Nutritional implications of dietary patterns in Mali

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Abstract

Mali's population is experiencing lifestyle and dietary changes that are driven in part by urbanisation and income growth. Utilising two large-scale datasets, we bring new empirical evidence regarding whether Malians are shifting toward highly processed foods, meals purchased away from home, and sugary foods. We find that on-farm production represents only 25% of the food consumed by rural households during the hungry season, and 36% after harvest. Processed food shares are greater in urban (60%) than in rural areas (48%), and considerably higher overall than those reported for Eastern and Southern Africa, but with a lower portion of highly processed foods and negligible shares of meals consumed outside the home. Average household dietary diversity scores are higher in urban than in rural areas. Women's and household diet diversity varies by season in both locations. About half of farm women interviewed did not meet minimum adequate dietary diversity during the lean season.

1. Introduction

The low-income countries of Sub-Saharan Africa are severely hit by malnutrition, but many also have rapidly growing rates of obesity. In Mali, one half of households are severely food insecure and another quarter are moderately food insecure (World Food Programme [WFP] 2017). Yet, from 1980 to 2015, obesity rates rose from under 2% to over 13% (The GBD 2015 Obesity Collaborators 2017). Obesity rates remain lower in Mali than in Southern Africa, where the rate of adult obesity (31%) is now equal to the rate of child stunting (Haggblade *et al*. 2016). Since diet transformation has begun in West Africa more recently (Zhou & Staatz 2016; Theriault *et al*. 2018), policymakers in this region may have the opportunity to "bend the curve" in the direction of healthier diets (Haggblade *et al*. 2016). A holistic approach to food systems (Global Panel on Agriculture and Food Systems for Nutrition [GLOPAN] 2016) is needed to attain this public good.

Rising per capita incomes and urbanising populations drive the demand for convenient (easy-to-prepare and ready-to-eat) foods. In Eastern and Southern Africa, the share of processed food represents 70% to 80% of food expenditure of the middle class, and shares are similar between urban and rural areas (Tschirley *et al*. 2015). In Tanzania, the diets of rural-urban migrants tend to shift

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away from traditional food, such as cassava, towards a greater consumption of sweets, animal products and food eaten away from home (Cockx & Weerdt 2016).

West Africa has some of the most rapidly urbanising areas in Sub-Saharan Africa. Nearly half of the region's population dwells in cities and, as a middle class gradually emerges, research indicates growing proportions of convenience and processed foods, animal products and perishables in the diets of both rural and urban consumers (Me-Nsope 2014; Hollinger & Staatz 2015). These patterns are not entirely negative; for example, the perishable category includes fresh vegetables and fruit with important nutrients.

Here we query secondary and primary data about evolving dietary patterns and nutrition in Mali. Our study contributes to the literature in several ways. First, we offer an example of how to use both secondary and primary data to analyse dietary patterns on the macro- and micro-scales. Second, we bring new empirical evidence to bear on whether diets in Mali are shifting toward more highly processed foods, meals purchased away from home, or sugary foods. On a macro-scale, we examine the distribution of consumption across food groups and processing content, comparing between urban and rural residence. This analysis is helpful in understanding how consumer demand for food groups changes as populations urbanise.

Third, on a micro-scale, we investigate the extent to which the diets of rural women, in particular, meet minimum adequate standards, contain key sources of micronutrients, and include elements such as fats, sugars and food purchased away from the home. We focus on women's diets because these are strong indicators of the diets of their children and other members of the household. In addition to being responsible for meal provision, Malian women who manage the plots granted to them for their use by the household head are expected to supplement the overall household with food when necessary. The micro-scale analysis provides insights into intrahousehold aspects of nutrition. Taken together, the findings from the macro- and micro-scale analysis inform us of the policies that might be helpful in coaxing nutritional paths toward favourable outcomes for Malians.

2. Concepts

Malnutrition encompasses three conditions: undernutrition, overnutrition, and micronutrient-related malnutrition. Wasting (low weight for height), stunting (low height for age), and underweight represent different forms of undernutrition. Children are the most at risk for undernutrition. In Mali, 13% of children under the age of five years are wasted and 38% are stunted (UNICEF 2013). Undernutrition can have long-term adverse consequences, such as growth failure and greater mortality (Victora *et al*. 2008).

Overnutrition, which leads to overweight and obesity (high weight for height) has been rising since the 1980s. The prevalence of obesity has doubled in more than 70 countries worldwide, including Mali (The GBD 2015 Obesity Collaborators 2017). There has been a sharp increase in disease burdens related to high body mass index, such as cardiovascular disease (The GBD 2015 Obesity Collaborators 2017). Accelerated infant weight gain during the first 1 000 days has been associated with an increased risk of obesity (Woo Baidal *et al*. 2016).

The third condition is micronutrient deficiency, which refers to the inadequate intake of vitamins and minerals, such as iodine, iron, vitamin A and calcium. Micronutrients are not made by the body but rather come from dietary intake. As in the case of the other two malnutrition conditions, micronutrient deficiencies can have adverse effects on growth and development. For instance, iodine deficiency and iron deficiency anaemia can hamper the intellectual development of children under five years of age (Walker *et al*. 2007).

Below, we present detailed data summaries that illuminate the nutritional status of households and individuals in Mali with respect to these conditions. In a related analysis, we develop a fuller conceptual framework and apply it in a causal analysis of the way a specific food policy – a fertiliser subsidy – affects the diet quality of rural women (Smale *et al*. 2020).

3. Methodology

3.1 Budget shares by source, perishability and processing

On a macro-scale, we analysed food group intake in rural and urban areas following Tschirley *et al*. (2015). First, we distributed aggregated household food consumption by commodity group and food expenditure category. Commodity groups include those frequently reported in similar studies. Food expenditure categories are defined by source (own production; purchase). Own production is divided between perishable and non-perishable items. The purchased category is then differentiated by degree of processing (none, low, high) and perishability. Food away from home is considered separately among purchased items (or as highly processed, non-perishable). To gain additional policy insights, specific commodities of national policy importance can be analysed separately from aggregated groups (e.g. for Mali, sorghum and millet as compared to rice and maize).

Second, household expenditures were computed for each food item in each expenditure category and converted into expenditure per commodity group within that category. Total market expenditure at the consumer level were calculated by summing across all households (h) for each commodity group i within each food expenditure category f:

$$V_{if} = \sum_h V_{if}^h \quad (1)$$

We adapted procedures for mapping multiple ingredient items in each food category that were developed by Tschirley *et al*. (2015) to better reflect the local composition of food items in Mali (additional details are available from the authors on request). Purchased foods are defined as unprocessed if undergoing no transformation from original state beyond removal from the plant and (for non-perishables) drying. Processed foods are assigned to the high value-added category if satisfying at least two of the following three conditions: multiple ingredients; physical change induced by heating, freezing, extrusion or chemical processes (more than simple physical transformation); and packaging more complex than simple paper or plastic. Foods satisfying one of these criteria were classified as low value-added, processed food.

3.2 Dietary diversity

Dietary diversity is measured as the number of different food groups that a household or an individual has consumed over a specified period of time. Nutritionists have documented a positive correlation between the diversity of energy, macro- and micronutrient intakes and more favourable anthropometric measures in adults and children (Arimond *et al*. 2010). Diets composed of a narrow range of food items, such as starchy staples, often lack macro- and micronutrient adequacy, even though they meet caloric requirements.

The household diet diversity score (HDDS) measures the access of a household to a number of different food groups, but sheds no light on intrahousehold distribution of dietary diversity, its equity or equality (International Dietary Data Expansion Project [IDDEP] 2019). In contrast, individual dietary diversity indicators, such as the women's dietary diversity score (WDDS) and minimum dietary diversity for women (MDD-W), provide information on individual household members. These indicators provide indirect but valuable insights into the nutrient adequacy of women and their children (Food and Agriculture Organization of the United Nations [FAO] & FHI 360 2016; Martin-

Prével *et al*. 2015). The MDD-W is based on interviews conducted with women of reproductive age (defined as 15 to 49). This age group is considered the most vulnerable among adult women. Within households, there is a high correlation between the dietary intake of women and their children.

We utilised information collected from the household head to compute the HDDS. The HDDS consists of food groups whose number and composition are adapted to the country and analytical context. Originally, the HDDS was based on 12 food groups proposed by Food and Nutrition Technical Assistance (FANTA) and elicited in 16 categories (Swindale & Bilinsky 2006). Research continues regarding suitable food groups. Across research contexts, the foods included in the HDDS groups also vary according to local diets.

Our survey team collected data from female household members of reproductive age to compute both the WDDS and MDD-W. In contrast to the HDDS, only nine food groups are employed to compute the WDDS. Fats and oils are not included because previous research suggests that this group did not contribute to micronutrient density in the diet (Kennedy *et al*. 2013). Similarly, the groups of sugars, spices and condiments are not considered to be important for this indicator. The MDD-W is a binary variable (0 and 1), measuring whether or not the respondent's consumption exceeded five out of 10 food groups in the recall period. There are slight differences in the way the WDDS and MDD-W are defined. We also derived indices for micronutrient adequacy, including vitamin A and iron, from the same survey instrument using the approach suggested by Kennedy *et al*. (2013). These indices are constructed as counts only across the food sources that are rich in either source of nutrients.

3.3 Data

We utilised nationally representative LSMS-ISA data for Mali for 2014/2015 to construct food group intake matrices in urban and rural areas. The final sample includes about 3 804 households compared to the planned sample of 4 218. This was due to insecurity in the northern region. To examine dietary diversity (micro-scale analysis), we utilised both the 2014/2015 LSMS/ISA dataset and the 2018/2019 PREPOSAM dataset. The LSMS-ISA dataset includes a household dietary diversity module, whereas the 2018/2019 PREPOSAM dataset includes an individual dietary diversity module.

Ten food groups were utilised by the LSMS-ISA team in Mali. As implemented in Mali, the HDDS refers to the frequency of consumption during the seven days preceding the survey. Data on food consumption was collected during the period of July to August (lean season) and during the period of October to December (harvest season).

The PREPOSAM data were collected by the Institut d'Economie Rurale and Michigan State University. The stratified random sample was drawn from the full list of enumeration areas in the agroecological zones of the Delta du Niger and the Plateau de Koutiala. Seasonal diet comparisons are based on the subsample of 1 026 women interviewed in both July of 2018 and February of 2019. The subsample was drawn from the original sample of 2 400 households and over 5 000 women. Mean values were not significantly different between the larger and smaller sample in the same season (July 2018). Women were asked about their food consumption over both a 24-hour and a seven-day recall period.

All PREPOSAM aggregates were computed by weighting data with the inverse sampling fraction, which is equal to the product of the probability of selecting the standard enumeration area (SE) times the probability of selecting the household within the SE.

4. Results

4.1 Composition of diets in rural and urban areas

Purchased foods represented 96% of the average food budget of urban households, with tiny percentages of own production (backyard and peri-urban areas) or food purchased as a snack or meal outside the home, along with tobacco (Tables 1 and 3). Highly processed food composed 15% of the urban diet – in the form of refined wheat products, liquid and dried milk, and oils. Meats other than poultry occupied 16% to 17% of the average budget, followed by rice and vegetables. Oils and fish come next in order of size, followed by root crops, fruit, wheat products, and sorghum or millet. Products with sugar (sugary foods, soft drinks, sugar for tea and coffee) represent only 4% to 6% of the average budget. Maize is less important than we expected, at 2% only in urban areas during either period. No foods were received as gifts. We saw no remarkable seasonal change in the overall structure of food budget shares in urban areas.

In the rural areas, purchased food represented 72% of budgets during the hungry season and 60% during the harvest season (Tables 2 and 4). Gifts were more common here than in urban areas. Food purchased away from the home was negligible. Post-harvest, a larger consumption share came from on-farm production (36% compared to 25%), and a smaller percentage was perishable. Rural households allocated about one-fifth of their food budget to rice during the harvest season. The share of the budget allocated to millet and sorghum remained relatively stable.

Highly processed, purchased foods represented only 7% of the rural budget in either season (as compared to 15% in urban areas). Foods with any type of processing represented 60% of the average budget in urban areas and only 48% in rural areas.

4.2 Household diet diversity scores

Cereals are among the categories consumed most frequently (at least six out of seven days) by households in either season, regardless of urban or rural residence (Table 5). Fish and meat, sugars, and fats and oils are consumed six out of seven days per week by households in urban areas, in either season. By contrast, consumption of fish and meat rises from under four to slightly over four days per week in rural areas after harvest in February. Between seasons, household consumption of oils and fats rises from about three to nearly five days per week and the consumption of sugars increases from only two days per week to six in rural areas. Vegetables are frequently consumed by urban households (five days per week in either season), but less often by the typical rural household. Fruits appear to be consumed far less often, with an average of two to three times per week in urban households and only one to two days per week in rural households. The food groups of legumes and seeds (including cowpeas and groundnuts, among other foods) and dairy and eggs are also consumed more in urban than in rural areas, but similarly across seasons.

Statistical tests comparing mean values confirm that differences between urban and rural areas in consumption days per week are highly significant for all food groups except for legumes and seeds in the post-harvest period, which is weakly significant at under 10%. Seasonal differences are highly significant in urban as well as rural households for all food groups, except legumes and seeds, dairy and eggs. Food consumption remains profoundly rural in Mali – that is, the constrained food choices of urban households still appear to reflect production patterns in rural areas.

Mean HDDS scores differed statistically at a significance level under 1% between urban (8.62) and rural (6.84) areas in the "hungry season", and also in the post-harvest season (9.01 and 7.45 respectively). We contend that, while this finding may convey information concerning access to food, it provides limited nutritional information, since the groups include spices and condiments, fats and

oils. These are included in small quantities in the sauces consumed daily in Mali. Fish and meat have been combined into a single group, as have dairy and eggs.

4.3 Diet quality of women

There are dramatic seasonal changes in rural women's consumption of starchy staples (Table 6).[2] The order of frequency of consumption of cereals was similar in July for maize, rice and millet (each about three days per week, with sorghum only once), but millet led after harvest (four days per week), followed by rice, maize and sorghum. Groundnut, widely used in the stews and sauces that accompany the starchy staple, was consumed three to four days per week on average. Green leafy vegetables were consumed four to five days per week in either season, and other vegetables five days a week post-harvest. In either season, fish was more frequently consumed on average than meat. Eggs are rarely consumed. Each type of milk or milk product is consumed one to two times per week in both July and February. Although women consume fats and oils six to seven days per week on average, the amounts are likely to be small – equivalent to that added to sauces and stews. Among foods with a higher sugar content, only sweetened tea or coffee was consumed most of the week. Wild plants or fruits were consumed 3.5 days per week on average during July, but only 2.2 days per week after the harvest in February.

Fewer than half of rural women in the study areas consumed at least five of the 10 groups included in the MDD-W at the same time that they were working in the fields (Table 7). Fortunately, the MDD-W rose from under 50% in the "hungry season" to 80% after harvest for the subsample of women interviewed in both periods. Similarly, the WDDS rose from a mean of 4.3 to 5.6 – an average increase of more than one food group.

[2] Since we requested information by subcategory, details included in indicators of women's diet quality could not be aggregated across the categories comparably to the HDDS.

Table 1: Urban food budget share (%) by commodity group, processing and perishability, July to August

Commodity group	Purchased						All purchased	All own production	All gifts	Meals purchased outside the home	Tobacco	Total
	Non-processed, non-perishable	Non-processed, perishable	Low-processed, non-perishable	Low-processed, perishable	High-processed, non-perishable	High-processed, perishable						
Rice	0.00	0.00	0.13	0.00	0.00	0.00	0.13	0.00	0.00	N/A	N/A	0.14
Maize	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	N/A	N/A	0.02
Millet/ sorghum	0.05	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.00	N/A	N/A	0.05
Wheat	0.00	0.00	0.00	0.00	0.00	0.04	0.05	0.00	0.00	N/A	N/A	0.05
Other grains	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	N/A	0.00
Pulses	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	N/A	N/A	0.01
Roots	0.00	0.04	0.00	0.00	0.00	0.00	0.04	0.00	0.00	N/A	N/A	0.05
Oils	0.00	0.00	0.02	0.00	0.05	0.00	0.08	0.00	0.00	N/A	N/A	0.08
Fruits	0.00	0.06	0.00	0.00	0.00	0.00	0.06	0.00	0.00	N/A	N/A	0.06
Vegetables	0.01	0.12	0.00	0.00	0.00	0.00	0.13	0.00	0.00	N/A	N/A	0.13
Poultry	0.00	0.00	0.00	0.02	0.00	0.00	0.02	0.00	0.00	N/A	N/A	0.02
Other meats	0.00	0.00	0.00	0.17	0.00	0.00	0.17	0.00	0.00	N/A	N/A	0.17
Liquid milk	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	N/A	N/A	0.01
Dried milk	0.00	0.00	0.00	0.00	0.04	0.00	0.04	0.00	0.00	N/A	N/A	0.04
Other dairy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	N/A	0.01
Fish	0.00	0.04	0.00	0.04	0.00	0.00	0.08	0.00	0.00	N/A	N/A	0.08
Salt	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	N/A	N/A	0.01
Sugars	0.00	0.00	0.03	0.00	0.00	0.00	0.04	0.00	0.00	N/A	N/A	0.04
Other nuts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	N/A	0.00
Total	0.09	0.27	0.21	0.24	0.10	0.05	0.96	0.01	0.00	0.02	0.01	1.00

Source: Authors, constructed from LSMS-ISA 2014 in Mali

Table 2: Rural food budget share (%) by commodity group, processing and perishability, July to August

Commodity group	Purchased						All purchased	All own production	All gifts	Meals purchased outside the home	Tobacco	Total
	Non-processed, non-perishable	Non-processed, perishable	Low-processed, non-perishable	Low-processed, perishable	High-processed, non-perishable	High-processed, perishable						
Rice	0.00	0.00	0.12	0.00	0.00	0.00	0.12	0.04	0.00	N/A	N/A	0.16
Maize	0.02	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.00	N/A	N/A	0.04
Millet/ sorghum	0.07	0.00	0.01	0.00	0.00	0.00	0.08	0.03	0.00	N/A	N/A	0.11
Wheat	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	N/A	N/A	0.02
Other grains	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	N/A	N/A	0.01
Pulses	0.01	0.00	0.01	0.00	0.00	0.00	0.02	0.02	0.00	N/A	N/A	0.04
Roots	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00	N/A	N/A	0.02
Oils	0.00	0.00	0.02	0.00	0.03	0.00	0.05	0.02	0.00	N/A	N/A	0.07
Fruits	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.01	0.00	N/A	N/A	0.04
Vegetables	0.02	0.05	0.00	0.00	0.00	0.00	0.06	0.02	0.00	N/A	N/A	0.09
Poultry	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	N/A	N/A	0.02
Other meats	0.00	0.00	0.00	0.09	0.00	0.00	0.09	0.01	0.01	N/A	N/A	0.10
Liquid milk	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	N/A	N/A	0.02
Dried milk	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	N/A	N/A	0.01
Other dairy	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	N/A	N/A	0.03
Fish	0.00	0.02	0.00	0.04	0.00	0.00	0.06	0.01	0.00	N/A	N/A	0.07
Salt	0.00	0.00	0.04	0.00	0.00	0.00	0.04	0.00	0.00	N/A	N/A	0.04
Sugar	0.00	0.00	0.05	0.00	0.00	0.00	0.05	0.00	0.00	N/A	N/A	0.05
Other nuts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	N/A	N/A	0.03
Total	0.13	0.11	0.25	0.16	0.04	0.03	0.72	0.25	0.03	0.00	0.01	0.99

Source: Authors, constructed from LSMS-ISA 2014 in Mali

Table 3: Urban food budget share (%) by commodity group, processing and perishability, October to December

Commodity group	Purchased						All purchased	All own production	All gifts	Meals purchased outside the home	Tobacco	Total
	Non-processed, non-perishable	Non-processed, perishable	Low-processed, non-perishable	Low-processed, perishable	High-processed, non-perishable	High-processed, perishable						
Rice	0.00	0.00	0.12	0.00	0.00	0.00	0.12	0.00	0.00	N/A	N/A	0.13
Maize	0.02	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	N/A	N/A	0.02
Millet/ sorghum	0.03	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	N/A	N/A	0.04
Wheat	0.00	0.00	0.00	0.00	0.00	0.03	0.03	0.00	0.00	N/A	N/A	0.03
Other grains	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	N/A	0.00
Pulses	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	N/A	N/A	0.02
Roots	0.00	0.05	0.00	0.00	0.00	0.00	0.05	0.00	0.00	N/A	N/A	0.05
Oils	0.00	0.00	0.02	0.00	0.05	0.00	0.07	0.00	0.00	N/A	N/A	0.07
Fruits	0.00	0.05	0.00	0.00	0.00	0.00	0.05	0.00	0.00	N/A	N/A	0.06
Vegetables	0.01	0.12	0.00	0.00	0.00	0.00	0.14	0.00	0.00	N/A	N/A	0.14
Poultry	0.00	0.00	0.00	0.04	0.00	0.01	0.05	0.00	0.00	N/A	N/A	0.05
Other meats	0.00	0.00	0.00	0.15	0.00	0.00	0.15	0.00	0.00	N/A	N/A	0.16
Liquid milk	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.00	0.00	N/A	N/A	0.01
Dried milk	0.00	0.00	0.00	0.00	0.05	0.00	0.05	0.00	0.00	N/A	N/A	0.05
Other dairy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	N/A	0.00
Fish	0.00	0.04	0.00	0.04	0.00	0.00	0.09	0.00	0.00	N/A	N/A	0.09
Salt	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	N/A	N/A	0.02
Sugar	0.00	0.00	0.06	0.00	0.00	0.00	0.06	0.00	0.00	N/A	N/A	0.06
Other nuts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	N/A	0.00
Total	0.08	0.27	0.22	0.24	0.10	0.05	0.96	0.01	0.02	0.02	0.01	1.02

Source: Authors, constructed from LSMS-ISA 2014 in Mali

Table 4: Rural food budget share (%) by commodity group, processing and perishability, October to December

Commodity group	Purchased						All purchased	All own production	All gifts	Meals purchased outside the home	Tobacco	Total
	Non-processed, non-perishable	Non-processed, perishable	Low-processed, non-perishable	Low-processed, perishable	High-processed, non-perishable	High-processed, perishable						
Rice	0.00	0.00	0.11	0.00	0.00	0.00	0.11	0.09	0.00	N/A	N/A	0.21
Maize	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.04	0.00	N/A	N/A	0.05
Millet/ sorghum	0.03	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.00	N/A	N/A	0.12
Wheat	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.00	0.00	N/A	N/A	0.03
Other grains	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	N/A	N/A	0.01
Pulses	0.01	0.00	0.00	0.00	0.00	0.00	0.02	0.03	0.00	N/A	N/A	0.05
Roots	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	N/A	N/A	0.03
Oils	0.00	0.00	0.02	0.00	0.03	0.00	0.05	0.02	0.00	N/A	N/A	0.07
Fruits	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.00	0.00	N/A	N/A	0.02
Vegetables	0.01	0.04	0.00	0.00	0.00	0.00	0.06	0.02	0.00	N/A	N/A	0.08
Poultry	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.01	0.00	N/A	N/A	0.03
Other meats	0.00	0.00	0.00	0.09	0.00	0.00	0.09	0.01	0.01	N/A	N/A	0.11
Liquid milk	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00	N/A	N/A	0.02
Dried milk	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	N/A	N/A	0.01
Other dairy	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	N/A	N/A	0.01
Fish	0.00	0.02	0.00	0.04	0.00	0.00	0.07	0.01	0.00	N/A	N/A	0.08
Salt	0.00	0.00	0.02	0.00	0.00	0.00	0.02	0.00	0.00	N/A	N/A	0.02
Sugar	0.00	0.00	0.04	0.00	0.00	0.00	0.04	0.00	0.00	N/A	N/A	0.04
Other nuts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	N/A	N/A	0.00
Total	0.07	0.11	0.20	0.15	0.04	0.03	0.60	0.36	0.04	0.01	0.01	0.99

Source: Authors, constructed from LSMS-ISA 2014 in Mali

Table 5: Frequency of food group consumption by Malian households

											Difference of means (p value)			
Food group	**Urban Days consumed per week**					**Rural Days consumed per week**					**Seasonal**			**Residential**
	Obs	**Mean**	**Std dev.**	**Min**	**Max**	**Obs**	**Mean**	**Std dev.**	**Min**	**Max**	**Urban**	**Rural**		**September**
September														
Cereals	1 405	6.57	1.41	0	7	2 399	6.25	1.85	0	7	0.0000	0.0000		0.0000
Tubers, plantains	1 405	1.71	1.84	0	7	2 399	0.60	1.33	0	7	0.0000	0.0000		0.0000
Legumes, seeds	1 405	2.95	2.21	0	7	2 399	2.50	2.47	0	7	0.4252	0.0000		0.0000
Vegetables	1 405	5.09	2.55	0	7	2 399	2.87	2.90	0	7	0.0001	0.0000		0.0000
Fish and meat	1 405	6.23	1.85	0	7	2 399	3.87	2.72	0	7	0.0040	0.0000		0.0000
Fruits	1 405	2.30	2.49	0	7	2 399	0.97	1.95	0	7	0.0000	0.0056		0.0000
Dairy, eggs	1 405	3.85	2.88	0	7	2 399	2.66	2.76	0	7	0.0536	0.7446		0.0000
Oil, fats	1 405	6.13	1.90	0	7	2 399	4.26	2.91	0	7	0.0005	0.0000		0.0000
Sugar	1 405	6.61	1.47	0	7	2 399	5.57	2.43	0	7	0.0002	0.0000		0.0000
Spices, condiments	1 405	6.56	1.58	0	7	2 399	5.98	2.27	0	7	0.0053	0.0000		0.0000
	Urban							**Rural**						
February														**February**
Cereals	1 405	6.75	1.11	0	7	2 399	6.60	1.34	0	7				0.0005
Tubers, plantains	1 405	2.19	1.88	0	7	2 399	0.81	1.41	0	7				0.0000
Legumes, seeds	1 405	2.90	2.03	0	7	2 399	3.04	2.53	0	7				0.0834
Vegetables	1 405	5.35	2.34	0	7	2 399	3.58	2.90	0	7				0.0000
Fish and meat	1 405	6.38	1.56	0	7	2 399	4.30	2.59	0	7				0.0000
Fruits	1 405	2.68	2.46	0	7	2 399	1.10	1.96	0	7				0.0000
Dairy, eggs	1 405	4.00	2.82	0	7	2 399	2.68	2.73	0	7				0.0000
Oil, fats	1 405	6.32	1.66	0	7	2 399	4.93	2.64	0	7				0.0000
Sugar	1 405	6.77	1.10	0	7	2 399	6.02	2.02	0	7				0.0000
Spices, condiments	1 405	6.68	1.34	0	7	2 399	6.42	1.74	0	7				0.0000

Source: Authors, based on LSMS-ISA Mali 2014/2015

Table 6: Days per week of food group consumption by women of reproductive age in rural Mali

Food group	July 2017					February 2018			
	Days consumed per week					Days consumed per week			
	Mean	Std dev.	Min	Max		Mean	Std dev.	Min	Max
Cereals									
Sorghum	0.78	2.06	0	7		1.83	2.86	0	7
Millet	3.12	3.19	0	7		4.02	3.02	0	7
Maize	3.11	3.37	0	7		2.30	3.01	0	7
Rice	3.29	2.76	0	7		3.48	2.62	0	7
Fonio	0.04	0.33	0	7		0.11	0.51	0	7
Cereal products	1.65	2.00	0	7		2.38	2.25	0	7
Tubers and plantains									
Roots and tubers (white)	0.38	1.00	0	7		1.41	1.80	0	7
Roots and tubers (orange)	0.10	0.57	0	7		0.31	1.04	0	7
Legumes, seeds									
Legumes (not groundnut)	0.97	1.82	0	7		1.51	2.16	0	7
Groundnut	3.28	2.58	0	7		3.89	2.67	0	7
Sesame	0.03	0.37	0	7		0.11	0.56	0	7
Vegetables and fruits									
Green leafy vegetables	5.11	2.60	0	7		4.08	3.07	0	7
Vitamin A-rich vegetables	0.80	2.04	0	7		1.27	2.31	0	7
Other vegetables	2.61	2.90	0	7		5.26	2.42	0	7
Vitamin A-rich fruits	0.18	0.76	0	7		0.59	1.21	0	7
Other fruits	0.39	1.17	0	7		0.79	1.47	0	7
Fish and meat									
Beef	0.98	1.47	0	7		0.70	1.25	0	7
Lamb, goat meat	0.73	1.24	0	7		0.98	1.33	0	7
Poultry	0.28	0.68	0	7		0.44	0.84	0	7
Organ meat	0.22	0.81	0	7		0.21	0.72	0	7
Insects, rodents	0.04	0.33	0	7		0.19	0.76	0	7
Other meats	0.02	0.21	0	7		0.03	0.32	0	7
Fish (fresh)	1.50	2.40	0	7		2.13	2.45	0	7
Fish (dried)	4.09	2.81	0	7		4.89	2.60	0	7
Dairy, eggs									
Eggs	0.43	1.13	0	7		0.38	0.93	0	7
Milk (fresh)	0.86	1.86	0	7		1.25	2.10	0	7
Milk products (yoghurt, curd)	1.16	2.15	0	7		1.67	2.43	0	7
Milk (powdered)	1.28	2.25	0	7		1.79	2.48	0	7
Oils, fats									
Palm oil or fruit	0.10	0.62	0	7		0.38	1.21	0	7
Other oil	6.38	1.49	0	7		6.41	1.50	0	7
Spices, condiments	6.90	0.55	0	7		6.95	0.43	0	7
Sugar									
Honey, jam	0.81	1.57	0	7		1.62	2.11	0	7
Sodas, bottled juices	0.42	1.18	0	7		0.46	1.00	0	7
Sweetened tea or coffee	5.12	2.71	0	7		5.37	2.61	0	7
Wild plants or fruits	3.49	3.12	0	7		2.24	2.68	0	7

Source: Authors, based on data collected from same women by IER/MSU in 2017-18

Table 7: Women's diet quality scores and other indicators in Mali

	July 2018						February 2019				
	Obs	**Mean**	**Std dev.**	**Min**	**Max**		**Mean**	**Std. dev.**	**Min**	**Max**	**Difference of means (p value)**
MDD_W	1 087	0.451	0.498	0	1		0.795	0.404	0	1	0.0000
WDDS	1 087	4.32	1.51	0	9		5.61	1.44	1	9	0.0000
Outside costs	1 087	35.4	166	0	3 000		58.9	198	0	3 900	0.0024
Soda or juice	1 087	0.065	0.247	0	1		0.107	0.309	0	1	0.0004
Sugars	1 087	0.802	0.399	0	1		0.845	0.362	0	1	0.0037
Fats or oils	1 087	0.946	0.227	0	1		0.966	0.181	0	1	0.0247
Iron-rich	1 087	0.363	0.481	0	1		0.419	0.494	0	1	0.0047
Vitamin A-rich	1 087	0.140	0.347	0	1		0.737	0.441	0	1	0.0000
Wild plants	1 087	0.585	0.493	0	1		0.393	0.489	0	1	0.0000

Source: Authors, based on IER/MSU data; 24-hour recall

Women spent 59 FCFA[3] on average on meals or snacks purchased outside the home after harvest compared to 35 FCFA in the "hungry season". After harvest, they had more cash to spend from sales of production on their plots or receipts shared with other family members. The frequency of consumption of all special categories increased, including soda and juice, sugars, fats and oils, but also foods rich in iron and vitamin A.

After the harvest, the likelihood that a respondent consumed a wild plant in the 24 hours preceding the survey declined from 60% to 48%. These are often considered to be "famine foods", although baobab leaves and other foods gathered in common areas around the farm also play a role in the typical diet of many rural households in Mali. The significance of wild plant consumption highlights the continued importance of natural areas in rural diets.

We did not observe high consumption of sugary foods by farm women in Mali. Even after harvest, the chances were only about one in 10 that a farm woman in Mali consumed a soda or juice on the day before the survey. Chances were four out of five that she consumed some type of sugar, but our data show that sugar added to tea or coffee accounts for most of this consumption. Fats and oils were consumed by almost all farm women in either season, and these were most probably in limited amounts used daily for the preparation of sauces to accompany the starchy staple. Nonetheless, these are important sources of energy.

5. Discussion

Estimates derived from the LSMS-ISA showed that, in 2017/2018, on-farm production in Mali provided on average only 25% of the food consumed by rural households during the hungry season, rising to 36% in the harvest season. In their analysis of LSMS data (circa 2010) from Ethiopia, Uganda, Tanzania, Malawi and Zambia, Tschirley *et al*. (2015) found that on-farm production accounted for 43% of food consumed (annually). Differences between regions might be explained by higher productivity in Eastern and Southern Africa, or by the time difference between the surveys, but the estimates for Mali are disturbing given the reliance of the rural population on farming.

In Mali, the consumption of food with any type of processing was considerably lower in rural than in urban areas (48% as compared to 60%). However, both of these estimates are higher than the 39% estimate reported by Tschirley *et al*. (2015) for Eastern and Southern Africa. We estimated the share of highly processed foods to be 15% in urban areas and 7% in rural areas. Tschirley *et al*. (2015)

[3] The West African CFA franc is known in French as the Franc CFA (FCFA), where CFA stands for Communauté financière d'Afrique ("Financial Community of Africa") or Communauté Financière Africaine ("African Financial Community").

report 20% across both rural and urban areas combined in the five countries in their study. The difference reflects the extent of processing.

Meals purchased outside the home are a feature of urban rather than rural households in Mali – but it still occupies only 2% of the average urban budget. This category represented 12% of food expenditure in the rural areas and 33% in the urban areas of Tanzania in 2010 (Tschirley *et al*. 2017). Haggblade *et al*. (2016) report survey data indicating that, in Johannesburg, 28% of adults aged 19 to 30 years consume fast foods two to three times a week; among 17-year-olds from Soweto, 50% of males and 38% of females consumed eight or more street food and fast-food meals weekly.

Together, these findings indicate that, while both rural and urban diets in Mali have shifted heavily toward purchased foods and processed foods, the shares of highly processed foods and meals purchased outside the home (street or fast foods) are still low relative to some other countries in Sub-Saharan Africa. Of course, processing is not always bad; for example, drying for preservation and the removal of toxicity have positive effects on nutrition and health (Cliffer *et al*. 2019). A rising consumption of meals away from home, packaged and ultra-processed foods causes greater concern than does consumption of processed foods in general (Cliffer *et al*. 2019).

Meat consumption occupied a higher share of the food budget in urban areas. Average budget shares of sorghum and millet are higher in rural areas. The maize budget share was lower than other cereals in either rural or urban areas (2% to 4%) – a finding that has relevance for the extent to which this crop is favoured over sorghum and millet because of the fertiliser subsidy and other farm policies. Among cereals, the share of rice in the budget is the greatest among cereals in both rural and urban areas, but slightly more so in rural compared to urban areas. Rice has been favoured by farm policy in most countries of West Africa for decades.

Urban households in Mali have a higher dietary diversity score than rural households. In Tanzania, Cockx and Weerdt (2016: 3) found little evidence of differences in dietary diversity "between individuals who relocated from rural to urban areas and their initial household members who stayed behind". The difference between Mali and Tanzania could reflect greater gaps in access to a broader range of foods between the urban and rural markets of Mali. Cockx and Weerdt (2016) also measured changes among migrant members of the same families – thus controlling for multiple intervening factors. In their Bamako study, Kennedy *et al*. (2009) found that women's diets were dominated by the starchy staples (refined white rice, refined wheat flour and millet), which provided half of the energy. Vegetable oil (included in the sauces that accompany the staples) also provided energy. Snacks and foods such as fruits, peanuts and doughnuts (*beignets*) made of cowpea flour enhanced diversity scores for rural women. Similarly, in neighbouring Ouagadougou, Burkina Faso, Becquey *et al*. (2010) concluded that diet diversity was low in urban areas and higher in rural areas, with variability introduced through "snacking" – which was not associated with a higher risk of being overweight.

Dietary diversity scores of both urban and rural households are lower during the lean season than during the harvest season. Seasonal differences observed in household access to food in both urban and rural areas are also observed in the micronutrient adequacy of rural women. Malian farm women consume one less food group during the lean season, and the percentage of them consuming at least five out of 10 food groups dropped by 34% (from 79.5% to 45.1%). In their study of over 5 000 women of reproductive age in the region of Kayes, Mali, Adubra *et al*. (2019) found that an even lower percentage of women (27%) reached the MDD-W. Over a decade ago, key research by Savy *et al*. (2006) emphasised the importance of seasonal variations in dietary diversity in rural areas of Burkina Faso, demonstrating that whether changes are positive or negative depends on the availability of food sources other than the cereals, including wild plants and fruits. Income enabled women in better-off households to purchase livestock products and oil.

6. Conclusions

We analysed the implications of dietary patterns for nutrition in Mali by reviewing the key dimensions of malnutrition and describing the methodological approaches used to examine dietary composition by food groups on the macro- and micro-scale. We presented matrices developed from the LSMS-ISA 2014/2015 data to depict the current "macro" structure of food consumption in rural and urban Mali. We then consulted primary data that we collected in two seasons in 2018 and 2019. We used these "micro" data to explore the diet quality of farm women in the agroecological zones of the Delta du Niger and the Koutiala Plateau.

The low food share contributed by on-farm production suggests that achieving family farm self-sufficiency is an unrealistic goal in rural Mali. Food is still received as gifts in rural areas, but we found gifts to be of no importance in urban areas. Highly processed foods still represent a relatively smaller share of processed foods consumed by urban and especially rural residents in Mali than we have observed in other studies conducted using a similar methodology in Eastern and Southern Africa. Malians do not purchase meals much outside the home. Sugary foods are rarely consumed by farm women, except in the form of sweetened tea or coffee.

We conclude that it may still be possible to "bend the curve" toward healthier diets in Mali and to avoid the overnutrition now faced by other nations. That being said, the statistic that fewer than half of the more than 5 000 women interviewed during the growing season met the minimum adequate dietary diversity is deeply troubling.

7. Policy implications

The Malian government prioritises rice in its strategy to achieve food and nutrition security, and we find the rice budget share to be highest among cereals. The current fertiliser subsidy targets rice, maize and, to a lesser extent, sorghum and millet, thereby favouring starchy staples over other, nutrient-rich crops that could further diversify diets. The goals and mechanisms of the subsidy programme should be revisited. Second, private and public investments are needed to minimise the rural bias and seasonality effects of the dietary diversity of Malian households and individuals. As only one example, small-scale, low-cost irrigation schemes to better manage seasonal water can contribute to balanced nutrition by increasing crop diversity and productivity. Farm women often are heavily involved in vegetable production when they have access to irrigation, land and nearby markets. Farm women also double as part-time traders in local markets, commercialising lightly processed foods such as cowpea *beignets*. Micro-finance options could create opportunities for small-scale enterprise development. Previous research has shown that interventions targeting women through empowerment activities, such as the promotion of increased control over income from product sales, often lead to positive nutritional outcomes, especially for children. Third, given the heavy dependence of the population on purchased food, more off-farm investments are needed to achieve food and nutrition security. This requires developing food markets and the agro-processing sector to enable the provision of affordable, diversified and nutritious food year-round in both rural and urban areas.

One useful direction for future research might be a meta-analysis of the LSMS-ISA data on dietary diversity in numerous countries of Sub-Saharan Africa, including analysis by household income. As suggested by an anonymous reviewer, quantitative research might be supplemented by a qualitative, comprehensive review of the gender and nutrition literature dating back to the early work of Amartya Sen.

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