578	<0.001	-1.96	0.339	<0.0001
	Model 2- with controls											
	OLS			Low SES			Medium SES			High SES		
Survey	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p
Ouaga 2009	-1.35	0.258	<0.0001	-1.37	0.455	0.006	-1.37	0.499	0.004	-1.36	0.403	0.001
Ouaga 2010	-1.94	0.302	<0.0001	-0.92	0.515	0.075	-0.64	0.555	0.24	-3.9	0.495	<0.0001
Ouaga 2011	-1.59	0.265	<0.0001	-0.84	0.536	0.116	-1.98	0.487	<0.0001	-1.76	0.391	<0.0001
Bobo 2009	-1.96	0.314	<0.0001	-2.17	0.656	0.001	-0.95	0.53	0.074	-2.68	0.483	<0.0001
Bobo 2010	-1.78	0.302	<0.0001	-3.49	0.685	<0.0001	-1.66	0.572	0.004	-1.23	0.413	0.003
Bobo 2011	-2.133	0.273	<0.0001	-1.41	0.609	0.02	-3.42	0.56	<0.0001	-1.84	0.363	<0.0001

In Table 5, we see that in both cities, women consuming five or more FG lived in households with a food insecurity (measured by HFIAS) that was by mean three to four points lower in relation to households of women consuming four FG or less. When we adjusted the association by the household socioeconomic and demographic variables, it decreased by 1.5-2 points in the scale (see the methods section for details). That is, when taking into account other household characteristics that may be confounding the association between MDD-W and the FS indicator (HFIAS), the magnitude of the association was reduced, yet the direction and significance was maintained.

The household socioeconomic score modified the association between the MDD-W and the food insecurity scores analysed, as described in Tables A2-6 and A2-7, and thus the analysis was stratified by this variable.

In Ouagadougou the association was strongest for women living in households falling in the high tertile of the socioeconomic index in the 3 years studied. That is, the difference in the mean of the food insecurity scale between households of women consuming five FG or more and households of women consuming four FG or less was more pronounced among households in the high socioeconomic category.

Table 6 shows that in all surveys studied there were also strong associations between the household hunger score and the MDD-W. Women consuming five FG or more live in households with a mean HHS between 0.5 and 0.7 points lower. Similarly to what happened with the HFIAS when the association was adjusted by the socioeconomic variables, the correlation decreased to about half, between 0.2 and 0.5 points below the HHS. By stratifying the analysis by the household socioeconomic score, it was clear that the association between HHS and MDD-W was stronger in higher socioeconomic categories of Ouagadougou. In Bobo-Dioulasso, the difference in the associations found in the different socioeconomic categories was not consistent throughout the years.

Table 6: Mean difference in HHS between MDD-W=0 and MDD-W=1, Ouagadougou and Bobo-Dioulasso, 2009-2011

	Model 1 -without Controls											
	OLS			Low SES			Medium SES			High SES		
Survey	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p
Ouaga 2009	-0.61	0.070	<0.0001	-0.36	0.154	0.02	-0.27	0.126	0.04	-0.12	0.069	0.078
Ouaga 2010	-0.72	0.073	<0.0001	-0.27	0.132	0.04	-0.02	0.136	0.908	-0.55	0.088	<0.0001
Ouaga 2011	-0.73	0.062	<0.0001	-0.27	0.139	0.05	-0.49	0.119	<0.0001	-0.17	0.063	0.007
Bobo 2009	-0.79	0.779	<0.0001	-0.65	0.191	0.001	-0.38	0.135	0.005	-0.55	0.955	<0.0001
Bobo 2010	-0.69	0.065	<0.0001	-0.73	0.174	<0.0001	-0.43	0.135	0.002	-0.21	0.688	0.003
Bobo 2011	-0.53	0.058	<0.0001	-0.22	0.148	0.136	-0.47	0.131	<0.0001	-0.21	0.062	0.001
	Model 2-with Controls											
	OLS			Low SES			Medium SES			High SES		
Survey	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p
Ouaga 2009	-0.19	0.066	0.004	-0.30	0.128	0.021	-0.26	0.116	0.023	-0.07	0.103	0.51
Ouaga 2010	-0.27	0.070	<0.0001	-0.25	0.120	0.039	-0.02	0.129	0.877	-0.49	0.116	<0.0001
Ouaga 2011	-0.26	0.057	<0.0001	-0.25	0.116	0.033	-0.46	0.106	<0.0001	-0.13	0.084	0.115
Bobo 2009	-0.50	0.078	<0.0001	-0.62	0.162	<0.0001	-0.38	0.131	0.004	-0.54	0.119	<0.0001
Bobo 2010	-0.35	0.658	<0.0001	-0.71	0.149	<0.0001	-0.43	0.124	0.001	-0.18	0.089	0.043
Bobo 2011	-0.26	0.057	<0.0001	-0.22	0.128	0.084	-0.47	0.118	<0.0001	-0.19	0.076	0.015

The association between the Coping Strategies Index and the MDD-W was similar to the one found with the other food insecurity indicators.

For all samples studied, there was a strong association between the CSI and the MDD-W. Women consuming five FG or more lived in households with a mean CSI four to six points lower compared to the household of women consuming less than five FG. In Ouagadougou, this association was strongest in the households belonging to the high socioeconomic category, while in Bobo-Dioulasso it differed depending on the year (Table 7).

Table 7: Mean difference in CSI between MDD-W=0 and MDD-W=1, Ouagadougou and Bobo-Dioulasso, 2009-2011

	Model 1 -without Controls											
	OLS			Low SES			Medium SES			High SES		
Survey	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p
Ouaga 2010	-6.07	0.538	<0.0001	-2.11	0.972	0.03	-1.45	1.01	0.15	-4.76	0.626	<0.0001
Ouaga 2011	-5.82	0.447	<0.0001	-1.02	0.941	0.276	-3.44	0.834	<0.0001	-2.18	0.461	<0.0001
Bobo 2010	-5.81	0.492	<0.0001	-4.88	1.25	<0.0001	-3.04	0.99	0.002	-1.73	0.507	0.001
Bobo 2011	-4.79	0.412	<0.0001	-2.2	1.003	0.03	-4.5	0.868	<0.0001	-2.14	0.45	<0.0001
	Model 2-with Controls											
	OLS			Low SES			Medium SES			High SES		
Survey	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p	Coef.	SE	p
Ouaga 2010	-2.68	0.513	<0.0001	-1.978	0.88	0.025	-1.41	0.947	0.138	-4.34	0.845	<0.0001
Ouaga 2011	-2.08	0.402	<0.0001	-0.855	0.81	0.292	-3.28	0.738	<0.0001	-1.95	0.591	0.001
Bobo 2010	-2.55	0.473	<0.0001	-4.7	1.075	<0.0001	-2.96	0.897	0.001	-1.56	0.65	0.016
Bobo 2011	-2.67	0.392	<0.0001	-2.23	0.876	0.011	-4.61	0.806	<0.0001	-2.02	0.523	<0.0001

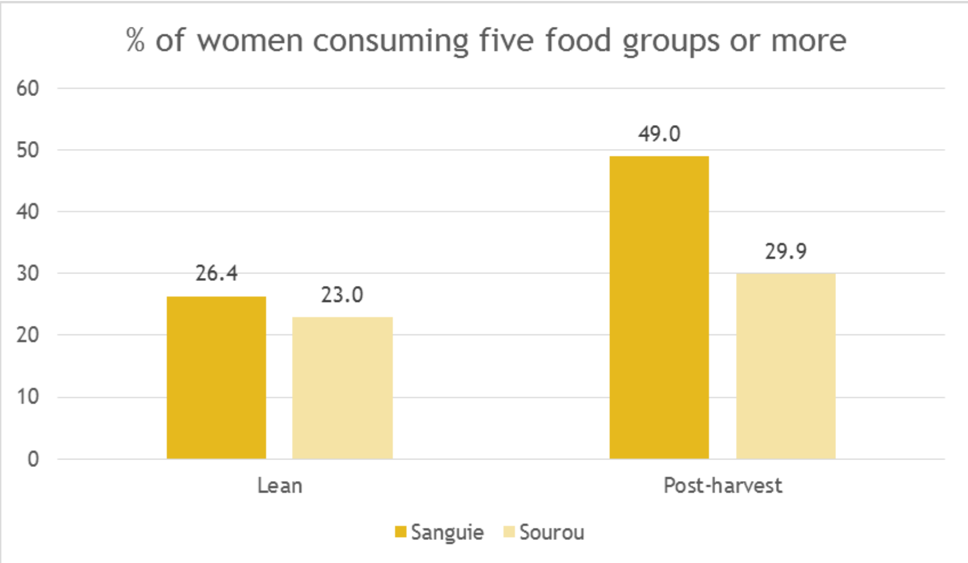
3.2 Rural samples

The characteristics of the samples of the Sanguie and the Sourou provinces are described in Table A3-3 in the appendix.

3.2.1 MDD-W and food group consumption in the rural samples

The proportion of women consuming five FG or more was significantly higher in Sanguie compared to in Sourou (49 % and 29.9 %, respectively). However, this was only the case in the PH season ($p < 0.0001$), as can be seen in Figure 7.

Figure 7: Percentage of women attaining MDD-W in Sanguie and Sourou provinces in the lean and post-harvest seasons, 2010



In Sanguie province, the percentage of women reaching MDD-W increased significantly from the lean season (26.4 %) to the PH season (49 %) with $p < 0.0001$. And in Sourou, the proportion of women achieving the MDD-W also increased from the lean season (23.0 %) to the PH season (29.9 %), but not significantly with $p = 0.089$. These results are consistent with the increased mean probability of adequacy (MPA) of women's micronutrient intakes from the lean season to the PH season reported for this same population (Arsenault et al., 2014).

The mean DDS increased from the lean season to the PH season from 3.9 to 4.5 in Sanguie and from 3.8 to 4.0 in Sourou (Figures 8 and 9).

During the lean season in both provinces the FG that was most consumed was the staple starchy, followed by vitamin A-rich leafy vegetables, nuts and seeds and vitamin A-rich vegetables and fruits. The consumption of flesh foods was more important in Sourou during this season, whereas nuts and seeds were more frequently consumed in Sanguie.

However, in the PH season, the FG consumption pattern changed in relation to the provinces. In Sanguie, second to starchy staples were nuts and seeds, followed by other vegetables and flesh foods, whereas in Sourou the vitamin A-rich leafy vegetables was the second group in frequency consumption, followed by nuts and seeds, flesh foods and other vegetables. Consumption of flesh food and vitamin A-rich vegetables and fruits was higher in Sanguie in the PH season. The consumption of other fruits was almost insignificant in both provinces (Figures 8 and 9).

Figure 8: Mean DDS and food group consumption in Sanguie province, lean and post-harvest season, 2010

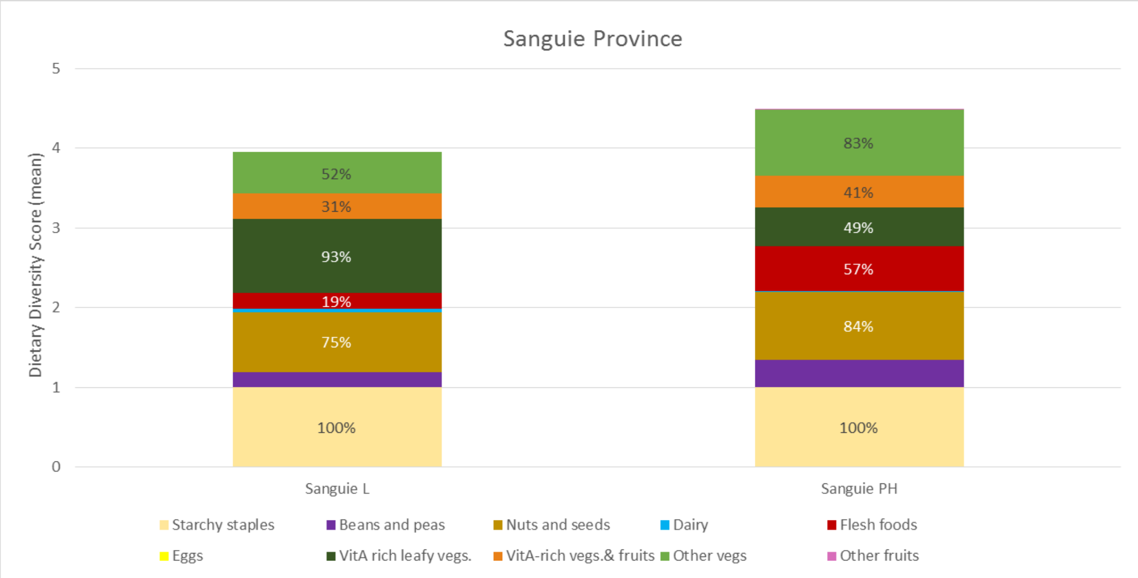
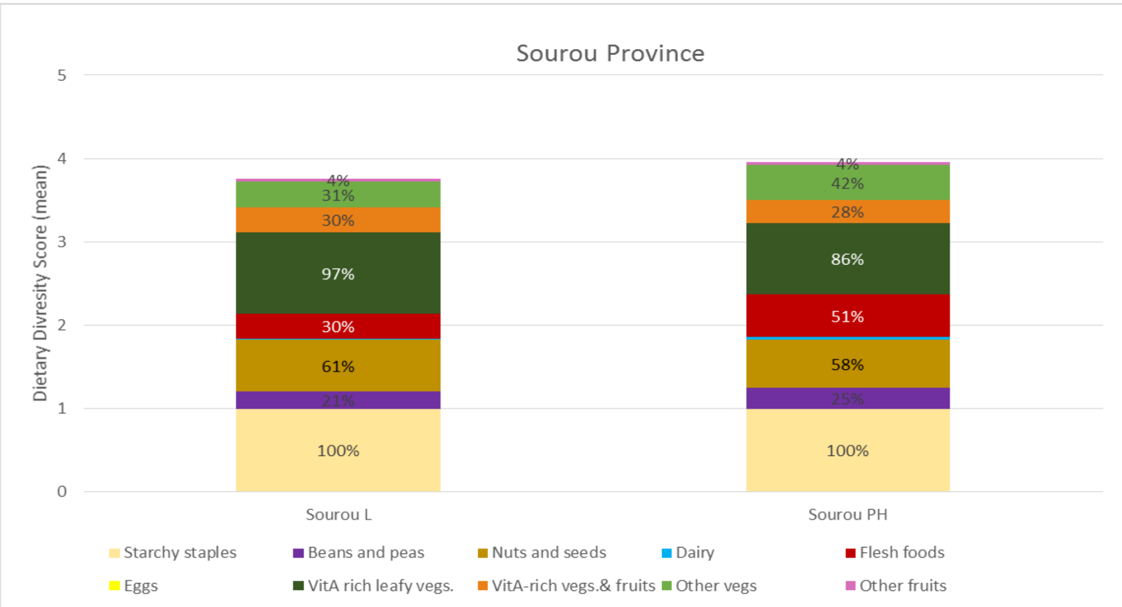
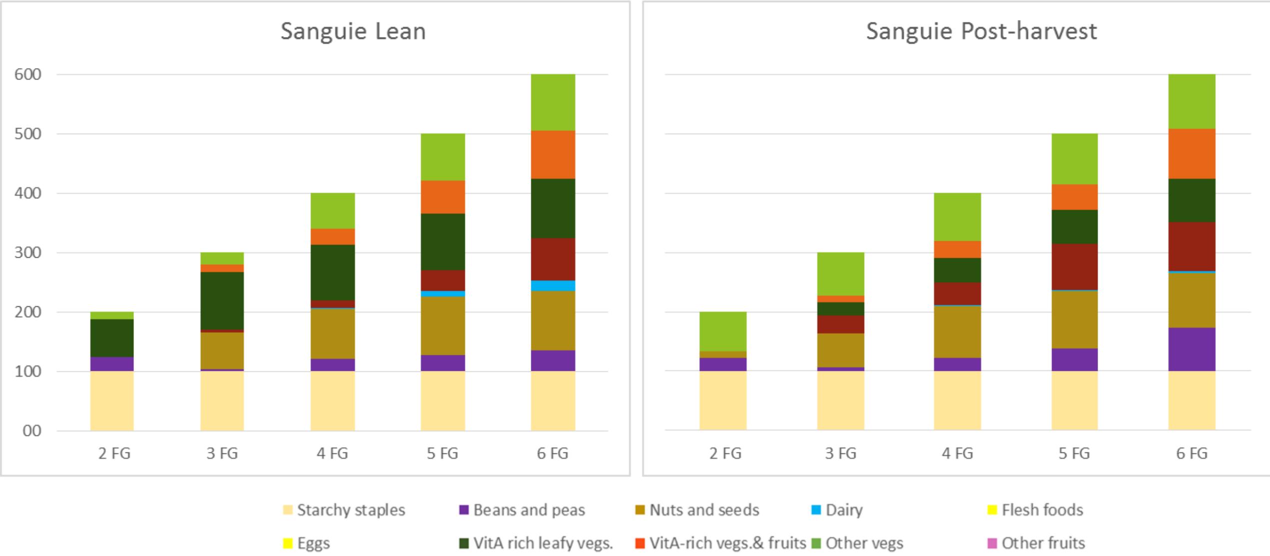


Figure 9: Mean DDS and food group consumption in Sourou province, lean and post-harvest season, 2010



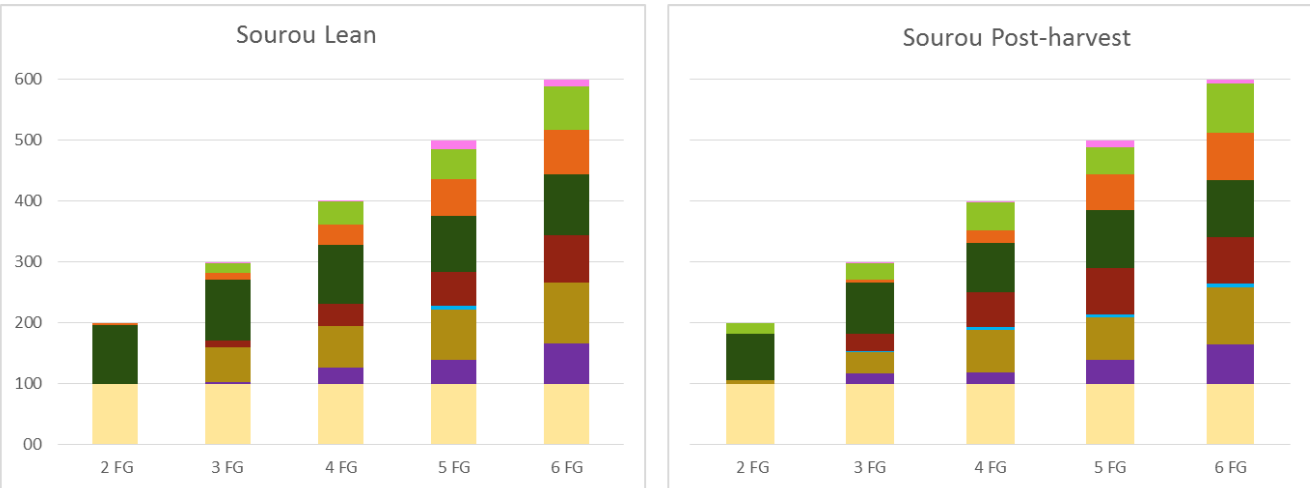
During the lean season in Sanguie, the FG involved in the transition from four FG to five FG or more was mainly the dairy, the nuts and seeds, the vitamin A-rich vegetables and fruits, other vegetables and the flesh foods. While in the PH season, the change from four FG to five FG was more important in the consumption of flesh foods (no dairy records in this season), the nuts and seeds and the vitamin A-rich vegetables and fruits FGs.

Figure 10: Percentage of food group consumption by dietary diversity scores in Sanguie province, 2010



In Sourou, conversely to what was seen in Sanguie, the contribution of the dairy group to the five FG categories was seen in the PH season and not in the lean season. In the latter season, apart from flesh foods, nuts, seeds, vitamin A-rich vegetables, and fruits shared with Sanguie, the consumption of other fruits increased in the five FG categories and above. In the PH season, the consumption of beans and peas was also proportionally higher in the categories above four FG.

Figure 11: Percentage of food group consumption by dietary diversity scores in Sourou province, 2010



3.2.2 Factors associated with MDD-W in the rural samples

In the following tables (Tables 8 to 11), we describe the results of the logistic regressions carried out in the rural samples with MDD-W as the dependent variable.

Table 8: MDD-W-associated factors in Sanguie province, lean season, 2010

	Sanguie Lean N=239		
Covariate	n	MDDW%	aOR (CI 95%)
Socioeconomic score			
Low	123	18.9	ref
Middle	79	31.7	2.09 (1.07-4.10)
High	38	39.5	2.51 (1.11-5.68)
p			0.03
Woman attended Post natal visit			
No	44	11.4	ref
Yes	195	29.9	3.3 (1.21-8.89)
p			0.02
Head of household education status			
None	204	23.6	ref
School	36	41.7	2.35 (1.08-5.11)
p			0.03
Pseudo R^2=0.07			

In the Sanguie province during the lean season, 39 % of the women living in households with a high SES consumed five FG or more, compared to only 19 % of the women living in households falling in the low tertile of the socioeconomic score. Moreover, if the head of the household had attended school, the likelihood of the women to reach MDD-W increased by around three times. In addition, the proportion of women consuming five FG or more was also significantly higher among women who had attended a post-natal visit.

Table 9: MDD-W-associated factors in Sanguie province, post-harvest season, 2010

	Sanguie Post-harvest N=237		
Covariate	n	MDDW%	aOR (CI 95%)
Household owns sheep			
No	51	40.2	ref
Yes	65	59.1	3.19 (1.71-5.96)
p			<0.0001
Religion of head of the household			
Muslim	61	38.3	ref
Christian	122	49.6	2.61 (1.26-5.43)
None/Animist	57	58.9	2.75 (1.15-6.55)
p			0.02
Received vitamin A supplementation			
No	40	38.5	ref
Yes	156	53.9	2.05(0.96-4.38)
p			0.06
Pseudo R^2=0.08			

However, during the PH season, the socioeconomic score was no longer related with MDD-W (not even at the bivariate level, see Table A2-5), whereas among households owning sheep the proportion of women consuming five FG or more was higher than in the households with no sheep (59 % and 40 %, respectively). The religion of the head of the household was also associated with the women's dietary diversity, and Muslim-headed households were less likely to reach MDD-W. Finally, if the woman had received vitamin A supplementation then her likelihood of consuming five FG or more doubled.

Table 10: MDD-W-associated factors in Sourou province, lean season, 2010

		N=239	
Covariate	**n**	**MDDW%**	**aOR (CI 95%)**
Floor			
Clay	37	14.7	ref
Cement	203	30.9	2.90 (1.49-5.66)
p			0.002
Age of head of household			
>50 years	73	23.4	ref
40-49 years	73	21.2	0.80 (0.35-1.82))
30-39 years	67	18.7	0.67 (0.29-1.58)
<30 years	27	45	3.41 (1.11-10.46)
p			0.04
Household owns cart			
No	145	11.4	ref
Yes	95	25	3.33 (1.05-10.56)
p			0.04
Pseudo R^2 =0.04			

In Sourou household materials and the possession of agricultural assets (cart in the lean season and plough in the PH season) replaced the socioeconomic score (which was not significant at the bivariate level either, see Table A2-5). Households with improved floors or agricultural assets showed higher proportions of women consuming five FG or more (Tables 10 and 11).

Table 11: MDD-W-associated factors in Sourou province, post-harvest season, 2010

		Sourou Post-harvest N=234	
Covariate	**n**	**%**	**aOR (CI 95%)**
Household owns plough			
No	42	14.6	ref
Yes	198	33.2	2.90 (1.49. 5.66)
p			0.02
Pseudo R^2=0.02			

The differences found in the associated MDD-W factors for each province may be related to basic characteristics of the provinces described before (Martin-Prével et al., 2013). The agro-ecological conditions of the two areas are very different: Sourou is dryer and has a shorter rainy season than Sanguie, thus the type of vegetation is also different, with more diversified vegetables in Sanguie than in Sourou. Moreover, although virtually all households were involved in agricultural production, many more possessed agricultural assets and cattle (cows, sheep and goats) in Sourou, characteristics that participated heavily in the construction of the socioeconomic score and that may partially explain these results.

3.2.3 MDD-W and other food security indicators in the rural samples

The food security indicators analysed in this section are the HFIAS and the HHS.

Table 12: Mean difference in HFIAS between MDD-W=1 and MDD-W=0, Sanguie and Sourou provinces, 2010

	OLS					
	Model 1 -Without Controls			Model 2 -With Controls*		
Survey	**Coef.**	**SE**	**p**	**Coef.**	**SE**	**p**
Sanguie lean season	-2.19	0.734	0.003	-1.77	0.732	0.016
Sanguie post harvest season	-0.26	0.260	0.311	-0.14	0.370	0.830
Sorou lean season	-0.37	0.745	0.616	-1.23	0.650	0.062
Sorou post harvest season	0.15	0.405	0.718	0.36	0.410	0.372
*Control variables differed for each model. See methodology section for details.						

When the analysis was stratified according to the socioeconomic score in the Sanguie lean season sample, the coefficient was – 2.98 and p = 0.014 in the low category, – 1.39, p = 0.236 in the medium category and – 0.04 and p = 0.975 in the high category.

Table 13: Mean difference in HHS between MDD-W=1 and MDD-W=0, Sanguie and Sourou provinces, 2010

	OLS					
	Model 1 -Without Controls			Model 2-With Controls*		
Survey	**Coef.**	**SE**	**p**	**Coef.**	**SE**	**p**
Sanguie lean season	0.04	0.162	0.010	0.69	0.258	0.009
Sanguie post harvest season	-0.04	0.356	0.273	-0.03	0.570	0.582
Sorou lean season	-0.05	0.143	0.755	-0.48	0.405	0.240
Sorou post harvest season	-0.02	0.077	0.780	-0.29	0.267	0.285
*Control variables differed for each model. See methodology section for details.						

According to our results, the HFIAS and the HHS were only significantly associated with the MDD-W in the Sanguie province sample during the lean season, and more specifically among the households falling in the low tertile of the socioeconomic score. Among them, women reaching MDD-W lived in households with a mean HFIAS and HHS at 2.98 and 0.04 times lower, respectively, compared to the households of the women not reaching MDD-W.

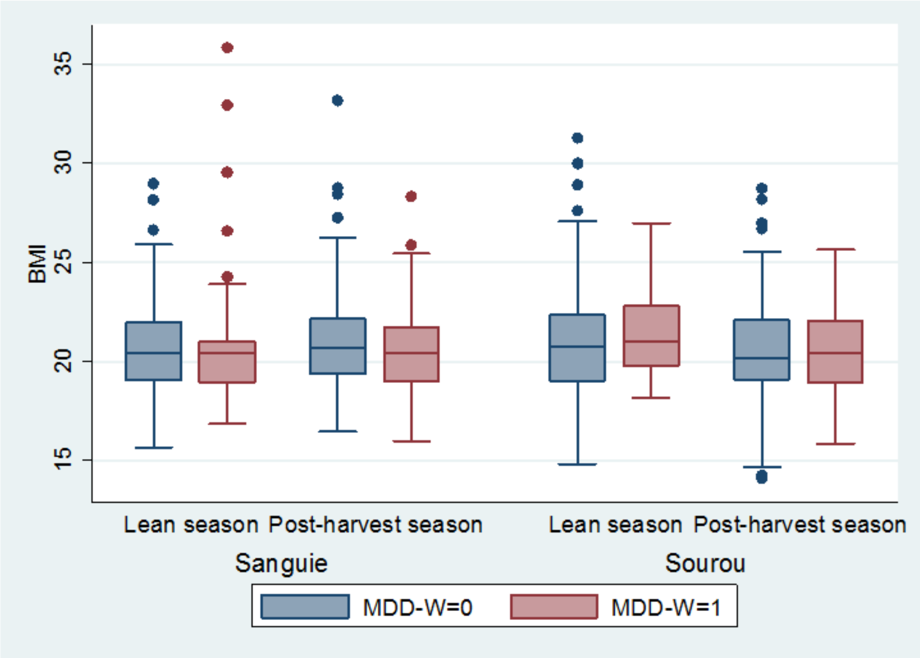
However, although not significant, the majority of the results point to the same negative association found among the urban samples, suggesting that sample size may be a constraint for the results of this analysis.

Larger datasets of rural populations will help to make a better assessment of this potential association.

3.2.4 MDD-W and women's nutritional status

According to our results, there was no association between the MDD-W and the BMI of the non-pregnant women in any of the rural settings or seasons studied.

Figure 12: Women mean body mass index according to MDD-W, by province and season, 2010



The average BMI in the sample of women consuming five FG or more is not different from the average BMI in the sample of women consuming four FG or less, according to the Student's *t*-test ($p = 0.62$).

Regressions on the pooled sample confirm that there is no association between MDD-W and BMI, even when controlling for the mothers characteristics, the season, and the province, as presented in Table A3-4.

However, the potentiality of the MDD-W is to serve as a proxy for possible micronutrient inadequacies and, thus, the assessment of the women nutritional status by micronutrient levels instead of BMI would be more appropriate to explore the MDD-W and nutritional status relationship.

4. Conclusions

At present time, there is a scarcity of public datasets collecting pertinent information on WRA to conduct a global study on the MDD-W. Diet surveys are costly to carry out and analyse and the sharing of data in the research community is still limited.

FAO and FANTA are developing a guidelines manual on how to collect the information for the construction of the MDD-W indicator. We expect that once the manual is released, public surveys and private initiatives will incorporate the indicator as well as become more available in the near future.

The MDD-W indicator seems to be sensitive to change. In the urban samples, the changes shown from year to year could be related to external shocks such as the food prices crisis or the floods that occurred in 2009.

The MDD-W is a season-specific indicator in this context, as it captured the differences in diet related to seasonality in the rural provinces and the effect varies with different livelihoods (pastoral versus agricultural, for instance). The design of surveys will need to take into account those effects.

However, it is important to emphasise that we assessed the changes in the indicator itself but did not assess the change in micronutrient intakes. So far, the changes of MDD-W have not been validated in the sense that formal tested have not yet been conducted to see if the changes in MDD-W also correspond to changes in the mean probability of adequacy of micronutrient intakes.

The FGs responsible for the shift between consuming four FG or consuming five FG are mainly animal source foods (dairy and flesh foods), although the relative importance may vary from urban to rural contexts and from agricultural to agro-pastoralist societies within the rural environment. The nuts and seeds and vitamin A-rich vegetables and fruits were key FGs in the achievement of the five FG consumption in this context.

In the urban environment, the MDD-W was mainly associated with socioeconomic status of the household, the level of education of the head of household and the food stocks of the household, although, depending on the context, other factors such as youth ratio or gender of the head of household may play a role.

In the rural samples, mainly the wealth of the households (measured by wealth index or agricultural assets) and the proxy of health services were associated with the MDD-W.

The FS indicators were strongly correlated to the MDD-W in the urban samples, showing that women consuming five FG or more lived in more food-secure households according to the indicators analysed. This association may be modified by socioeconomic variables and thus results should be stratified accordingly. Results from the rural samples point out in the same direction but larger sample sizes are needed to reach sound conclusions.

The nutritional status of the women measured by the BMI was not associated with the MDD-W. However, the MDD-W is likely to reflect the dietary adequacy in terms of micronutrient intakes and thus, the nutritional status measured by micronutrient levels should be more appropriate to explore this association.

5. MDD-W and programmatic action

The MDD-W has the potential to track changes in dietary diversity across countries and thus contribute to monitoring progress at the global level in terms of dietary quality improvement. Furthermore, it can monitor progress in the well-being of women of reproductive age, a vulnerable group that is often the last to eat and the last to eat nutritious food, as well as be a key player in the achievement of the stunting reduction through the 1 000-day approach.

Whether it can be recommended for programmatic uses still needs to be debated and would likely depend on the scale of programmes. However, it is important to reinforce the idea that it is strongly not recommended for individual screening.

The tool to collect data in order to construct the MDD-W indicator (validated diet questionnaire) is being developed by FANTA/FAO and will be released in the manual to be published soon. The procedures to collect the data (type of survey and frequency) would mainly depend on the objectives at stake.

If the objective is to track changes due to a specific action, the data should be collected in the targeted population before and after the intervention is delivered. However, although the MDD-W indicator provides a useful and practical dichotomous outcome, we recommend complementing the reporting with an analysis of the different FG consumption, as was presented here. Moreover, it is important to keep in mind that the MDD-W indicator can show improvement in diet adequacy right after the implementation of a specific action, but the interest is to capture changes that are sustainable through time.

For this reason, the MDD-W indicator will be best suited to monitoring nutrition-sensitive actions at national or regional level, for which the indicator should be incorporated into surveys that are conducted periodically and have national or regional scope. The most suitable surveys are those that already collect information on women of reproductive age, like the Demographic and Health Surveys funded by USAID, the Multiple Indicator Clusters surveys promoted by Unicef, the baseline surveys of the Feed the Future Lab lead by Tufts University, or the Food Security and Nutrition Surveillance project started by HKI in Bangladesh, among others.

Furthermore, it could be incorporated into other surveys that currently collect information on food consumption at household level, like national household surveys, the Living Standards Measurement study surveys conducted by the World Bank, the Comprehensive FS and Vulnerability analysis of the world food programme (WFP) or the household consumption and expenditure surveys. The challenge for the incorporation of the indicator on these surveys will be to adapt the procedures of data collection at household level to data collection at individual level. However, there are initiatives taking these challenges into account, like the new joint approach in nutrition and food security assessment developed by the WFP, which includes MDD-W as a potential indicator to be collected if needed.

However, the actual implications and challenges of data collection for MDD-W should be clearer once the FANTA/FAO manual is released, as there should be a full description of the number of questions and the time spent on the questionnaire, etc.

The MDD-W has been advocated as an additional indicator of the SDGs, as it can provide information on multiple targets under goal 2 (end hunger, achieve FS and improved nutrition, and promote sustainable agriculture), and would also capture progress on goal 5 (achieve gender equality and empower all women and girls).

Specifically, FAO and the International Fund for Agricultural Development (IFAD) ([4]) suggested to include MDD-W as an additional indicator for Target 2.2 ([5]), advocating that it is an indicator of the probability of micronutrient adequacy, which provides the necessary link between food and nutrition in the global assessment. At the time being, the two selected indicators for this target are stunting and wasting, leaving out other indicators of paramount importance for the nutrition community, like overweight children or anaemic women, so it is unlikely that MDD-W will finally be included under this target.

Other institutions and entities still advocate ([6]) for the MDD-W to be included as an additional indicator for Target 2.1 ([7]). These are non-governmental organisations like Action Against Hunger, HKI, World Vision, the Sustainable Development Solutions Network, the Bill & Melinda Gates Foundation, the International Coalition for Advocacy of Nutrition and the 1 000-day initiative, among others. The justification given is that women's dietary diversity reflects micronutrient intake for a vulnerable population made reference to in the target, and that MDD-W reflects a key dimension of high-quality food consumption with adequate micronutrient content, which the actual selected indicators for the target of undernourishment and of food insecurity experience do not capture.

However, the drawback according to other agencies like FAO is that collecting data of individual food consumption is particularly difficult and extremely costly. They show concern about the burden that this would impose on countries if these methods were to be used for regular monitoring of undernourishment at global level. This may be true for collecting individual information needed to assess the adequacy of dietary energy intake at the needed level of precision to inform reliable nutritional assessments, but the tools and methodologies needed for the calculation of the MDD-W are much simpler and less costly.

In the current debate, the position of the governments and national institutions in target countries is almost absent, whereas they have the ultimate responsibility in monitoring and reporting the progress on the nutrition agenda. A rapid review and stocktaking exercise with some countries that have already clear nutrition policies would help to identify advantages and potential issues of using the MDD-W as a monitoring indicator.

By early 2016, the final indicators to be included in the SDGs will be released. Nevertheless, even if it is unlikely that the MDD-W will be in the final list of the SDGs indicators, the interest and support showed by important agencies and entities that are involved in the undertaking and/or promotion of surveys is an encouraging sign towards the availability of more reliable data and the potential use of the indicator in programmatic action in the near future.

([4]) In the August 2015 version of the list of indicators proposals available at http://unstats.un.org/sdgs/

([5]) Target 2.2: to end all forms of malnutrition by 2030; to achieve the internationally agreed targets on stunting and wasting in children under 5 years of age by 2025; and to address the nutritional needs of adolescent girls, pregnant and lactating women and older persons.

([6]) In the November 2015 open consultation of list of indicators available at http://unstats.un.org/sdgs/

([7]) Target 2.1: to end hunger and ensure access to safe, nutritious and sufficient food all year round and by all people, in particular the poor and people in vulnerable situations including infants, by 2030.

References

Allen, L., *Multiple micronutrients in pregnancy and lactation: an overview*, American Journal of Clinical Nutrition, 2005, 81(5), 1206S-12S.

Arimond, M., Wiesmann, D., Becquey, E., Carriquiry, A., Daniels, M.C., Deitchler, M., et al., *Simple food group diversity indicators predict micronutrient adequacy of women's diets in five diverse, resource-poor settings*, Journal of Nutrition, 2010; 140:2059-69S.

Arimond, M., Wiesmann, D., Becquey, E., Carriquiry, A., Daniels, M., Deitchler, M., Fanou, N., Ferguson, E., Joseph, M., Kennedy, G., Martin-Prével, Y., Torheim, L.E., *Dietary diversity as a measure of the micronutrient adequacy of women's diets in resource-poor areas: summary of results from five sites*, Food and Nutrition Technical Assistance FANTA-2 Bridge and Food Health International, FHI 360, Washington, D.C., 2011.

Arsenault, J.E., Nikiema, L., Allemand, P., Kossiwavi A., A., Lanou, H., Moursi, M., et al., *Seasonal differences in food and nutrient intakes among young children and their mothers in rural Burkina Faso*, Journal of Nutritional Science, 2014, Vol. 3, e55.

Ballard, T., Coates, J., Swindale, A. and Deitchler, M., *Household hunger scale (HHS): indicator definition and measurement guide*, Food and Nutrition Technical Assistance II Project, FHI 360, Washington, D.C., 2011.

Bartley, K.A., Underwood, B.A. and Deckelbaum, R.J., *A life cycle micronutrient perspective for women's health*, American Journal of Clinical Nutrition, 2005, 81(5): 1188S-93S.

Becquey, E., Martin-Prével, Y., 'Mesure de la vulnérabilité alimentaire en milieu urbain Sahélien: résultats de l'étude de Ouagadougou. Description et évaluation de deux outils de mesure de la vulnérabilité alimentaire', Institut de recherche pour le développement, Ouagadougou, 2008, p. 15.

Becquey, E., Depleuch, F., Konate, A.M., et al, *Seasonality of the dietary dimension of household food security in urban Burkina Faso*, British Journal of Nutrition, 2012, Vol. 107, 1860-1870.

Boyer, F. and Delaunay, D., '"Ouaga 2009" Peuplement de Ouagadougou et développement urbain', Institut de recherche pour le développement, Ouagadougou, 2009, p. 250.

Coates, J., Swindale, A. and Bilinsky, P., *Household food insecurity access scale (HFIAS) for measurement of food access: indicator guide*, Food and Nutrition Technical Assistance Project, Academy for Educational Development, Washington, D.C., 2007, Vol. 3.

FAO report, *Guidelines for measuring household and individual dietary diversity*, Rome, 2013.

FAO Summary Report, *Meeting to reach consensus on a global dietary diversity indicator for women*, Washington, D.C., 15-16.7.2014.

Gibson, R.S. and Ferguson, E.L., *An interactive 24-hour recall for assessing the adequacy of iron and zinc intakes in developing countries*, HarvestPlus Technical Monograph 8., Washington, D.C., and Cali: International Food Policy Research Institute (IFPRI) and International Center for Tropical Agriculture (CIAT), 2008.

'Recensements généraux de la population et de l'habitation', Institut national de la statistique et de la démographie de Burkina Faso, 1985, 1996 et 2006.

Kameli, Y., Martin-Prével, M., Fortin, S., 'Mesure de la vulnérabilité alimentaire et nutritionnelle en milieu urbain sahélie. Evolution de la situation à Bobo-Dioulasso de 2009 à 2010. Rapport provisoire', Institut de recherche pour le développément, 2011.

Martin-Prével, Y., Becquey, E. and Arimond, M., *Food group diversity indicators derived from qualitative list-based questionnaire misreported some foods compared to same* *indicators derived from quantitative 24-hour recall in urban Burkina Faso,* Journal of Nutrition, 2010, 140(11):2086S-93S. doi:10.3945/jn.110.123380, Epub 29.9.2010.

Martin-Prével, Y., Allemand, P., Nikiema, L., et al., *Food consumption and iron status survey in the rural Sourou and Sanguie provinces of Burkina Faso*, Final Technical and Financial Report-Revised, Institut de recherche pour le développement, Institut de recherche en sciences de la santé, HarvestPlus, Ougadougou, Burkina Faso, 2013.

Martin-Prével, Y. et al., *Moving forward on choosing a standard operational indicator of women's dietary diversity*. The 'Women's dietary diversity follow-up project' (WDDP-II) — Technical Report, Food and Agricultural Organisation, 2015.

Maxwell, D.G., *Measuring food insecurity: the frequency and severity of coping strategies*, FCND discussion paper, IFPRI, Washington, D.C., 1995.

May, J.F., 'Lutte contre la pauvreté au Burkina Faso: l'importance de l'écart urbain-rural des indicateurs santé. Nutrition et population', Africa Region Human Development, The World Bank, Washington, D.C., 2006.

Mirmiran, P., Azadbakht, L., Esmaillzadeh, A., Azizi, F., *Dietary diversity score in adolescents — a good indicator of the nutritional adequacy of diets: Tehran lipid and glucose study,* Asia Pacific Journal of Clinical Nutrition, 2004, 13: 56-60.

Mirmiran, P., Azadbakht, L., Azizi, F., *Dietary diversity within food groups: an indicator of specific nutrient adequacy in Tehranian women*, Journal of the American College of Nutrition, 2006, 25: 354-61.

Ogle, B.M., Hung, P.H., Tuyet, H.T., *Significance of wild vegetables in micronutrient intakes of women in Vietnam: An analysis of food variety*, Asia Pacific Journal of Clinical Nutrition, 2001, 10: 21-30.

Ruel, M.T. et al., *Developing Simple measures of women's diet quality in developing countries: overview*, Journal of Nutrition, 29.9.2010.

Ruel, M.T., *Operationalising dietary diversity: a review of measurement issues and research priorities*, Journal of Nutrition, 2003; 133 (11 Suppl. 2): 3911-26.

Torheim, L.E., et al., *Women in resource-poor settings are at risk of inadequate intakes of multiple micronutrients*, Journal of Nutrition, 2010, Vol. 140, pp. 2051S-8S.

Vernay, M., 'Perspectives de la surveillance de l'insécurité alimentaire et nutritionnelle en milieu urbain au Burkina Faso. Master's thesis: Master Sciences et technologies de la santé', Institut de recherche pour le développement, Montpellier University, 2012.

List of abbreviations

aOR adjusted Odds Ratio

BMI Body Mass Index

CI confidence interval

CSI Coping Strategies Index

DD dietary diversity

DDS Dietary Diversity Score

DHS Demographic and Health Surveys

EU European Union

FANTA Food and Nutrition Technical Assistance project

FAO Food and Agriculture Organisation

FG food group

FS food security

FGI food group indicator

GIFT Global Individual Food Consumption Data Tool

HFIAS Household Food Insecurity Access Scale

HHS Household Hunger Scale

HKI Hellen Keller International

IFPRI International Food Policy Research Institute

IRD Institut de Recherche pour le Développement

LSMS Living Standards Measurement surveys

MDD-W Minimum Dietary Diversity-Women

MeSH medical subject headings

MICS Multiple Indicators Cluster surveys

OLS ordinary least squares

PH post-harvest

SE standard error

SES socioeconomic score

UN United Nations

Unicef United Nation's Children Fund

USAID United States Agency for International Development

WDDP Women Dietary Diversity Project

WHO World Health Organisation

WRA women of reproductive age

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Appendix

Appendix 1: Introduction

Table A1-1: WDDP-I food groups

FGI-6	FGI-9	FGI-13	FGI-21
All starchy staples	All starchy staples	All starchy staples	Grains and grain products
			All other starchy staples
All legumes and nuts	All legumes and nuts	All legumes and nuts	Cooked dry beans and peas
			Soybeans and soy products
			Nuts and seeds
All dairy	All dairy	All dairy	Milk/yoghurt
			Cheese
Other animal source foods	Organ meat	Organ meat	Organ meat
	Eggs	Eggs	Eggs
	Flesh foods and other miscellaneous small animal protein	Small fish eaten whole with bones	Small fish eaten whole with bones
		All other flesh foods and miscellaneous small animal protein	Large whole fish/dried fish/shellfish and other seafood
			Beef, pork, veal, lamb, goat, game meat
			Chicken, duck, turkey, pigeon, guinea hen, game birds
			Insects, grubs, snakes, rodents and other small animals
Vitamin A-rich fruits and vegetables	Vitamin A-rich dark green leafy	Vitamin A-rich dark green leafy vegetables	Vitamin A-rich dark green leafy vegetables
	Other vitamin A-rich vegetables and fruits	Vitamin A-rich deep yellow/orange/red vegetables	Vitamin A-rich deep yellow/orange/red vegetables
		Vitamin A-rich fruits	Vitamin A-rich fruits
Other fruits and vegetables	Other fruits and vegetables	Vitamin C-rich vegetables	Vitamin C-rich vegetables
		Vitamin C-rich fruits	Vitamin C-rich fruits
		All other fruits and vegetables	All other vegetables
			All other fruits

Appendix 2: Methods

Table A2-1: IFPRI households and community databases review

Year pub	Year study	Country	Name	Observations for MDD-W
1997-1998	1997-1998	Honduras	Honduras: IFAD technical assistance grant, 1997-1998	Food frequency questionnaires of certain foods, not enough to construct the index
1999	1999	Guatemala	Guatemala, strengthening and evaluation of the 'Hogares comunitarios' programme in Guatemala City, 1999	Only household food consumption
2000	1984-1985	Philippines	Philippines cash cropping project, Southern Bukidnon Province, 1984-1985	24-hour recall, food group aggregation non valid
2000	1997	Ghana	Ghana, Accra, urban food and nutrition security, 1997	Household food consumption — weekly
2000	1986-1991	Pakistan	Pakistan panel survey, 1986-1991	Household food consumption
2000		Mexico	Mexico, evaluation of PROGRESA	Household food consumption
2000	1995	Malawi	Malawi financial markets and household food security, 1995	Data in .wd format, not accessible. Probably household food consumption
2000	1993-1999	South Africa	South Africa: KwaZulu-natal income dynamics study (KIDS), 1993-1999	Intra-allocation focused on assets ownership, not on diet
2000	1997-1999	Egypt	Egypt integrated household survey, 1997-1999	Household food consumption only
2001	1996-1997	Bangladesh	Bangladesh, commercial vegetable and polyculture fish production — their impact on income, household resource allocation and nutrition, 1996-1997	Household food consumption. Food preferences at individual level only
2002	1998-1999	Bangladesh	Bangladesh coping strategies, 1998-1999	Household food consumption
2003		Bangladesh	Bangladesh, baseline data of SHAHAR project, CARE-Bangladesh, 2000 — slum areas of Tongi and Jessore municipalities	No women diet
2003	1997-1998	Mali	Mali, Lacustre zone, household dataset, 1997-1998	Household food consumption — weekly
2004	1998	Benin	Benin: small farmer survey, 1998	Agricultural productivity. No food consumption

2004	2000-2002	Malawi	Malawi complementary panel survey (CPS) 2000-2002	Focused on poverty, no food consumption
2005	2000-2002	Nicaragua	Nicaragua, 'Red de protección social' (RPS) evaluation dataset, 2000-2002	Survey based on LSMS survey. No food consumption
2005	2001	Philippines	Philippines, smallholder livestock production dataset, 2000-2001	On livestock production, no food consumption
2006	2003	Burkina Faso	Burkina Faso PNDSA II impact analysis baseline survey, 2002-2003	Based on agriculture, no food consumption
2006	2002-2003	Senegal	Senegal PSAOP impact analysis baseline survey, 2002-2003	Based on agriculture, no food consumption
2008	2003-2004	Philippines	Philippines, Bukidnon, panel survey, 2003-2004	24-hour recall at individual level. Survey focused on migrant children. WRA representative?
2008	2004	Ghana	Ghana, Savelugu-Nanton Household survey dataset, 2004	Household food consumption — weekly
2009	2002-2003	Bangladesh	Bangladesh, Shahar Dinajpur, baseline survey, 2002-2003	No food consumption
2010	1994	Bangladesh	Rural finance and food security study in Bangladesh, 1994	It contains the food consumption as key word but no access to databases. Focus on formation of rural groups and its impact in household food security. Most probably food consumption at household level
2011	1989-2009	Ethiopia	Ethiopian rural household surveys (ERHS), 1989-2009	Part III Section 6 of the questionnaire. Household food consumption — weekly
2012		Bangladesh	Women's empowerment in agriculture index (WEAI) pilot for Bangladesh	Women empowerment in agriculture sector, no food consumption
2013	2011-2012	Bangladesh	Bangladesh integrated household survey (BIHS), 2011-2012	24-hour recall info collected. Menu codes not available. Investigate further
2013	2010-2011	South Asia	Cereal systems initiative for South Asia (CSISA) baseline household survey, 2010-2011	No food consumption
2014	2012	Pakistan	Pakistan rural household panel survey (PRHPS), 2012	Children dietary intake. No women
2015		Nigeria	Dietary intakes, vitamin A and iron status of women of childbearing age and children 6-59 months of age from Akwa Ibom state in Nigeria	Food group aggregation non valid for the analysis.

Table A2-2: MDD-W construction from the dietary information in urban surveys

Food groups and descriptions in the questionnaire (in French)		Food groups numbers and definitions in MDD-W	
CEREALES	Sorgho blanc, sorgho rouge, mil, petit mil, riz, maïs, pâtes alimentaires (macaronis..), blé (couscous, pain, galettes…), fonio…	1	All starchy staple foods
RACINES ET TUBERCULES	Patate douce blanche, pomme de terre, igname, taros, autres tubercules (fabirama…), manioc (atiéké, gari), + banane plantain (alloco)	1	All starchy staple foods
PROTEAGINEUX	Haricots (niébé), pois de terre, petits pois, pois chiches, lentilles, autres légumes secs	2	Beans and peas
OLEAGINEUX	Arachide (en pâte ou autre), soja, sésame, noix de cajou, noix de karité, noix sauvages, graines de coton, graines de palme…	3	Nuts and seeds
LEGUMES RICHES EN VITAMINE A	Courge, citrouille, carotte, poivron rouge, patate douce à chair orange	8	Other vitamin A-rich vegetable and fruits
LEGUMES FEUILLES	Oseille, amarante, salade, feuilles de baobab, corète potagère (bulvaka), épinards, feuilles d'oignon, de haricot, de manioc, de patates, etc. + toutes feuilles sauvages, kapok, etc.	7	Vitamin A-rich dark green leafy vegetables
LEGUMES AUTRES	Tomates (sauf concentré), gombo frais ou sec, aubergines, courgettes, concombres, choux, navets, oignons, poivrons verts, haricots verts…	9	Other vegetables
FRUITS RICHES EN VIT A	Mangue, papaye rouge/orange, melon orange, néré (fruits ou farine)	8	Other vitamin A-rich vegetable and fruits
FRUITS AUTRES	Ananas, banane, goyave, dattes, pastèque, jujube, canne à sucre, pomme cannelle, orange, citron, etc., jus de fruits frais (fruits pressés), fruits sauvages (« raisins », tamarin, pain de singe, etc.)	10	Other fruits
HUILE RICHE EN VIT A	huile de palme rouge	8	Other vitamin A-rich vegetable and fruits
AUTRES HUILES ET GRAISSES	Huile végétale (sauces, assaisonnements, fritures), beurre (lait ou karité), margarine, mayonnaise, lard, saindoux…		
OEUFS	OEufs de poule, pintade, caille…	6	Eggs
PRODUITS LAITIERS	Lait frais, lait en poudre, lait concentré (sucré ou non), yaourt, fromage, crème fraîche…	4	Dairy
FOIES/ ABATS PLEINS	Foie (veau, mouton, volailles,,,), abats PLEINS (coeur, reins, rate, poumon) et boudin noir	5	Flesh foods
AUTRES ABATS/ INSECTES	Abats autres que les abats pleins (tripes, queue de boeuf, etc.) ou insectes	5	Flesh foods
VIANDES ET VOLAILLES	Boeuf, mouton, chèvre, porc (y compris charcuteries), langue, lapin, viande de brousse, Poulet, pintades…	5	Flesh foods
POISSONS ET FRUITS DE MER	Poisson frais, poisson fumé, salé, séché (sauf pincée de poudre), conserves (sardines, thon..), tous fruits de mer	5	Flesh foods
SUCRES SIMPLES	Sucre en poudre ou en morceaux (dans le thé, le café, la bouillie…), boissons sucrées (sucreries, zom-kom, bissap, jus de gingembre…), lait concentré sucré, miel, confiture, bonbons, gâteaux sucrés…		
BOISSONS ALCOOLISEES	Bière, dolo, chiapalo, bangui, vin, sangria, pastis, whisky, etc.		
CONDIMENTS	concentré de tomates, soumbala, piment…		
AUTRE	Un autre aliment non cité. Si oui, précisez :		

Table A2-3: MDD-W construction from the dietary information in rural surveys

Food groups in the rural questionnaire	**Food groups numbers and definitions in MDD-W**	
Grains and grain products	1	All starchy staple foods
Other starchy staples	1	All starchy staple foods
Cooked dry beans and peas	2	Beans and peas
Oils and fats		
Vitamin A-rich oils and fats	8	Other vitamin A rich vegetables and fruits
Nuts and seeds	3	Nuts and seeds
Milk and yogurt	4	Dairy
Cheese	4	Dairy
Organ meat	5	Flesh foods
Eggs	6	Eggs
Large whole fish, dried fish, shellfish and other seafood	5	Flesh foods
Large whole fish, dried fish, shellfish and other seafood	5	Flesh foods
Beef, pork, veal, lamb, goat, game meat	5	Flesh foods
Chicken, duck, turkey, pigeon, guinea hen, game birds	5	Flesh foods
Insects, grubs, snakes, rodents and other small animals	5	Flesh foods
Vitamin A-rich dark green leafy vegetables	7	Vitamin A rich dark green leafy vegetables
Vitamin A-rich deep yellow, orange, red vegetables	8	Other vitamin A rich fruits and vegetables
Vitamin A-rich fruits	8	Other vitamin A rich fruits and vegetables
Vitamin C-rich vegetables	9	Other vegetables
Vitamin C-rich fruits	10	Other fruits
Other vegetables	9	Other vegetables
Other fruits	10	Other fruits
Coffee, tea, herbal tea		
Alcoholic beverages		
Condiments		
Sugar and sugar products		
Soybeans and soy products	2	Beans and peas

Table A2-4: P-values resulting from bivariate logistic regression analysis with MDD-W as the dependent variable on urban surveys

		OUAGADOUGO			BOBO-DIOULASSO		
		2009	**2010**	**2011**	**2009**	**2010**	**2011**
Dimension	**Covariate**	p-value	p-value	p-value	p-value	p-value	p-value
Individual characteristic	Woman's age	0.38	0.07	0.11	0.7	0.88	0.001
Head of Household Sociodemographic characteristics	Head of Household (HHH) age	0.81	0.08	0.64	0.51	0.21	0.57
	HHH sex	0.054	0.93	0.12	0.83	0.45	0.88
	HHH level of studies	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	HHH profession				0.64	0.23	0.11
	HHH number of wifes	0.085	0.92	0.088	0.108	0.51	0.426
Household Sociodemographic characteristics	Youth ratio	0.0001	0.0001	0.0001	0.003	0.0001	0.001
	Dependence ratio	0.076	0.0001	0.0001	0.0001	0.17	0.049
Food Access household characteristics	Food stocks	0.0001	0.0001	0.0001	0.0001	0.0001	no data
	Chicken	0.011	0.19	0.023	0.075	0.29	0.02
	Livestock	0.022	0.49	0.118	0.121	0.86	0.307
	Garden	0.0001	0.013	0.0001	0.058	0.014	0.001
Socioeconomic Households characteristics	No income	0.11	0.0001	ns	0.038	0.0001	0.0001
	HH income from salary	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
	revtrav	0.03	0.0001	0.001	0.35	0.0001	0.16
	revcomm	0.52	0.0001	0.142	0.012	0.34	0.94
	Food share expenditure	0.0001	0.008	0.001	0.081	0.008	0.001
	Socioeconomic score	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001

Table A2-5: P-values resulting from bivariate logistic regression analysis with MDD-W as the dependent variable on rural surveys

		Sanguie Province		Sourou Province	
		Lean	Post-harvest	Lean	Post-harvest
Dimension	**Covariate**	p-value	p-value	p-value	p-value
Individual characteristic		0.75	0.16	0.5	0.44
	Woman received post natal care	0.01	0.17	0.07	0.47
	Woman received Vit A capsule after birth	0.16	0.08	0.38	0.37
	Woman received iron tablets during pregnancy	0.23	0.47	0.07	0.17
	Woman has a bed net	0.93	0.71	0.26	0.55
Head of Household Sociodemographic characteristics	Head of Household (HHH) age	0.95	0.08	0.09	0.28
	HHH sex*				
	HHH level of studies	0.02	0.75	0.53	0.39
	Marital status	0.01	0.95	0.69	0.77
	Religion head of household	0.68	0.58	0.87	0.89
Household Sociodemographic characteristics	Youth ratio	0.8	0.17	0.89	0.23
	Dependence ratio	0.91	0.17	0.11	0.43
Food access household characteristics	Livestock	0.29	0.72	0.08	0.31
	Coe	0.1	0.007	0.67	0.02
	Sheep	0.02	0.004	0.8	0.66
	Goat	0.26	0.62	0.19	0.27
	Fattening crops own production	0.41	0.52	0.23	0.6
	Maize own production	0.3	0.39	0.14	0.96
	Rice own production	0.84	0.21	0.77	0.39
	Groundnuts own production	0.26	0.33	0.36	0.89
Socioeconomic households characteristics	Roof	0.22	0.52	0.45	0.21
	Wall	0.64	0.06	0.03	0.56
	Floor	0.36	0.89	0.008	0.45
	Radio	0.05	0.41	0.81	0.35
	Cell phone	0.25	0.24	0.57	0.15
	Moped	<0,001	0.36	0.91	0.82
	Cart	0.04	0.06	0.08	0.07
	Plough	0.89	0.18	0.5	0.02
	Socioeconomic score	0.02	0.38	0.28	0.23

*Not enough heterogeneity to take into account in the analysis.

Table A2-6: Results from FS indicators — OLS models introducing MDD-W*year of survey interaction terms, Ouagadougou, 2009-2011

HFIAS	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_ImDDw_1	-3.453524	.3071556	-11.24	0.000	-4.055655	-2.851393
_Iannee_2010	.8553579	.2503227	3.42	0.001	.3646391	1.346077
_Iannee_2011	-.3314717	.2489376	-1.33	0.183	-.8194754	.1565319
_ImDDXann_1_2010	-.7724779	.4536808	-1.70	0.089	-1.661849	.1168929
_ImDDXann_1_2011	-.9337967	.4217247	-2.21	0.027	-1.760523	-.1070708
_cons	12.09318	.1781547	67.88	0.000	11.74393	12.44242

csi	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_ImDDw_1	-6.072576	.5269038	-11.53	0.000	-7.105588	-5.039565
_Iannee_2010	1.689862	.3902148	4.33	0.000	.924833	2.45489
_Iannee_2011	0	(omitted)				
_ImDDXann_1_2010	0	(omitted)				
_ImDDXann_1_2011	.2496057	.6968718	0.36	0.720	-1.116634	1.615845
_cons	13.38085	.2744087	48.76	0.000	12.84287	13.91884

HHS	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_ImDDw_1	-.6149061	.0681546	-9.02	0.000	-.7485126	-.4812997
_Iannee_2010	.347252	.0555706	6.25	0.000	.2383145	.4561896
_Iannee_2011	.0325099	.0552631	0.59	0.556	-.0758249	.1408447
_ImDDXann_1_2010	-.1038235	.1006931	-1.03	0.303	-.3012168	.0935697
_ImDDXann_1_2011	-.1193646	.0935973	-1.28	0.202	-.3028476	.0641185
_cons	1.477623	.0395496	37.36	0.000	1.400092	1.555154

Table A2-7: Results from FS indicators — OLS models introducing MDD-W*year of survey interaction terms, Bobo-Dioulasso, 2009-2011

HFIAS	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_ImDDw_1	-3.693501	.3204757	-11.53	0.000	-4.321739	-3.065262
_Iannee_2010	-2.04736	.2413122	-8.48	0.000	-2.520412	-1.574308
_Iannee_2011	-3.041305	.2408281	-12.63	0.000	-3.513408	-2.569203
_ImDDXann_1_2010	-.5012251	.4485714	-1.12	0.264	-1.380574	.3781235
_ImDDXann_1_2011	-.062095	.442054	-0.14	0.888	-.9286673	.8044773
_cons	13.34805	.1768373	75.48	0.000	13.00139	13.69471

HHS	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_ImDDw_1	-.7943153	.0689086	-11.53	0.000	-.9293989	-.6592317
_Iannee_2010	-.4268999	.0518869	-8.23	0.000	-.5286153	-.3251845
_Iannee_2011	-.4852132	.0517828	-9.37	0.000	-.5867245	-.3837018
_ImDDXann_1_2010	.100522	.0964517	1.04	0.297	-.0885552	.2895992
_ImDDXann_1_2011	.2662996	.0950503	2.80	0.005	.0799695	.4526296
_cons	1.662084	.0380235	43.71	0.000	1.587545	1.736623

csi	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
_ImDDw_1	-4.794745	.4456994	-10.76	0.000	-5.668536	-3.920954
_Iannee_2010	1.331848	.3391718	3.93	0.000	.6669038	1.996792
_Iannee_2011	0	(omitted)				
_ImDDXann_1_2010	-1.024005	.6401044	-1.60	0.110	-2.278926	.2309164
_ImDDXann_1_2011	0	(omitted)				
_cons	11.06803	.2393087	46.25	0.000	10.59886	11.53719

Table A2-8: Results from FS indicators — random effects models introducing MDD-W*year and MDD-W*season interaction terms, pooled rural sample, Sanguie and Sourou provinces, 2010

HFIAS	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_IMDDW_1	-2.113451	.5158983	-4.10	0.000	-3.124593	-1.102309
_IPROVINCE_2	-2.55304	.3242322	-7.87	0.000	-3.188524	-1.917557
_IMDDXPRO_1_2	1.879999	.5786858	3.25	0.001	.7457952	3.014202
_IMDDW_1	0	(omitted)				
_ISEASON_2	-5.190302	.3254246	-15.95	0.000	-5.828122	-4.552481
_IMDDXSEA_1_2	.6703502	.5831996	1.15	0.250	-.4726999	1.8134
_cons	8.757665	.272147	32.18	0.000	8.224267	9.291063
sigma_u	0					
sigma_e	4.2216941					
rho	0	(fraction of variance due to u_i)				

HHS	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
_IMDDW_1	-.3745144	.1025395	-3.65	0.000	-.5754881	-.1735406
_IPROVINCE_2	-.3927619	.0644441	-6.09	0.000	-.5190701	-.2664537
_IMDDXPRO_1_2	.3194146	.1150191	2.78	0.005	.0939812	.5448479
_IMDDW_1	0	(omitted)				
_ISEASON_2	-.8561674	.0646811	-13.24	0.000	-.98294	-.7293947
_IMDDXSEA_1_2	.1119313	.1159163	0.97	0.334	-.1152605	.339123
_cons	1.264634	.0540917	23.38	0.000	1.158616	1.370652
sigma_u	0					
sigma_e	.8380852					
rho	0	(fraction of variance due to u_i)				

Appendix 3: Results

Table A3-1: Sample characteristics by city and year of survey

Covariate	OUAGADOUGOU			BOBO-DIOULASSO		
	2009 N=2055	2010 N=1957	2011 N=2259	2009 N=1988	2010 N=2207	2011 N=2272
	%	%	%	%	%	%
Age respondent						
15-25 years	36.9	31.8	30.8	23.7	28.2	29.6
26-35 years	39.5	41.5	45.5	38.9	39.9	44.0
36-49 years	23.7	26.7	23.7	37.3	31.9	29.4
Gender of head of household						
Male	90.0	89.5	91.6	86.7	89.2	89.9
Female	10.0	10.5	8.4	13.3	10.8	10.1
Education status of head of household						
None	44.8	44.3	42.2	51	49.0	46.1
Literate	11.2	12.7	9.1	12.3	7.9	8.0
Primary school	20.5	21.5	22.0	18.1	21.0	18.4
Secondary school and above	23.6	21.5	26.7	18.6	22.1	27.5
Household youth ratio score*						
Low	25.2	22.3	20.9	32.9	39.4	36.7
Middle	35.6	35.0	37.0	37.3	38.5	40.5
High	39.2	42.6	42.0	29.8	21.6	22.8
Household food stocks						
None	34.9	40.2	36.2	38.3	31.8	//
Little (food for 2 days at least)	14.6	19.1	6.9	11.7	15.1	//
At least 5 kg of cereals	21.2	23.2	24.0	19.8	23.2	//
At least 20 kg of cereals	29.4	17.5	32.9	30.2	30.0	//
Poultry in the house						
No	90.5	85.7	82.4	83.0	82.4	81.3
Yes	9.5	14.3	17.6	17.0	17.6	18.7
Vegetable garden						
No	85.2	80.4	84.7	81.6	87.0	84.3
Yes	14.2	19.6	15.3	19.4	13.0	15.6
Socioeconomic score*						
Low	33.2	44.3	30.7	32.8	33.9	28.4
Middle	32.9	28.8	30.8	34.5	28.0	27.3
High	33.9	26.9	38.5	32.7	38.1	43.8

*For categories representing the tertiles of index distribution, see methods section index construction.

Table A3-2: Logistic regression results with MDD-W as independent variable and survey year as dependent variable

	2009		2010		2011		2009 versus 2010		2011 versus 2010		
	n	% Yes	n	% Yes	n	% Yes	p	AOR (95%CI)±	p	AOR	(95%CI)±
Ouaga	2055	33.7	1957	27.7	2259	36.2	<0.0001	1.3 (1.1-1.5)	<0.0001	1.4	(1.2-1.6)
Bobo	1988	30.5	2207	27.4	2272	28.8	<0.0001	1.2 (1.1-1.5)	0.678	1.0	(0.9-1.2)

* adjusted by gender head of household, women age, youth ratio and head of household level of studies.

Table A3-3: Sample characteristics by province

Covariate	**SANGUIE N=240**	**SOUROU N=240**
	%	%
Age of the respondent		
15-25 years	26.7	20
26-35 years	48.3	52.5
36-49 years	25.0	27.5
Gender of head of household		
Male	98.8	100
Female	1.2	0
Religion of head of household		
Animist/None	23.8	7.5
Muslim	25.4	76.7
Christian	50.8	15.8
Education status of head of household		
None	77.1	72.5
Literate	7.9	15.4
Primary school	11.7,	10
Secondary school and above	3.3	2.1
Household youth ratio score *		
Low	42.9	31.7
Middle	30.0	35.4
High	27.1	32.9
Livestock		
Yes	79.6	92.9
Cow		
Yes	64.2	49.6
Sheep		
Yes	46.3	74.2
Socioeconomic score*		
Low	51.3	15.8
Middle	23.9	33.3
High	15.8	50.8

Table A3-4: Results of OLS — random effects (RE) and fixed effects (FE) regressions with BMI as dependent variable

Dep. Var: BMI	OLS	RE	FE
MDD-W=1	0.18	0.13	0.127
(ref: MDD-W=0)	(0.326)	(0.129)	(0.133)
MDD-W=1 and PH season	– 0.545	0.0784	0.125
(ref: MDD-W=1 and lean season)	(0.370)	(0.132)	(0.135)
MDD-W=1 and Sourou	0.184	– 0.214	-0.252
(ref: MDD-W=1 and Sanguie)	(0.368)	(0.150)	(0.155)
PH season	0.0275	**– 0.169****	**– 0.183****
(ref: lean season)	(0.209)	(0.063)	(0.063)
Sourou	0.0504	0.182	0
(ref: Sanguie)	(0.208)	(0.231)	(.)
Constant	20.78***	20.79***	20.84***
	– 0.175	– 0.166	– 0.0418
Observations	835	835	835
Number of mothers		467	467

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

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