Constructing a Nutrition Deficiency Index Applications for the Democratic Republic of the Congo under a Decade of Humanitarian Crises

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ABSTRACT

The Democratic Republic of the Congo (DRC) is perennially plagued by prolonged phases of poverty, conflict, and increased internal migration, as well as pandemic outbreaks such as Ebola and COVID-19 and limited livelihood opportunities. Such unexpected or catastrophic events have rendered households vulnerable and resulted in poor health outcomes. Given this background, we intend to analyze the nutritional profile of households for a period spanning almost a decade using the Household Consumption Expenditure Survey (HCES). We construct a composite nutrition deficiency index (NDI), capturing intake of 14 different macro- and micronutrients (which we refer to as *dimensions*)—namely, calories, protein, calcium, zinc, folate, thiamine, niacin, iron, vitamin A, vitamin B_{12}, vitamin D, vitamin B_6, vitamin C, and vitamin E—using the popular Alkire-Foster methodology. This methodology, usually used to construct multidimensional poverty indexes, in this case, helps measure the incidence, intensity, and combined extent of multinutrient deprivation. DRC's values on the multidimensional NDI vary regionally from 0.13 to 0.73. Urban DRC performs worse than rural DRC. Regions subject to the conflict and Ebola crises are the worst-affected of the nutritionally deprived regions. Deficiency in calorie and protein intake contributes to the highest values of the NDI, but we also find evidence of a double burden of malnutrition, with households lacking consumption of both macro- and micronutrients. South Kivu is the worst-performing of all regions and Mongala the best. The northern parts of DRC have fewer nutritionally deprived households than the central and southwestern parts. Our main policy recommendation is to help improve market access in urban areas so that people consume a more diverse diet. Due to conflicts and infrastructure-related issues, rural produce does not reach urban markets. Urban markets flood with imported food. The urban population cannot afford the products and end up consuming high-calorie food items and subsequent nutritional deprivation. It also partly explains why urban DRC performs poorly compared to rural DRC. In rural areas, the government should support improving nutrition-sensitive agricultural production. We discuss the existing Nutrition Smart Agriculture (NSmartAg) practices and technologies, market potential, map with NDI performance across regions and identify prospective regions for nutrition intervention. Our disaggregated analysis on nutrient deprivation can guide the ag-nutri policymakers to identify and formulate the required region and nutrition-specific interventions. Although the World Food Programme has a sustained presence in the country, uplifting households from severe hunger, active and continued participation by the government and collaboration with multiple stakeholders is called for.

Keywords: nutrition deficiency index, Alkire-Foster methodology, household consumption and expenditure surveys, Democratic Republic of the Congo

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1. INTRODUCTION

Tackling malnutrition remains a major challenge for the Democratic Republic of the Congo (DRC) in the face of prolonged phases of poverty, conflict, and increased internal migration, as well as pandemic outbreaks such as Ebola and COVID-19, and limited livelihood opportunities (UNECA 2015, WFP 2020). In December 2012, around 6.4 million people were affected by food and job insecurity (IPC 2012). The prevalence of stunting and wasting for children less than five years old are estimated to be 42.6 and 8.1 percent, respectively, and the trend is not favourable (DHS 2014). The numbers are higher than those of neighbouring countries (DHS 2014). This situation is despite the government prioritizing nutrition in National Plans since the 2000s. Overall, DRC ranks dismally, at 176th in the world, with a low Human Development Index value of 0.457 (UNDP 2018).

Given the country's gloomy health outcomes, we intend to analyze the nutritional profile of households for a period spanning almost a decade. The intake of calories is as important as that of micronutrients to reduce the impact of a plethora of diseases and the so-called triple burden of malnutrition (Gómez et al. 2013). This burden is the simultaneous existence of undernourishment, overnourishment, and micronutrient deficiency in the same population. A healthy diet is key to reducing morbidity and mortality globally. The EAT-*Lancet* Commission's article "Food in the Anthropocene: The EAT–*Lancet* Commission on Healthy Diets from Sustainable Food Systems" outlined a global reference diet based on an understanding of nutrient adequacy and future mortality rates (Willett et al. 2019). The reference diet prescribed is tilted toward improved intake of important micronutrients such as iron, zinc, folate, vitamin A, calcium, and vitamin B_{12}. The food groups that form the basis of this intake are vegetables and fruits, whole grains, legumes and nuts, and unsaturated oils, as well as seafood and poultry in low to moderate amounts; the diet also recommends low to no consumption of red meat, processed meat, added sugar, refined grains, and starchy vegetables.

Prescribed intake of such a diverse food basket leads to the question as to whether the poor can afford it. Hirvonen and colleagues (2019) computed the cost of the EAT-*Lancet* diet to be 1.6 times the minimum cost of consuming a "nutrient-adequate" diet. Globally, 1.58 billion people cannot afford an EAT-*Lancet* diet due to the relatively high price of animal-source foods and of fruits and vegetables.

The next step is to understand how the present diets of countries fall behind the prescribed recommendations. For example, Sharma and others (2020) provided a disaggregated analysis of how the Indian diet compares with the EAT-*Lancet* reference diet. The analysis, primarily expressed in terms of food groups, found that the share of calories from protein sources in India was almost 11 percent lower than the reference diet norms. Spurred by findings such as these, the global policy discussion is in favour of diets that are more nutrition sensitive, improved in nutrient intake, and affordable. This motivates us to examine the disaggregated and overall multinutrient intake of households in the DRC and identify suitable policy recommendations.

In this paper, we construct a composite nutrition deficiency index (NDI) capturing intake for 14 different macro- and micronutrients (which we refer to as 14 "dimensions")—namely, calories, protein, calcium, zinc, folate, thiamine, niacin, iron, vitamin A, vitamin B_{12}, vitamin D, vitamin B_6, vitamin C, and vitamin E—using the popular Alkire-Foster (AF) methodology. Our key findings are in line with those of other developing countries suffering from the double burden of malnutrition (Babu, Gajanan, and Hallam 2016; Kimmel et al. 2019).

It is surprising to note that in both conflict-affected and unaffected zones, nutritional outcomes for the DRC are the same. Different interventions have been experimented within the DRC to improve nutritional outcomes. For example, the National Multisectoral Strategic Nutrition Plan (Plan Stratégique National Multisectoriel de Nutrition, PNSMN, 2016 2025) demands the agriculture sector to address malnutrition with greater availability and access to a diversified food basket, and inclusion of bio-fortification of crops and fortified food. Interventions are spatially targeted to map the nutritional outcomes with production, access, and utilization constraints (Marivoet, Becquey, and Van Campenhout 2019). Multistakeholder involvement in the success of the interventions is required. Good governance is key to improved nutritional outcomes in the face of rising decentralization (Marivoet 2016, Saxena 2016). In the face of rising uncertainty, food systems need to be more adaptive and capable of withstanding shocks. Resiliency in food systems, focusing on policy, institutions, technology, capacity, and governance, is the need of the hour (Babu and Blom 2014; Iyappan and Babu 2018).

DRC is not just another developing country struggling to ensure food security for all its citizens. Despite being rich in natural resources with the potential to play a major role in Africa's growth process, DRC is, unfortunately, one of the most conflict-ridden countries in Africa. Conflict leads to the loss of lives, wealth, land, and other crucial components for vital

living and internal displacement and migration. The internal displacement is the largest of around 1.7 million in 2017, a total of 4.5 million internally displaced persons (IDPs) has been reported, and about 600,000 people outside DRC in the neighbouring countries of Africa (OCHA 2017, 2018; UNHCR 2018). Agricultural production declines due to such sudden movement of large sections of the rural population. IDPs are without any resources to rehabilitate themselves. The issue affects women and children the most and perpetuates the vicious circle of poverty and malnutrition in this primarily agropastoral economy. The World Health Organization described the current challenges: Conflicts have led the Congolese to remain starving for days and live in the most inhospitable conditions possible. The spread of communicable diseases, coupled with chronic malnutrition, leads to preventable death and makes the future look bleak (WHO 2018). The Ebola crises have greatly added to the woes. Bushmeat, a favourite of many Congolese, brings forth these crises. This is primarily a feature of the central, northern, and eastern parts of the country. As of June 2020, around 3,500 people were affected in the eastern part of the country, and 2,500 had succumbed to death in the DRC (WHO 2020). Kasai, in the central part of the country, was the most affected due to conflict.

International organizations such as the Food and Agriculture Organization of the United Nations (FAO) and the World Food Programme (WFP) have repeatedly issued warnings about the alarming food insecurity situation in the DRC, deeming it a major humanitarian crisis. The country ranks dismally, alongside Afghanistan, Ethiopia, northern Nigeria, South Sudan, Sudan, the Syrian Arab Republic, and Yemen, for alarming levels of food insecurity (WFP 2019). Some of the relief measures include giving away seeds of staple food crops and vegetables and agricultural implements, especially to IDPs, to grow food crops and ensure food security. However, such measures are seriously underfunded, and several curtailments in existing funding have worsened the situation (FAO 2018). Application of the capability approach in understanding what hinders growth and development in this country is very important. The index we construct using the AF methodology helps to identify groups and regions that are multidimensionally deprived in the intake of certain nutrients.

This paper is motivated by three different approaches of the literature. The first draws from the poverty and inequality literature and the second from the different pathways in agriculture and nutrition that can lead to positive nutritional outcomes. The final approaches is literature based on the objective of attaining the United Nations Sustainable Development Goals (SDGs). All

the strands are interrelated and indicate that reducing multidimensional poverty in the agriculture-nutrition nexus can lead to food security and the attainment of multiple SDGs.

The recent poverty and inequality literature has extensively discussed the need for multidimensional measures to estimate the number of poor and identify the main factors contributing to poverty (Cuenca García, Navarro Pabsdorf, and Moran Alvarez 2019). A low level of income is not the only factor leading to poverty. Households may be deprived in many other dimensions, resulting in poverty. For example, inadequate access to safe drinking water may lead to waterborne diseases, leading to higher expenditure on health, lowering income below the poverty threshold. Therefore, lack of water results in poor health and financial outcomes. Some other possible dimensions or pathways that can lead to poverty on similar lines are sanitation and hygiene, flooring, cooking fuel, education, assets, access to electricity, and so on. Multidimensionally poor households may be more prone to risk due to catastrophic events. For example, sudden out-of-pocket expenditures on health may be highly inflationary (Ntembwa and Van Lerberghe 2015) and render the household perpetually poor. This understanding is very pertinent to the importance of constructing the NDI. Deficiency in multiple nutrients may render individuals vulnerable to a plethora of communicable and noncommunicable diseases. Such vulnerability is bound to have major implications for nutrition and health policymaking and the design and implementation of multisectoral nutrition-sensitive interventions (Shekar et al. 2015).

Poverty is reflected not only in monetary measures but also in reducing capabilities and freedom (Conconi and Viollaz 2017). Understanding such issues of human development requires an exploration of the capability approach, which provides a framework for measuring well-being. The AF methodology, based on this framework, helps researchers construct multidimensional poverty measures. At the global level, the Multidimensional Poverty Index (MPI) is constructed to compare regional, national, and subnational performance on poverty and other aspects of development. Drawing from this literature, this paper shows the construction of a multidimensional NDI for the DRC. The objective is to understand the multidimensionality of nutrition deficiency, whereby poor nutritional status can be attributed to the deficiency in intake of one nutrient and the interaction of many deficiencies. Unfortunately, due to certain data limitations, we cannot examine the intake of fat, which is very important for absorbing specific vitamins.

The second approach of literature is on the agriculture-nutrition pathways (Kadiyala et al. 2014). Agriculture can improve nutritional outcomes through the following channels: agriculture as a source of food; agricultural income for food and nonfood expenditures; agricultural policy and food prices; women in agriculture and intrahousehold decision making and resource allocation; maternal employment in agriculture and child care; and finally, women in agriculture and maternal health and nutritional status. Doocy and colleagues (2018) studied several strategies and their effectiveness in improving South Kivu's nutritional outcomes. The study's key objective was to understand the different pathways through which the situation of food security can be improved. Some of the key interventions were women's empowerment groups, the Preventing Malnutrition in Children Under 2 Approach (known as PM2A), farmer field schools, and farmer-to-farmer extension (F2F). Despite a rigorous implementation of the different interventions, food insecurity prevailed. Among the interventions F2F had the least impact. Nutrition Smart Agriculture (NSmartAg) also strengthens the agriculture-nutrition linkages. It has two objectives: increase productivity and income of farm/and or agribusiness and overall nutritional intake. Even though Nutrition Smart Agriculture practices are available in the DRC, farmers' and agribusiness's adoption is in the initial stages (World Bank 2020). It can help unlock DRC's huge potential of being a major agricultural producer in the national and regional food markets. The main food groups produced which can improve protein, iron, zinc, and vitamin A intake fall short of the EAT-Lancet recommendations. The shortfall in fish, vegetables, fruits, legumes, grains, nuts, and dairy is 73, 71, 58, 85, 64, 45, and 7 percent, respectively (World Bank 2020). Production of starch is 1545 percentage more than the recommendation. As far as consumption is concerned, the shortfall is by 88, 21, 63, 68, 34, 84, 68, and 66 percent respectively for poultry, fish, vegetables, fruits, legumes, grains, nuts, oil, and insects (World Bank 2020). Dairy consumption is as per the recommendation; production and consumption almost meet the requirement. Given the surplus production of starchy staples, the consumption is also 393 percent more than the recommendation. Diet diversity and the number of meals consumed are also low, and more so for children in urban areas (IPC 2016). Sixty-five percent of adults consume only two meals per day (World Bank 2020).These results call for an examination of how the different pathways interact, operate, and bring forth the best results.

Some of the SDGs that are crucial in improving nutritional outcomes are related to education, conflict, and agricultural systems. One of the subgoals of SDG 2 (Zero Hunger) is to double the agricultural productivity and income of smallholder farmers. An SDG 4 subgoal focuses

on equal access for girls and boys to quality early childhood development and adequate literacy and numeracy skills. SDG 16 is all about peace, justice, and strong institutions; one of its subgoals is to reduce all forms of violence and related death rates everywhere. Needless to mention, the DRC is far behind the rest of the world in attaining these SDG subgoals. Recurrent conflicts, children out of school, and poor agricultural systems aggravate nutritional poverty and food insecurity situation in this region. Multistakeholder partnerships are expected to play a major role in solving such complex and diversified issues by achieving sustainable food security solutions in the DRC (HLPE 2018). Thus, multidimensional concepts become more important in measurement-related matters.

2. DATA

The study uses two independent rounds of data from DRC national Household Consumption Expenditure Surveys (HCES) collected in 2004–2005 and 2012–2013 in rural and urban areas of the country. For data collection, both surveys followed the same methodology, called a "1-2-3 survey" (in French, *enquête 1-2-3*). The numbers represent the main objectives of the survey: (1) employment, (2) the informal sector, and (3) consumption. This study is based on data from the third phase (Institut National de la Statistique 2014; Marivoet, De Herdt, and Ulimwengu 2018). The sample size covers 12,087 households for the 2005 round and 21,403 households for 2012. The 1-2-3 surveys employed stratified, cluster, random, and systematic sampling techniques to seek representation by sector (statutory cities, provincial towns, and villages) at the provincial level (Institut National de la Statistique 2014; Marivoet and De Herdt 2017; Marivoet, De Herdt, and Ulimwengu 2018). The sampling design was based on the country's previous 11 provinces. However, in 2015, the country was divided into 26 provinces. Using the locations of the different households, International Food Policy Research Institute (IFPRI) researchers associated each household with its new province (Marivoet and De Herdt 2017). Unfortunately, no households were surveyed in the urban areas of Tshuapa, Mai-Ndombe, Sankuru, Tanganyika, Haut Lomami, and Bas-Uele in 2005. Moreover, the province of Kinshasa, the capital, does not formally have a rural area; hence, the results for that province relate to urban areas only. To correct the weights and cope with sampling problems, Marivoet and De Herdt (2017) added another step to the sampling technique after stratification to ensure equitable representation of the population in the sample. This post-stratification step ensured that subgroups would be proportionately represented to safeguard the significance of inferences made from the households' budget data.

3. METHODOLOGY

The AF methodology is used for measuring multidimensional poverty (Alkire and Foster 2011, Alkire et al. 2015). Based on the Foster-Greer-Thorbecke measures (Foster et al. 1984), AF involves counting the different types of deprivation that individuals undergo simultaneously, such as poor quality of education, unemployment, poor health, and low living standards. In this paper, we use this methodology to measure the incidence of multinutrient deprivation, its intensity, and a combination of both. In our case, the deprivation profiles (shortfalls in nutrient intake) are analyzed to identify who is nutritionally deprived and then used to construct an NDI. We use the information on intake of different nutrients per day per adult male equivalent for computation purposes. For each nutrient, there is an adult male equivalence scale. The Adult Male Equivalent (AME) was developed to have a household food intake expression that accounts for the household composition and enables household food or energy intake of various sizes and compositions to be specifically compared (Weisell and Dop 2012). To identify the poor in general, the AF method counts the overlapping or simultaneous deprivations that a person or household experiences concerning various poverty indicators. The indicators may be equally weighted or take different weights. Oldiges (2017) constructed a similar index using the information on food groups consumed by households in India. That study discussed the advantages of using the AF methodology for constructing an NDI. First, the NDI provides information on the incidence and intensity of nutrition deprivation compared with the popular Household Dietary Diversity Score, which measures the number of food groups usually consumed daily or weekly or fortnightly (Ruel 2003). Further, the NDI incorporates individual-specific nutrition requirements. Finally, it is possible to decompose the NDI using the AF methodology to identify the sources of nutrition deprivation across demographics and design possible interventions. One needs to take care of the fact that the AF method is used in the literature to measure deprivations on various dimensions and not only pertaining to multidimensional poverty or nutrition. Like employment, health insurance, financial inclusion, etc (OPHI working papers different years and others).

Households are identified as multidimensionally poor (that is, multinutrient-poor) if the weighted sum of their deprivations is greater than or equal to a cutoff, k, such as 20 percent, 30 percent, 40 percent, or 50 percent of all possible deprivations. AF is a flexible approach that can be tailored to a variety of situations by selecting different dimensions (such as education), indicators of poverty within each dimension (such as how many years of schooling

a person has), and poverty/deprivation cutoffs (whereby, for instance, a person with fewer than five years of education is considered deprived). The most common way of measuring poverty is to calculate the percentage of the poor population (or, in our case, the count of multinutrient-poor), known as the headcount ratio (H). Having identified who is poor, the AF method generates a unique class of poverty measures (M_α) that goes beyond the simple H for different values of α. We compute the adjusted headcount ratio (M_0), or MPI, which in our case is the NDI. This measure reflects both the incidence of nutrition poverty (in our case, the percentage of the population who are poor in nutritional intake) and the intensity of nutrition poverty (the percentage of deprivations suffered by each person or household on average, or the shortfall in the intake of the different nutrients). M_0 (NDI) is calculated by multiplying the nutrition poverty incidence (H) by the nutrition poverty intensity (A):

$$\text{NDI} = H \times A. \tag{1}$$

The AF method is unique in that by measuring intensity, it can distinguish between, for example, a group of poor households that suffer two nutrition deprivations on average (that is, have a shortfall in intake of two nutrients) and a group of poor households that suffer five nutrition deprivations (a shortfall in intake of five nutrients) on average at the same time. Although the AF method provides a single headline measure of nutrition poverty, it can also be broken down and analyzed in powerful ways to inform policy. Some of its other key features are:

a. Decomposition by population group: It can be broken down by geographic area, ethnicity, or other sub-groups of a population, to show the composition of nutrition poverty within and among these groups.
b. Breakdown by dimension or indicator: It can be broken down to show which types of nutrition deprivation are contributing to nutrition poverty within groups.
c. Changes over time: The AF Method can be used to monitor changes in nutrition poverty over time, using data collected at different periods. It reflects changes, dimensions, and indicators of nutrition poverty directly and quickly, making it an effective monitoring tool.
d. Complements other metrics: The AF Method can complement other measures, such as measures of income poverty.

Table 1 describes the different dimensions, the corresponding indicators (cutoffs for identifying a household as deprived or not deprived), and the weighting matrix. We closely follow the standard weighting structure for computing the global MPI (Alkire et al. 2015).

Macronutrients such as calories and protein receive a weight of 1/6 each, and micronutrients, vitamins, and minerals receive a weight of 1/18each. In total, we consider 14 different nutrients for the construction of the NDI.

Table 1: Dimension, Deprivation, and Weighting matrix

Dimension	Deprivation Cut-offs	Weight
Calorie	Deprived if intake is less than 2750 kcal	1/6
Protein	Deprived if intake is less than 50 g	1/6
Calcium	Deprived if intake is less than 1000 mg	1/18
Zinc	Deprived if intake is less than 14 mg	1/18
Folate	Deprived if intake is less than 400 mcg	1/18
Thiamine	Deprived if intake is less than 1.2 mg	1/18
Niacin	Deprived if intake is less than 16 mgNEs	1/18
Iron	Deprived if intake is less than 27.4 mg	1/18
Vitamin A	Deprived if intake is less than 600 mcg	1/18
Vitamin B12	Deprived if intake is less than 2.4 mcg	1/18
Vitamin D	Deprived if intake is less than 10 mcg	1/18
Vitamin B6	Deprived if intake is less than 1.3 mg	1/18
Vitamin C	Deprived if intake is less than 45 mg	1/18
Vitamin E	Deprived if intake is less than 15 mg	1/18

4. KEY FINDINGS

Some of our key findings are as follows:

a. Comparison of Performance on Raw and Censored Headcount Ratios

The AF methodology allows the dimensional breakdown of the NDI. This helps in computing the percentage of multidimensionally nutrition-poor households and simultaneously deprived in a given dimension (nutrient). This is known as the "censored headcount ratio" of a dimension (nutrient). It helps us analyze the composition of multidimensional nutrition poverty as the proportion of nutrition-poor households and deprived of each of the nutrients. The censored headcount ratio differs from the raw headcount ratio in that it considers only the nutrition deprivation of households that are, overall, multidimensionally nutrition-deprived (that is, whose weighted sum of deprivations is greater than or equal to the cutoff value of k = 40), omitting those that are not multidimensionally nutrition-deprived.

As per the raw headcount ratio the maximum number of rural households, almost more than 94 percent are deprived in the intake of nutrients like thiamine, Vitamin D, and Vitamin E in 2005. In 2012 more than 96 percent of the households are deprived in the same nutrients. Household performed well in the intake of nutrients like Vitamin C and Vitamin A. As far as

the censored headcount ratio is concerned only eight percent of the households are deprived in the intake of Vitamin A.

An in-depth analysis of the data reveals that the country is in a severe nutrition crisis (Table 2). Almost 40 percent of the population was still deprived of calorie intake in 2012, with an increase of 8 percentage points only. This finding exists, although cassava, rich in calories, is a staple in the diet of most Congolese. A similar result holds for protein intake. Thus, the population is severely undernourished. Vitamin and mineral intake portray a similar nutrition deprivation profile. Thus, a double burden of malnutrition is a major feature of this country. There is the simultaneous existence of both undernutrition and deprivation in the intake of micronutrients. Only pockets of the country, such as the city of Goma, house the obese, who are very few and not of major concern for the country at present. Though the vitamin A deprivation figures are low, the numbers for the population as a whole are quite high if we compare them with the proportion of, say, infants who were deficient in vitamin A intake in the 1990s (Samba et al. 2006).

A similar story holds for urban DRC as far as the intake of the different macronutrients, micronutrients, vitamins, and minerals is concerned (Table 2). However, contrary to expectations, the value of the NDI is higher for urban DRC than for rural DRC. Despite the higher purchasing power of the former, this can be attributed to the availability of better-quality food for the latter. Based on estimates of the Food Consumption Score (a count of the food groups consumed by the household in the past week), urban households perform better than rural households (Marivoet, Becquey, and Van Campenhout 2019). However, urban households spend days without any food reserves or maybe one meal per day (D'Haese, Banea-Mayambu, and Remaut-De Winter 2013). This can explain our finding that the proportion of nutrition-deprived households is higher in urban than in rural areas.

Table 2(a): Raw and Censored Headcount ratios, Rural DRC

Dimension	Indicator	Raw Headcount		Censored Headcount	
		2005	**2012**	**2005**	**2012**
Calorie	Deprived if intake is less than 2750 kcal	40.63	48.27	40.55	48.16
Protein	Deprived if intake is less than 50 g	39.6	42.9	39.6	42.89
Calcium	Deprived if intake is less than 1000 mg	50.59	58.15	43.48	51.45
Zinc	Deprived if intake is less than 14 mg	72.17	78.46	52.74	58.73
Folate	Deprived if intake is less than 400 mcg	31.63	41.71	30.75	40.69
Thiamine	Deprived if intake is less than 1.2 mg	94.14	96.87	53.07	59.01
Niacin	Deprived if intake is less than 16 mgNEs	49.7	55.79	47.45	53.7
Iron	Deprived if intake is less than 27.4 mg	71.91	78.85	52.39	58.52
Vitamin A	Deprived if intake is less than 600 mcg	9.15	8.73	8.5	8.3
Vitamin B12	Deprived if intake is less than 2.4 mcg	84.39	81.88	51.52	55.98

Vitamin D	Deprived if intake is less than 10 mcg	94.36	96.46	53.02	58.95
Vitamin B6	Deprived if intake is less than 1.3 mg	24.54	31.34	24.54	31.33
Vitamin C	Deprived if intake is less than 45 mg	17.84	20.07	16.86	19.66
Vitamin E	Deprived if intake is less than 15 mg	94.14	96.87	53.07	59.01

Table 2(b): Raw and Censored Headcount ratios, Urban DRC

Dimension	Indicator	Raw Headcount		Censored Headcount	
		2005	2012	2005	2012
Calorie	Deprived if intake is less than 2750 kcal	57.22	59.1	57.18	58.92
Protein	Deprived if intake is less than 50 g	41.37	37.22	41.37	37.22
Calcium	Deprived if intake is less than 1000 mg	75.71	79.67	65.24	68.74
Zinc	Deprived if intake is less than 14 mg	81.62	83.01	67.63	70.35
Folate	Deprived if intake is less than 400 mcg	53.05	59.62	51.17	57.03
Thiamine	Deprived if intake is less than 1.2 mg	96.65	96.88	68.35	71.11
Niacin	Deprived if intake is less than 16 mgNEs	63.42	63.24	61.95	62.17
Iron	Deprived if intake is less than 27.4 mg	85.24	87.76	68.06	70.8
Vitamin A	Deprived if intake is less than 600 mcg	5.85	11.76	5.66	11.08
Vitamin B12	Deprived if intake is less than 2.4 mcg	82.88	77.92	65.51	64.47
Vitamin D	Deprived if intake is less than 10 mcg	95.85	94.72	68.23	70.72
Vitamin B6	Deprived if intake is less than 1.3 mg	37.2	37.04	37.2	37.03
Vitamin C	Deprived if intake is less than 45 mg	39.53	39.43	38.14	38.29
Vitamin E	Deprived if intake is less than 15 mg	96.65	96.88	68.35	71.11

b. Discussion on Aggregated Measures

A comparison of the key aggregated measures across regions and values of '*k'* is important. The headcount ratio (H) or the incidence of those who experience nutrition poverty: With a rise in the cut-off the proportion of the nutritionally deprived decreases in both 2005 and 2012. The fall is the greatest when the cut-off rises from 30 to 40. However, the absolute value of the deprived as measured by H is more in 2012 as compared to 2005 which is dismal. An inverse picture exists for the intensity of deprivation (A). Overall, even the NDI values are higher for 2012 than 2005 even though for any particular year the values decline with a rise in the value of *k*. This implies that the nutritional status of the people of the DRC has severely declined over time.

Table 3(a): Aggregated Measures (Rural)

Cut-off (k)	Headcount Ratio (H)		Intensity of Deprivation (A)		Nutrition Deficiency Index (NDI)	
	2005	2012	2005	2012	2005	2012
30	68.52	74.03	66.93	69.31	0.46	0.51
40	53.09	59.03	76.17	77.98	0.4	0.46
50	50.1	55.79	78.06	79.92	0.39	0.45
60	41.15	47.68	83.38	84.47	0.34	0.4
70	33.39	39.33	88.08	88.87	0.29	0.35
80	26.12	32.51	91.69	91.79	0.24	0.3

A similar kind of finding is observed for urban DRC for the headcount ratio, the intensity of nutrition deprivation, and the overall value of NDI. However, as discussed in the comparative analysis of rural and urban DRC for the raw and censored headcount ratio, urban DRC continues to perform worse than rural DRC.

Table 3(b): Aggregated Measures (Urban)

Cut-off (k)	Headcount Ratio (H)		Intensity of Deprivation (A)		Nutrition Deficiency Index (NDI)	
	2005	**2012**	**2005**	**2012**	**2005**	**2012**
30	81.26	83.3	71.39	70.71	0.58	0.59
40	68.38	71.12	78.08	76.65	0.53	0.55
50	63.16	65.73	80.87	79.3	0.51	0.52
60	55.98	56.97	84.47	83.41	0.47	0.48
70	46.22	46.08	88.88	87.95	0.41	0.41
80	36.9	34.04	92.45	92.7	0.34	0.32

For k=40, Rural 2005

In 2005 the highest proportion of households were nutritionally deprived in the regions of Tshuapa, South Kivu, and Sankuru. It is the lowest in the regions of Mongola and Equateur. The intensity of deprivation is the highest in the regions of Kwilu, South Kivu, Sankuru, and Kasai. It is the lowest in the regions of Mongala, Haut-Katanga, and Kasai-Oriental. Overall, the value of the NDI is the highest in the regions of South Kivu, Sankuru, and Kwango. The better-performing regions are those of Mongala and Equateur.

Table 4(a): Rural 2005: by Region when *k*=40

Region	Headcount Ratio (H)	Intensity of Nutrition Deprivation (A)	Nutrition Deficiency Index (NDI)
Kongo Central	0.58	0.73	0.42
Mai-Ndombe	0.51	0.7	0.36
Kwilu	0.65	0.81	0.53
Kwango	0.8	0.77	0.62
Equateur	0.26	0.71	0.19
South Ubangi	0.39	0.71	0.28
North Ubangi	0.44	0.71	0.31
Mongala	0.23	0.64	0.15
Tshuapa	0.72	0.79	0.57
Tshopo	0.35	0.7	0.25
Bas-Uele	0.31	0.72	0.22
Haut-Uele	0.45	0.74	0.34
Ituri	0.54	0.74	0.4
North Kivu	0.44	0.78	0.34
South Kivu	0.87	0.83	0.73
Maniema	0.45	0.74	0.33
Lualaba	0.45	0.74	0.33
Haut-Lomami	0.53	0.76	0.4
Tanganyika	0.45	0.7	0.32
Haut-Katanga	0.32	0.68	0.22
Kasai-Oriental	0.52	0.65	0.34
Sankuru	0.87	0.84	0.72
Lomami	0.5	0.79	0.4

Kasai	0.54	0.8	0.44
Kasai-Central	0.62	0.79	0.49

For k=40, Urban 2005

For urban DRC the nutrition deprivation profile as represented by the headcount ratio H provides a much gloomier picture than that of rural DRC in 2005. More than half the population is overall impoverished in the intake of all the 14 nutrients considered. Almost 91 percent of the population is deprived in the urban capital region of Kinshasa. Mongala and North Ubangi are the better-performing regions. Both rural and urban South Kivu is one of the poor performing regions. The intensity of nutrition deprivation (A) is the highest in Kinshasa implying that despite being the richest of all regions the nutrition security is contrary to expectations. Despite quite a well-spread distribution for the headcount ratio across different regions for the intensity, we find quite a less spread out distribution with the range being around only 17 percentage points. The NDI value is the highest for the capital of Kinshasa. It is the lowest for the regions of North Ubangi, Mongola, and Maniema. The extreme western and eastern parts of urban DRC are the most nutrition poor. The conflict-prone zone of Kasai is the other severely deprived region. It is quite surprising to observe the neighboring regions of Maniema and South Kivu with starkly different levels of performance. This can be explained by the presence of numerous army groups in South Kivu who destabilize the economy and reduce livelihood opportunities of the population. However, the two regions have an almost equal share of expenditure of around 80 percent on food (Mirindi et al., 2019). Marivoet et al. (2019) find that Kinshasa has the highest Food Consumption Score but one of the lowest calorie intakes. Maniema exhibits one of the lowest Food Consumption Scores but the highest calorie intake. The north-western part of the country comprising of the regions of South Ubangi, Mongola, and North Ubangi are some of the best performing regions with the lowest value of NDI. The better performance of these regions can be attributed to the low headcount ratio in these regions even though the level of intensity remains comparable to most of the other regions. However, a similar kind of a claim cannot be made for the intake of the fourteen different nutrients that we analyse.

Table 4(b): Urban 2005: by Region when *k*=40

Region	Headcount Ratio (H)	Intensity of Nutrition Deprivation (A)	Nutrition Deficiency Index (NDI)
Kinshasa	0.91	0.86	0.78
Kongo Central	0.77	0.8	0.61
Mai-Ndombe			
Kwilu	0.69	0.79	0.54
Kwango	0.71	0.76	0.54

Equateur	0.6	0.81	0.49
South Ubangi	0.53	0.74	0.39
North Ubangi	0.36	0.74	0.26
Mongala	0.34	0.79	0.27
Tshuapa			
Tshopo	0.78	0.77	0.59
Bas-Uele			
Haut-Uele	0.62	0.68	0.42
Ituri	0.77	0.8	0.62
North Kivu	0.58	0.69	0.4
South Kivu	0.82	0.81	0.66
Maniema	0.39	0.73	0.28
Lualaba	0.76	0.74	0.56
Haut-Lomami			
Tanganyika			
Haut-Katanga	0.62	0.72	0.45
Kasai-Oriental	0.74	0.73	0.54
Sankuru			
Lomami	0.57	0.76	0.43
Kasai	0.76	0.77	0.59
Kasai-Central	0.57	0.72	0.41

For k=40, Rural 2012

In 2012 the rural provinces of DRC with the highest levels of nutrition poverty are those of South Kivu, Tanganyika, and Sankuru. It is the lowest in the provinces of North Kivu, Tshuapa, and Mongala. The intensity of nutrition deprivation is the highest in the provinces of Tanganyika, Kwango, and South Ubangi. It is the lowest in the regions of Haut-Uele and North Kivu. Overall, the NDI value is the highest in the provinces of Tanganyika, Sankuru, South Kivu, and Kasai Central. It is the lowest in the regions of North Kivu, Tshuapa, and Mongala.

Table 5(a): Rural 2012: by Region when *k*=40

Region	Headcount Ratio (H)	Intensity of Deprivation (A)	Nutrition Deficiency Index (NDI)
Kinshasa			
Kongo Central	0.67	0.77	0.52
Mai-Ndombe	0.66	0.8	0.53
Kwilu	0.4	0.76	0.31
Kwango	0.67	0.83	0.56
Equateur	0.56	0.77	0.43
South Ubangi	0.67	0.82	0.55
North Ubangi	0.48	0.72	0.35
Mongala	0.37	0.74	0.27
Tshuapa	0.34	0.75	0.25
Tshopo	0.49	0.71	0.35
Bas-Uele	0.47	0.77	0.36
Haut-Uele	0.48	0.64	0.31
Ituri	0.63	0.76	0.48
North Kivu	0.32	0.65	0.21

South Kivu	0.86	0.81	0.69
Maniema	0.49	0.76	0.37
Lualaba	0.71	0.8	0.56
Haut-Lomami	0.64	0.78	0.5
Tanganyika	0.84	0.92	0.78
Haut-Katanga	0.57	0.75	0.43
Kasai-Oriental	0.71	0.74	0.53
Sankuru	0.83	0.84	0.7
Lomami	0.72	0.83	0.6
Kasai	0.53	0.75	0.39
Kasai-Central	0.78	0.8	0.63

For k=40, Urban 2012

For urban DRC the nutrition deprivation levels are the highest in South Kivu, Kasai-Oriental and Haut-Lomami, and lowest in Mongola, Tshuapa, and Tshopo. The intensity of nutrition deprivation is again the highest in South Kivu, Tanganyika, and Haut-Lomami. It is the lowest in Tshuapa and Tshopo but the level of intensity is quite high across most regions and is more than 65 percent. The composite value of NDI is the highest in the regions of South-Kivu and Haut-Lomami. It is the lowest in the regions of Mongala and Tshuapa. As compared to 2005, aggregate nutrition deprivation in the capital city of Kinshasa witnessed a fall of almost 21 percentage points. Other regions that witnessed a rise in the values of H, A, and NDI are those of Sankuru, Kasai, and Kasai-Central.

Table 5(b): Urban 2012: by Region when *k*=40

Region	Headcount Ratio (H)	Intensity of Nutrition Deprivation (A)	Nutrition Deficiency Index (NDI)
Kinshasa	0.75	0.76	0.57
Kongo Central	0.77	0.8	0.62
Mai-Ndombe	0.82	0.83	0.68
Kwilu	0.74	0.8	0.59
Kwango	0.61	0.8	0.48
Equateur	0.61	0.78	0.47
South Ubangi	0.67	0.75	0.5
North Ubangi	0.65	0.79	0.51
Mongala	0.35	0.7	0.24
Tshuapa	0.41	0.65	0.27
Tshopo	0.48	0.68	0.33
Bas-Uele	0.75	0.8	0.6
Haut-Uele	0.71	0.77	0.55
Ituri	0.7	0.72	0.5
North Kivu	0.67	0.74	0.49
South Kivu	0.92	0.85	0.78
Maniema	0.52	0.74	0.38
Lualaba	0.8	0.79	0.63
Haut-Lomami	0.84	0.84	0.71
Tanganyika	0.58	0.85	0.49
Haut-Katanga	0.77	0.73	0.56

Kasai-Oriental	0.89	0.77	0.69
Sankuru	0.58	0.79	0.46
Lomami	0.75	0.76	0.57
Kasai	0.59	0.7	0.41
Kasai-Central	0.78	0.79	0.62

On the Distribution of H, A, and NDI

A comparison of the boxplots for 2005 and 2012 for the rural uncensored headcount ratio reveals a rise in the nutrient poverty intake of the population.[1] The distribution changes from uniformly distributed to negatively skewed. The median value of the level of intensity rises over time. The distribution was positively skewed in 2005, and in 2012 the interquartile range almost halves with the presence of a few outliers. The boxplot for the aggregate NDI shows a similar change in profile from 2005 to 2012 as that of the headcount ratio. For urban DRC the median headcount ratio is higher than the rural value. Over time the median value of the urban headcount ratio slightly rises with the interquartile range and skewness remaining the same. The distribution for urban intensity is much spread out as compared to that of rural DRC as reflected by the interquartile range. The median value of urban NDI stays put at 0.5 over time quite close to the rural DRC value in 2012. This implies that food security policies have been ineffective in improving nutritional outcomes in both rural and urban DRC.

c. Performance across Regions (Incidence of Nutrition Deprivation)

Rural Regions

An analysis by region across the intake of different nutrients reveals many interesting findings.[2]For rural DRC in 2005, calorie deprivation is the highest in South Kivu, at almost 88 percent. It is the lowest in Mongala and Haut-Katanga. Protein deficiency is the highest in the eastern regions of the DRC. In Tshuapa, Kwilu, and South Kivu, more than 60 percent of households are protein-deprived. The lowest protein deprivation is in Bas-Uele, Mongala, and Haut-Katanga, with less than 20 percent. Thus, the performance of the consumption of macronutrients in DRC is very poor.

[1] Detailed box-plots are available on request.

[2]We use the word *deprivation* when explaining the findings for both uncensored and censored headcount ratios. Strictly speaking, however, there is a difference. For the case of uncensored headcount ratios, deprivation implies nutrition poverty in that particular dimension or region. For the case of censored headcount ratios, it implies that the household or region is not only deprived but overall nutrition poor.

As for micronutrients, calcium deficiency is the highest among South Kivu, Kasai-Central, and Kasai-Oriental households. It is the lowest in Equateur and Mai-Ndombe. The distribution range is highest for calcium, with a difference of almost 75 percentage points in the proportion of deprived households between the worst- and best-performing regions. Zinc deprivation is the highest in South Kivu, Sankuru, and Kwango. It is the lowest in the regions of Haut-Katanga and Equateur. Overall, the level of zinc deprivation is very high, with more than 50 percent of the households lacking the recommended intake in almost all regions. Folate deprivation is the lowest in Equateur, Bas-Uele, and Haut-Uele. It is the highest in the region of Sankuru. Thiamine deprivation is almost the same across most regions, at around 80 percent, which is quite alarming. Niacin deprivation is the lowest in Bas-Uele, Mongala, and Haut-Katanga. It is the highest in the regions of South Kivu and Tshuapa. Iron deprivation is the highest in Sankuru, South Kivu, and Kwango. It is the lowest in the region of Equateur. Even for iron deprivation, the range is quite high, at almost 60 percentage points.

As discussed earlier, of all the nutrients considered in constructing the NDI, the impoverishment for vitamin A is minimal across most of the regions, except for Kwango, Mai-Ndombe, and South Kivu. The shortfall in vitamin B_{12} and vitamin D intake follows a pattern like that of deprivation for thiamine. For most of the regions, the deprivation is almost 70 percent, except for Haut-Katanga and Mongala. For vitamin D, the deprivation is more than 90 percent in most regions, except for Bas-Uele.[3] The deprivation profile for vitamin B_6 has a wide range of almost 60 percentage points. The regions with lower levels of vitamin B_6impoverishment are Haut-Uele, North Ubangi, Kwilu, and Kasai. It is the highest in Tanganyika and Sankuru. The range of the distribution for vitamin C deprivation is the highest of all the vitamins considered, at almost 60 percentage points. For vitamin E intake, almost all regions are seriously impoverished, with more than 75 percent of the population lacking the required intake. Thus, for rural DRC over the period studied, the northwestern regions of Equateur and Mongala perform the best, along with the southernmost region, Haut-Katanga. One probable reason why Equateur is one of the best-performing regions is that the fewest conflicts are reported in this region (UNICEF Learning for Peace 2015).

Urban Regions

[3] It is 100 percent for Haut-Uele, South Kivu, and Kasai Oriental. One plausible explanation for these findings is that consumption of sources rich in vitamin D is very low in the DRC (Marivoet, De Herdt, and Ulimwengu 2018).

For 2005, calorie deprivation is the highest in Kinshasa, Ituri, Kongo Central, and Kwilu. It is the lowest in Haut-Uele and Maniema. Protein deficiency is the highest in Kinshasa and Kongo Central and lowest in North Ubangi and North Kivu provinces. The shortfall of required calcium intake is the highest in Kinshasa, Lualaba, Kasai, Haut-Katanga, Kasai Oriental, and South Kivu. It is the lowest in the provinces of Kwango, North Ubangi, and Mongala. Zinc impoverishment is the highest in Kinshasa, Haut-Uele, Equateur, Kwango, Kwilu, and Kongo Central. It is the lowest in the regions of Haut-Katanga and Lomami. Folate deprivation is the highest in Kinshasa and the lowest in North Kivu, Haut-Uele, and Mongala. Thiamine deprivation in urban DRC follows a profile similar to that of the rural sector, with more than 90 percent of the households deprived across most regions. North Ubangi has the lowest deprivation, but still with 85 percent undernourished. Intake of niacin has the highest shortfall from the recommended level in Kinshasa, Ituri, Tshopo, and Kongo Central. Iron deficiency is the highest in Kinshasa, Kasai, South Kivu, and Kongo Central. Vitamin deprivation follows a similar profile in rural and urban DRC. The better-performing regions are those of North Ubangi, South Ubangi, and Maniema. As in rural DRC, most of the regions are not deficient in the intake of vitamin A; exceptions are South Kivu, Lualaba, and Haut-Katanga, with between 20 percent and 30 percent of households deprived. Kasai-Central, Haut Uele, Lomami, South Kivu, and Kasai are the poor-performing regions for vitamin B_{12} intake. The better-off region is North Ubangi, which, with less than 50 percent of households deprived, still houses quite a high proportion of the undernourished. More than 90 percent of the households in all regions are deprived of the intake of vitamin D. Performing poorly on the intake of vitamin B_6 is Kinshasa, and the better-performing areas are Kasai-Central, Maniema, North Ubangi, and North Kivu. The regions of Kinshasa, Kasai-Oriental, South Kivu, and Kasai are deficient in vitamin C intake. The better-performing regions are Haut-Uele, Tshopo, and Lualaba. Both thiamine and vitamin E intake have similar deprivation profiles to that of vitamin C. Overall, almost all nutrition deprivation profiles remain alarming from 2005 to 2012, with a reasonable performance by Mongala.

Even though rural DRC has a lower NDI value than urban DRC, the share of expenditure on food is very high in the former (Mirindi et al. 2019). Also, there is quite a significant rise in expenditure from 2005 to 2012, implying that households have very little left to spend on other goods and services after food. Therefore, compared with global standards, the quality of life in both the rural and urban regions of DRC is very poor. The rural households are

multidimensionally poor, with little to no spending on dimensions such as health and education (Alkire et al. 2011). The urban households have access to various goods and services, but these are of poor quality, as reflected by the poor nutritional status. One plausible reason why urban DRC performs poorly compared with rural DRC is a lack of urban access to agricultural produce due to underdeveloped marketing channels.

d. Performance across Regions (Average Deprivation Score among the Deprived)

Rural Censored 2012

The situation does not improve in rural DRC in 2012 (Table 6(a), 6(b)) as compared with 2005. The distribution profile for most nutrients shifts upward, with the median now more than 50 percent. Positive skewness remains a dominant feature, except for calorie and folate intake.

Table 6(a): Performance across regions - Rural Censored 2005

Region	Calorie	Protein	Calcium	Zinc	Folate	Thiamine	Niacin	Vitamin A	Vitamin B12	Vitamin D	Vitamin B6	Vitamin C	Vitamin E
Kinshasa													
Kongo Central	37.82	50.88	43.86	58.28	23.98	58.28	54.39	3.31	57.7	58.28	19.1	3.12	58.28
Mai-Ndombe													
Kwilu	48.55	60.76	57.56	65.41	52.03	65.41	58.14	4.07	65.41	65.41	43.9	13.66	65.41
Kwango	49.11	75.74	50.89	79.88	43.2	79.88	55.03	40.83	79.88	79.88	40.24	26.63	79.88
Equateur	22.35	19.41	11.76	26.47	10.59	26.47	26.47	0	26.47	26.47	8.82	1.18	26.47
South Ubangi	31.18	24.12	32.94	39.41	22.94	39.41	28.24	0.59	39.41	39.41	14.71	1.76	39.41
North Ubangi	42.77	21.97	30.06	43.93	23.12	43.93	31.79	0	42.77	43.93	19.65	11.56	43.93
Mongala	14.62	15.2	14.04	23.39	5.26	23.39	20.47	0	22.22	23.39	1.17	0	23.39
Tshuapa													
Tshopo	19.88	27.71	26.51	34.94	20.48	34.94	30.12	0.6	34.34	34.94	10.84	1.2	34.94
Bas-Uele													
Haut-Uele	36.09	39.85	32.33	45.11	13.53	45.11	44.36	0	45.11	45.11	15.79	0.75	45.11
Ituri	43.89	36.05	47.65	53.61	24.14	53.61	49.84	6.27	48.59	53.29	22.26	13.17	53.61
North Kivu	38.74	28.66	41.7	42.69	19.76	44.27	40.32	10.47	43.48	44.27	19.37	21.94	44.27
South Kivu	87.42	61.84	81.55	87	43.82	87.42	86.79	28.51	84.7	87	54.09	42.98	87.42
Maniema	28.51	31.4	41.12	44.63	34.71	44.63	42.15	0.21	40.91	44.42	24.79	10.95	44.63
Lualaba	31.43	30.86	31.71	43.43	28.86	45.14	36	16.57	44.57	45.14	14.86	18.86	45.14
Haut-Lomami													
Tanganyika													
Haut-Katanga	18.82	20.59	25.29	30.59	8.82	31.76	25.88	4.71	30	31.76	5.88	11.76	31.76
Kasai-Oriental	30.41	9.36	51.46	50.29	49.12	52.05	44.44	0	52.05	52.05	2.92	27.49	52.05
Sankuru													
Lomami	45.71	33.14	47.43	50.29	33.71	50.29	45.71	3.43	49.71	50.29	28	16	50.29
Kasai	42.03	43.19	50.14	54.49	43.77	54.49	46.38	9.86	46.96	54.49	30.43	30.72	54.49
Kasai-Central	45.29	46.47	60.59	61.76	50.59	61.18	54.12	10	61.18	61.76	31.18	30.59	61.18

Table 7(a): Performance across regions - Rural Censored 2012

Region	Calorie	Protein	Calcium	Zinc	Folate	Thiamine	Niacin	Iron	Vitamin A	Vitamin B12	Vitamin D	Vitamin B6	Vitamin C	Vitamin E
Kinshasa														
Kongo Central	57.73	46.19	63.62	66.88	37.69	66.88	61	66.45	7.41	64.92	66.88	35.95	14.16	66.88
Mai-Ndombe														
Kwilu	29.71	30.92	32.37	40.1	28.74	40.1	36.47	39.37	4.11	39.37	39.86	17.63	11.84	40.1
Kwango	62.58	56.02	56.67	66.52	50.11	66.74	62.36	65.86	12.25	61.71	66.74	43.98	24.29	66.74
Equateur	48.61	44.33	39.83	56.1	35.76	56.1	50.32	55.67	8.99	50.54	56.1	26.55	10.49	56.1
South Ubangi	59.57	48.91	63.26	66.52	59.35	66.52	61.3	65.87	4.35	65.22	66.52	47.17	25	66.52
North Ubangi	45.44	31.85	35.24	48.41	21.87	48.41	38.85	46.5	0.21	44.37	48.41	17.2	0.42	48.41
Mongala	22.86	31.65	31.43	36.7	22.64	36.7	33.85	36.7	0	32.97	36.7	15.16	4.62	36.7
Tshuapa														
Tshopo	36.05	36.28	41.04	49.43	26.76	49.43	40.36	48.98	2.04	41.27	49.43	15.87	1.36	49.43
Bas-Uele														

Table 7(a) Continued

Region	Calorie	Protein	Calcium	Zinc	Folate	Thiamine	Niacin	Iron	Vitamin A	Vitamin B12	Vitamin D	Vitamin B6	Vitamin C	Vitamin E
Haut-Uele	17.23	31.29	43.99	48.07	16.78	48.07	46.71	47.85	0.23	48.07	48.07	16.1	0.45	48.07
Ituri	53.1	38.57	61.43	61.67	27.62	62.62	58.1	62.62	9.76	60.71	62.62	31.67	19.52	62.62
North Kivu	27.13	8.75	29.98	31.07	7	31.95	29.76	31.51	2.63	31.29	31.95	4.81	2.19	31.95
South Kivu	75.84	59.09	84.45	85.41	48.56	85.89	82.54	85.89	4.55	84.69	85.89	57.66	49.04	85.89
Maniema	38.42	36.39	39.69	48.6	34.1	48.6	46.82	48.6	4.83	44.27	48.35	22.9	6.87	48.6
Lualaba	57.93	52.41	56.78	69.89	52.87	70.8	61.15	69.89	22.3	68.51	70.8	39.08	31.72	70.8
Haut-Lomami														
Tanganyika														
Haut-Katanga	50.87	26.74	49.13	55	44.13	56.52	45.87	56.3	18.48	49.35	55.87	21.96	25.65	56.52
Kasai-Oriental	50.34	40.82	69.84	70.52	65.99	71.2	62.36	70.98	2.27	71.2	71.2	27.89	23.58	71.2
Sankuru														
Lomami	62.47	54	65.9	71.17	60.41	71.85	65.9	71.4	17.62	71.17	71.85	43.71	41.19	71.85
Kasai	40.21	34.47	43.62	52.55	40.43	52.55	44.89	52.34	6.38	49.79	52.55	18.3	15.74	52.55
Kasai-Central	67.04	63.25	70.38	78.4	61.25	78.4	72.83	77.06	5.57	77.28	78.4	43.21	23.16	78.4

Urban Censored 2012

There is an improvement from 2005 to 2012 in urban DRC, as shown in the censored headcounts (Table 7(a), 7(b)). Even though the median value of the distribution remains the same, there is an overall increase in the negative skewness of the distribution. This implies that many households moved out of nutritional deprivation. However, the number was not large enough to tend to asymmetric distribution. The vitamin B_6 deprivation profile provides a healthier picture than those of the other nutrients.

Table 7 (a): Performance across regions - Urban Censored 2005

Region	Calorie	Protein	Calcium	Zinc	Folate	Thiamine	Niacin	Iron	Vitamin A	Vitamin B12	Vitamin D	Vitamin B6	Vitamin C	Vitamin E
Kinshasa	79.35	67.03	91.14	91.03	90.05	91.24	84.54	91.24	4.86	86.49	91.14	74.49	86.05	91.24
Kongo Central	67.93	52.56	75.28	76.84	49.22	77.06	73.05	76.84	5.57	73.94	75.72	45.66	35.63	77.06
Mai-Ndombe														
Kwilu	66.07	51.79	59.38	68.75	48.21	68.75	65.18	67.86	0.45	65.18	68.3	29.46	12.05	68.75
Kwango	61.74	59.57	38.7	71.3	34.35	71.3	58.26	70.43	1.3	69.57	71.3	33.04	16.09	71.3
Equateur	49.14	44.83	57.76	60.34	52.59	60.34	57.76	60.34	1.72	55.17	60.34	43.97	27.59	60.34
South Ubangi	49.54	30.73	46.79	52.75	35.32	52.75	42.66	50	0	50.46	52.75	24.77	4.59	52.75
North Ubangi	30.69	17.82	32.67	35.64	32.67	35.64	23.76	35.64	1.98	24.75	35.64	16.83	17.82	35.64
Mongala	30.36	24.11	31.25	33.93	25.89	33.93	33.04	33.93	0	30.36	33.93	20.54	5.36	33.93
Tshuapa														
Tshopo	59.81	52.34	73.83	77.57	63.55	77.57	74.77	77.57	1.87	76.64	77.57	49.53	5.61	77.57
Bas-Uele														
Haut-Uele	27.62	45.71	61.9	61.9	22.86	61.9	60.95	61.9	0	61.9	61.9	23.81	1.9	61.9
Ituri	68.95	49.32	76.71	77.17	38.36	77.17	77.17	77.17	3.65	74.89	77.17	51.6	52.51	77.17
North Kivu	49.91	21.5	53.08	56.26	18.13	57.2	53.46	57.2	4.3	55.33	57.57	17.57	13.64	57.2
South Kivu	72.58	46.13	80.97	79.35	50	81.61	73.55	81.61	28.71	80.97	81.61	49.68	63.23	81.61
Maniema	29.39	23.03	37.27	38.79	31.52	39.09	36.06	38.79	0.3	32.12	39.09	15.15	5.76	39.09

Lualaba	58.77	30.7	76.32	74.56	66.67	76.32	59.65	76.32	19.3	76.32	76.32	25.44	44.74	76.32

Table 7 (a) Continued

Region	Calorie	Protein	Calcium	Zinc	Folate	Thiamine	Niacin	Iron	Vitamin A	Vitamin B12	Vitamin D	Vitamin B6	Vitamin C	Vitamin E
Haut-Lomami														
Tanganyika														
Haut-Katanga	44.61	20.99	61.81	57.73	55.39	61.81	48.1	60.93	19.53	59.77	61.81	20.99	38.78	61.81
Kasai-Oriental	52.71	23.26	73.64	70.54	73.64	73.64	62.79	73.64	3.88	72.87	73.64	21.71	65.89	73.64
Sankuru														
Lomami	44.98	31	55.62	56.53	41.95	56.53	54.41	56.53	0.91	56.53	56.53	24.92	23.4	56.53
Kasai	58.53	40.09	76.5	76.04	70.97	76.5	65.9	76.5	0.46	73.73	76.5	32.26	59.91	76.5
Kasai-Central	42.03	27.05	57	56.52	46.38	57	49.76	57	0.97	57	57	13.53	27.05	57

Table 7(b): Performance across regions - Urban Censored 2012

Region	Calorie	Protein	Calcium	Zinc	Folate	Thiamine	Niacin	Iron	Vitamin A	Vitamin B12	Vitamin D	Vitamin B6	Vitamin C	Vitamin E
Kinshasa	60.12	31.67	74.45	73.91	67.29	74.78	61.43	74.62	13.35	67.78	74.62	41.47	52.19	74.78
Kongo Central	64.71	49.49	76.67	77.08	59.03	77.28	69.17	77.28	7.51	74.24	76.88	54.97	44.02	77.28
Mai-Ndombe														
Kwilu	61.49	55.65	67.54	73.59	62.9	73.79	69.15	73.19	2.82	72.58	73.59	36.29	29.23	73.79
Kwango	55.63	50.33	52.98	60.93	42.38	60.93	53.64	60.26	0.66	59.6	60.93	29.8	11.92	60.93
Equateur	50.88	44.12	53.24	60.88	45.29	60.88	55	60.88	0.59	55.59	59.71	35.88	19.71	60.88
South Ubangi	57.53	40.15	58.69	66.8	43.24	66.8	60.23	66.02	1.16	59.85	66.41	39.38	13.51	66.8
North Ubangi	58.08	45	61.15	65	45.77	65	59.23	62.69	0	61.15	65	36.92	23.46	65
Mongala	28.47	16.67	31.25	34.72	19.44	34.72	31.25	34.03	0	31.25	34.72	11.81	5.56	34.72
Tshuapa														
Tshopo	43.67	18.99	44.62	47.78	21.52	48.42	39.87	48.1	1.9	32.91	47.78	12.34	7.28	48.42
Bas-Uele														
Haut-Uele	62.9	41.13	69.35	70.97	37.9	70.97	66.13	70.97	0	70.97	70.97	52.42	21.77	70.97
Ituri	59.29	27.14	69.29	70	33.57	70	69.29	70	5.71	62.14	70	31.43	25	70
North Kivu	61.75	31.66	65.33	64.61	28.65	66.62	61.75	65.9	14.47	62.89	66.76	27.36	17.19	66.62
South Kivu	87.63	58.86	91.97	91.64	67.89	91.97	88.63	91.97		89.63	91.97	63.88	65.89	91.97

Maniema	40.5	27.69	48.76	51.24	40.08	51.65	48.76	51.65	39.46	37.6	51.65	25.21	10.33	51.65
Lualaba	76.82	35.99	78.89	79.24	70.59	79.58	60.21	79.58	32.53	56.4	75.43	48.79	52.25	79.58
Haut-Lomami														
Tanganyika														
Haut-Katanga	66.56	16.97	76.18	75.77	71.57	77.2	60.43	76.89	26.28	59.2	76.38	29.14	54.5	77.2
Kasai-Oriental	65.37	48.06	89.25	87.46	85.37	89.25	78.81	89.25	3.88	88.96	89.25	42.09	69.55	89.25
Sankuru														
Lomami	51.86	42.86	74.53	73.91	62.11	74.84	68.32	74.53	4.04	72.98	74.84	33.85	50.62	74.84
Kasai	33.43	27.67	58.21	58.21	54.76	58.5	53.03	58.5	0	58.21	58.5	20.17	15.27	58.5
Kasai-Central	58.98	48.2	78.14	76.95	76.65	78.44	67.66	78.44	8.68	77.54	78.44	42.22	54.79	78.44

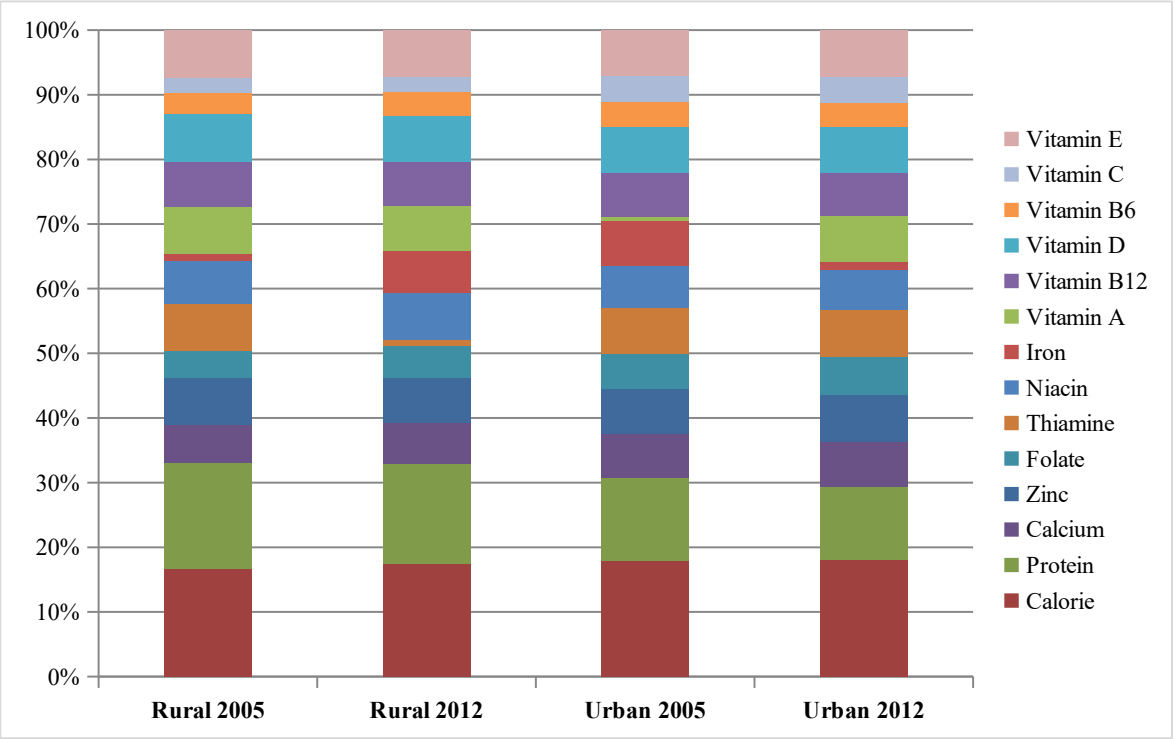
e. **Contribution of Dimensions to NDI**

For rural DRC in 2005, the highest contribution to nutritional deprivation (as measured by the NDI) is the major nutrients, calories and protein, at around 16 percent each (Figure 1). The lowest contribution is that by iron. In 2012, the highest contribution was again made by calories and protein. The lowest contribution is that of thiamine. For urban DRC in 2005, the highest contribution to NDI is again that by calories and protein, to the extent of 17 and 12 percent, respectively. The lowest contribution is that by vitamin A. In 2012, the extent of contribution by calorie intake rose to 18 percent and that by protein fell slightly, to 11 percent. The lowest contribution was that by iron. Thus, to conclude, for both urban and rural DRC, the highest contribution to nutritional deprivation is calories and protein. This finding remains the same when examining the disaggregated results across different regions in both the sectors in 2005 and 2012.

Table 8: Contribution of dimensions to NDI

Indicator	Raw Headcount Ratio				Censored Headcount Ratio				Nutrition Deficiency Index (NDI)			
	Rural		Urban		Rural		Urban		Rural		Urban	
	2005	2012	2005	2012	2005	2012	2005	2012	2005	2012	2005	2012
Calorie	40.63	48.27	57.22	59.1	40.55	48.16	57.18	58.92	16.71	17.44	17.85	18.01
Protein	39.6	42.9	41.37	37.22	39.6	42.89	41.37	37.22	16.32	15.53	12.91	11.38
Calcium	50.59	58.15	75.71	79.67	43.48	51.45	65.24	68.74	5.97	6.21	6.79	7
Zinc	72.17	78.46	81.62	83.01	52.74	58.73	67.63	70.35	7.25	7.09	7.04	7.17
Folate	31.63	41.71	53.05	59.62	30.75	40.69	51.17	57.03	4.22	4.91	5.32	5.81
Thiamine	94.14	96.87	96.65	96.88	53.07	59.01	68.35	71.11	7.29	1	7.11	7.25
Niacin	49.7	55.79	63.42	63.24	47.45	53.7	61.95	62.17	6.52	7.12	6.45	6.34
Iron	71.91	78.85	85.24	87.76	52.39	58.52	68.06	70.8	1.17	6.48	7.08	1.13
Vitamin A	9.15	8.73	5.85	11.76	8.5	8.3	5.66	11.08	7.2	7.06	0.59	7.21
Vitamin B12	84.39	81.88	82.88	77.92	51.52	55.98	65.51	64.47	7.08	6.76	6.82	6.57
Vitamin D	94.36	96.46	95.85	94.72	53.02	58.95	68.23	70.72	7.29	7.12	7.1	7.21
Vitamin B6	24.54	31.34	37.2	37.04	24.54	31.33	37.2	37.03	3.37	3.78	3.87	3.77
Vitamin C	17.84	20.07	39.53	39.43	16.86	19.66	38.14	38.29	2.32	2.37	3.97	3.9
Vitamin E	94.14	96.87	96.65	96.88	53.07	59.01	68.35	71.11	7.29	7.12	7.11	7.25

Figure 1: Contribution of dimensions to NDI



f. **Dominance Analysis**

Kinshasa and South Kivu dominate the performance of all rural DRC regions, followed by Sankuru and North Ubangi, in both 2005 and 2012; further, Mongala was the best-performing in 2005 and North Kivu in 2012 for rural DRC (Figures 2).

Figure 2(a): Dominance analysis, Rural 2005

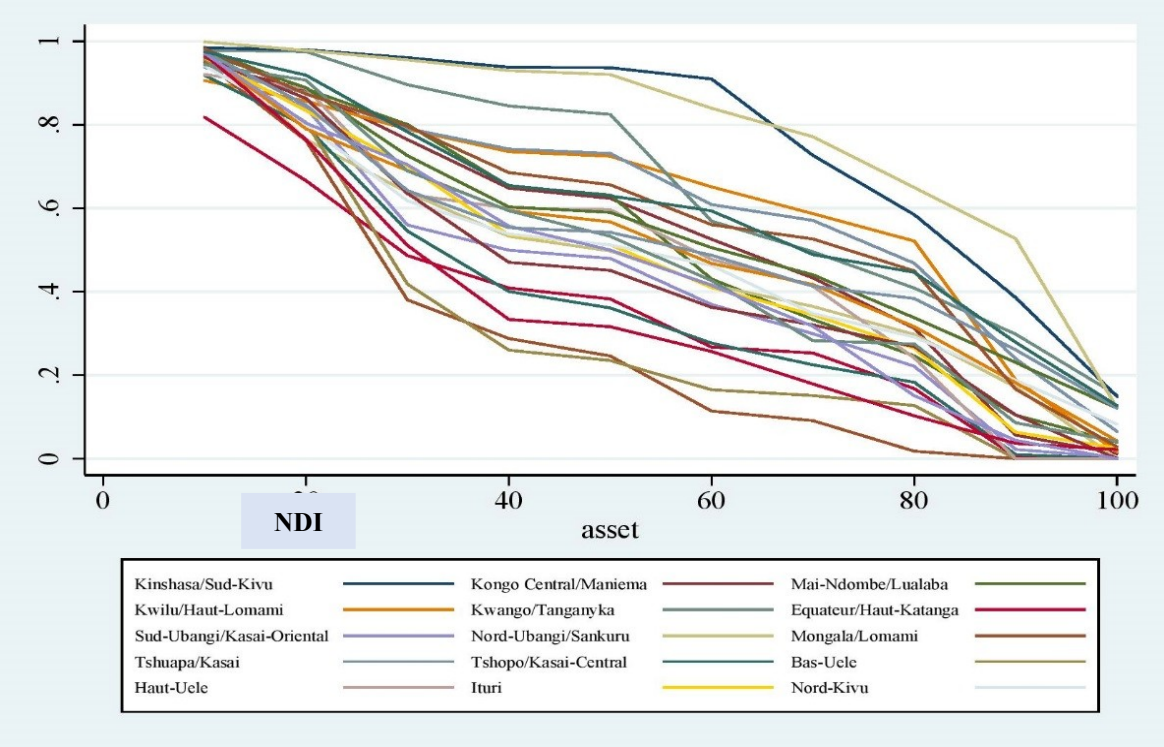
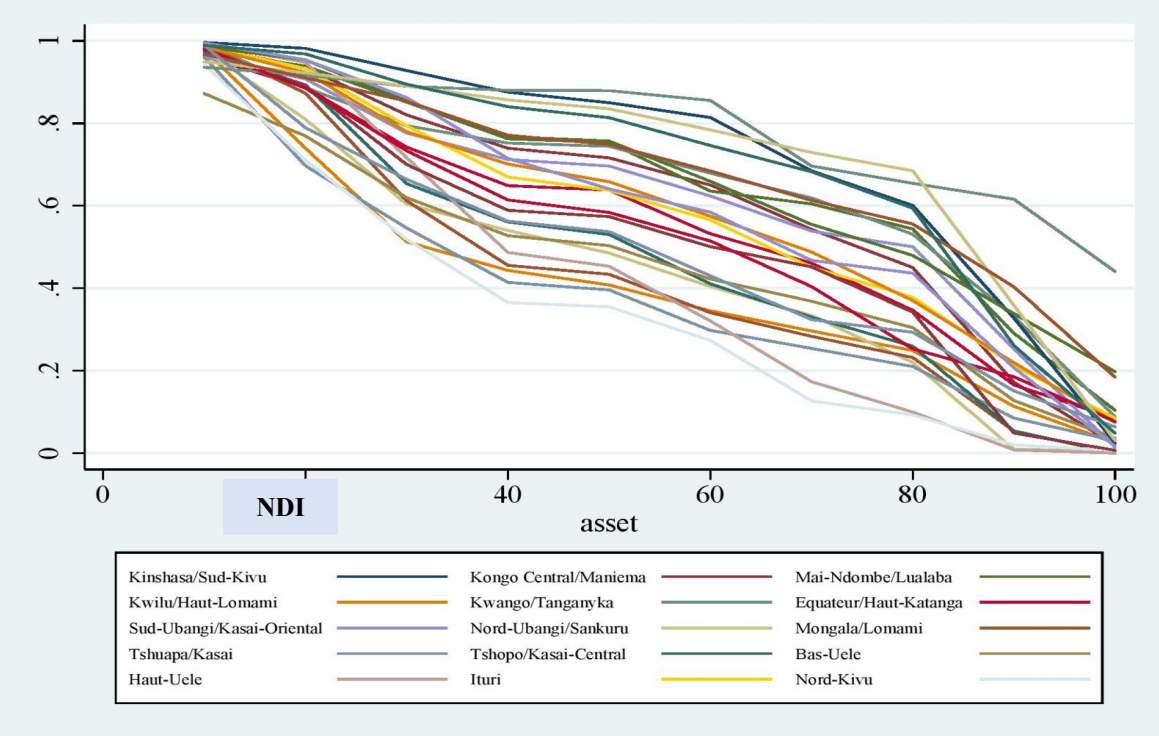


Figure 2(b): Dominance analysis, Rural 2012



South Kivu dominates the performance of all regions of urban DRC in both 2005 and 2012, whereas Sankuru and Mongala are the best-performing regions in urban DRC in 2005 and 2012, respectively (Figures 3).

Figure 3(a): Dominance analysis, Urban 2005

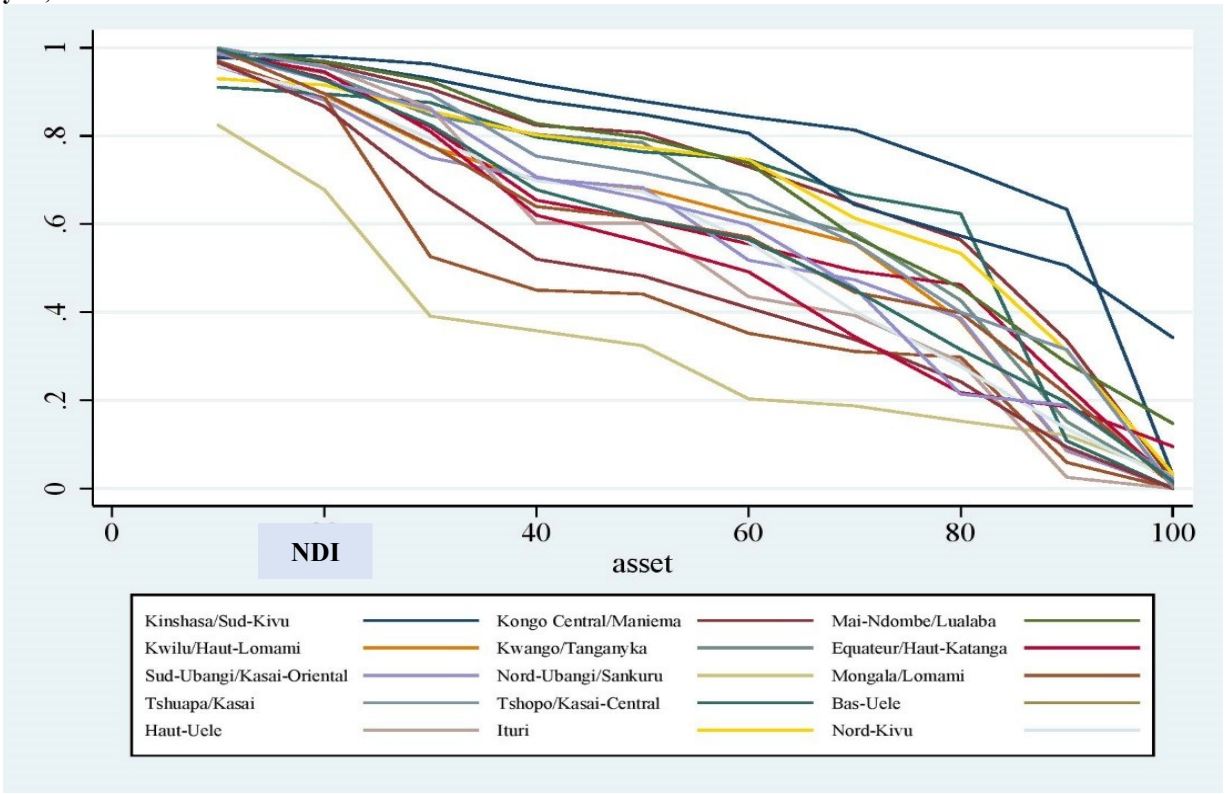
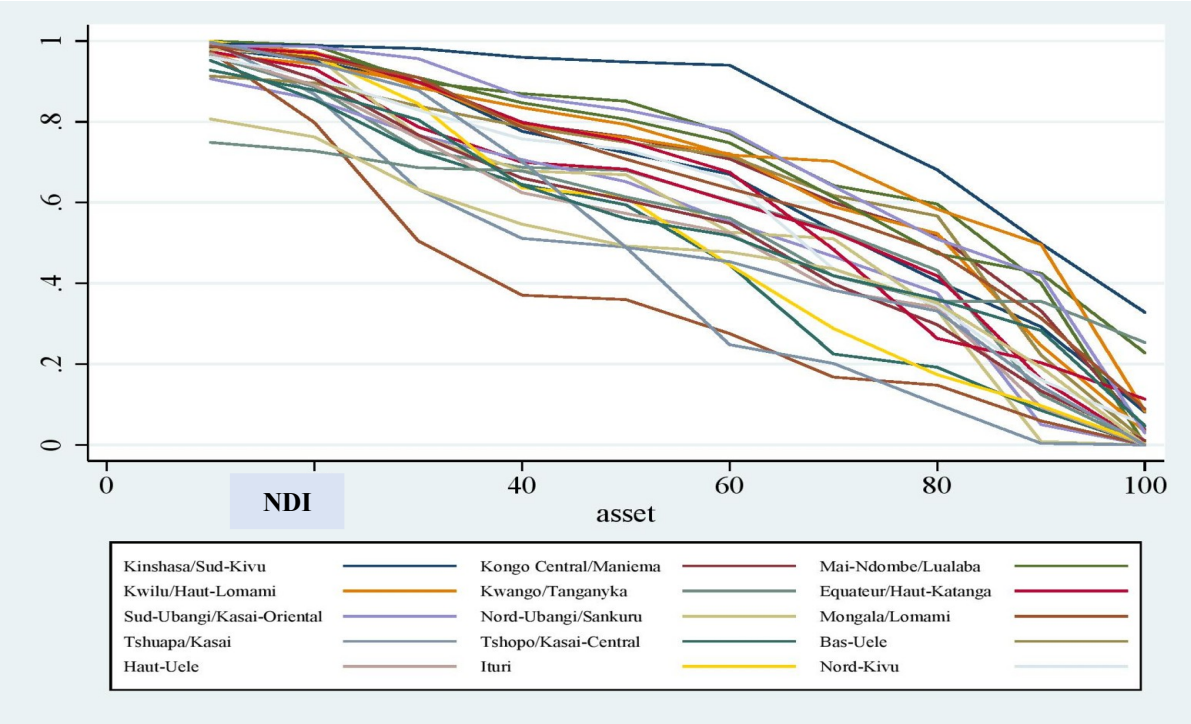


Figure 3(b): Dominance analysis, Urban 2012



To summarize, South Kivu is the worst-performing of all regions and Mongala the best. South Kivu is one of the regions worst hit with conflict. It is not surprising that around 22 percent of the children in the region are school dropouts. This is a hindrance to attaining SDGs 4 and 16. It is quite well established in the literature on the linkages between education and food security that education is an effective tool for improving nutritional outcomes. For example, midday lunches improve educational outcomes and food security (Ahmed and del Ninno 2002). This finding is substantiated because North Kivu, South Kivu, and southern DRC were in serious need of humanitarian assistance as per a study conducted by the Integrated Food Security Phase Classification (IPC 2019). South Kivu is the home of the country's smallholder farmers. Our findings also substantiate the recent literature on the plight of the smallholder farmers in least-developed or developing countries (Dev 2014). Smallholder

farmers, who are 450 million in number and feed billions, are key to attaining SDG 2 (Fan et al. 2013). Our overall understanding from the analysis is that food availability, access, and supply stability are severely jeopardized in the DRC due to the onslaught of humanitarian crises.

Our findings on the status of nutrition deprivation in each region are also in line with a World Bank study on the scaling up of different nutrition interventions in the DRC (Shekar et al. 2015). Some of the key cost-effective interventions are vitamin A supplementation, deworming, behaviour change communication, acute malnutrition programming, public provision of complementary food or micronutrients, iron–folic acid supplementation, promotion of intake of iodized salt and iron-fortified flour, and zinc supplementation with oral rehydration salts for management of diarrhea. The study provides selected evidence on the proportion of the population belonging to different age groups who did not receive the required intervention. According to our analysis and the high proportion of the population devoid of the benefits of the particular nutrition program, we observe a similarity between the nutritionally deprived regions. For example, vitamin A deprivation was the highest in Maniema in 2012, and the same region, according to World Bank estimates, has the highest proportion of children in the age group of 6–59 months not covered by vitamin A supplementation. Similarly, Katanga and Equateur house the highest proportion of those deprived of receiving the benefits of the above-mentioned interventions.

Spatial Mapping

A visual representation of nutritional deficiency is provided by the spatial maps in Figures 4 and 5. As corroborated by the index values, the pockets of high nutrition deprivation are central and southwestern DRC regions, both rural and urban, in both 2005 and 2012.

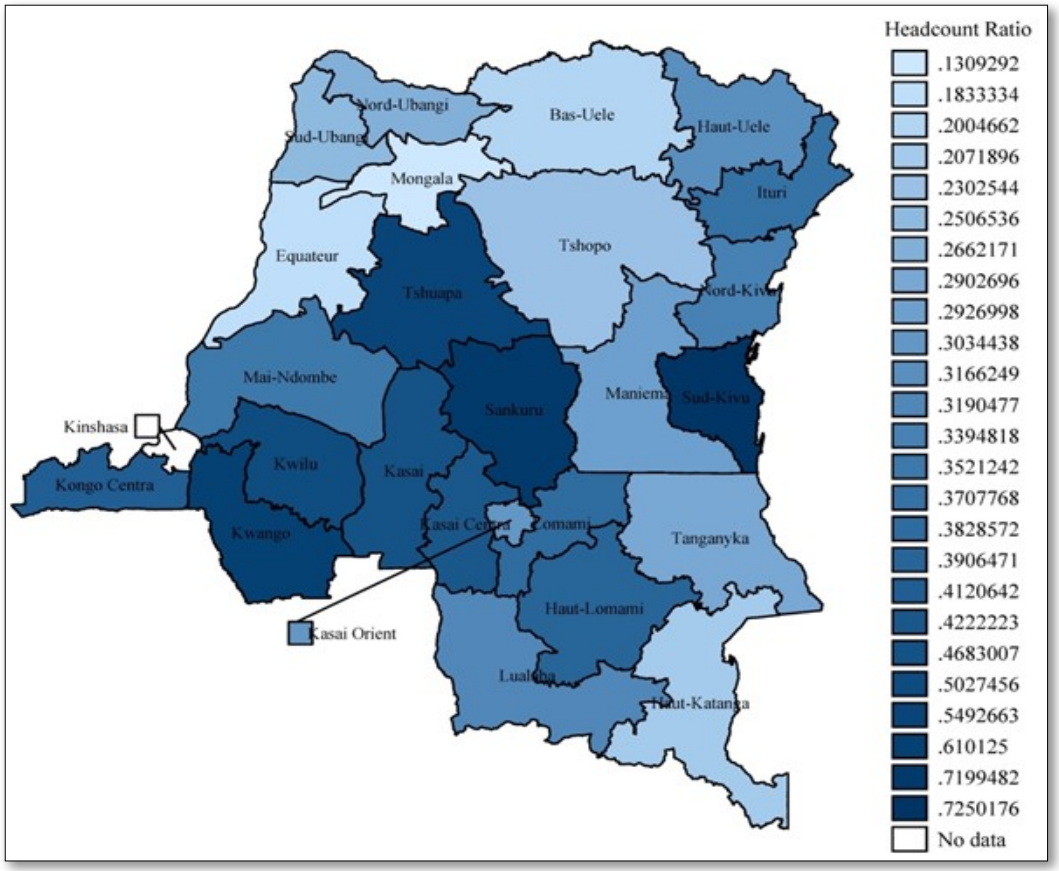
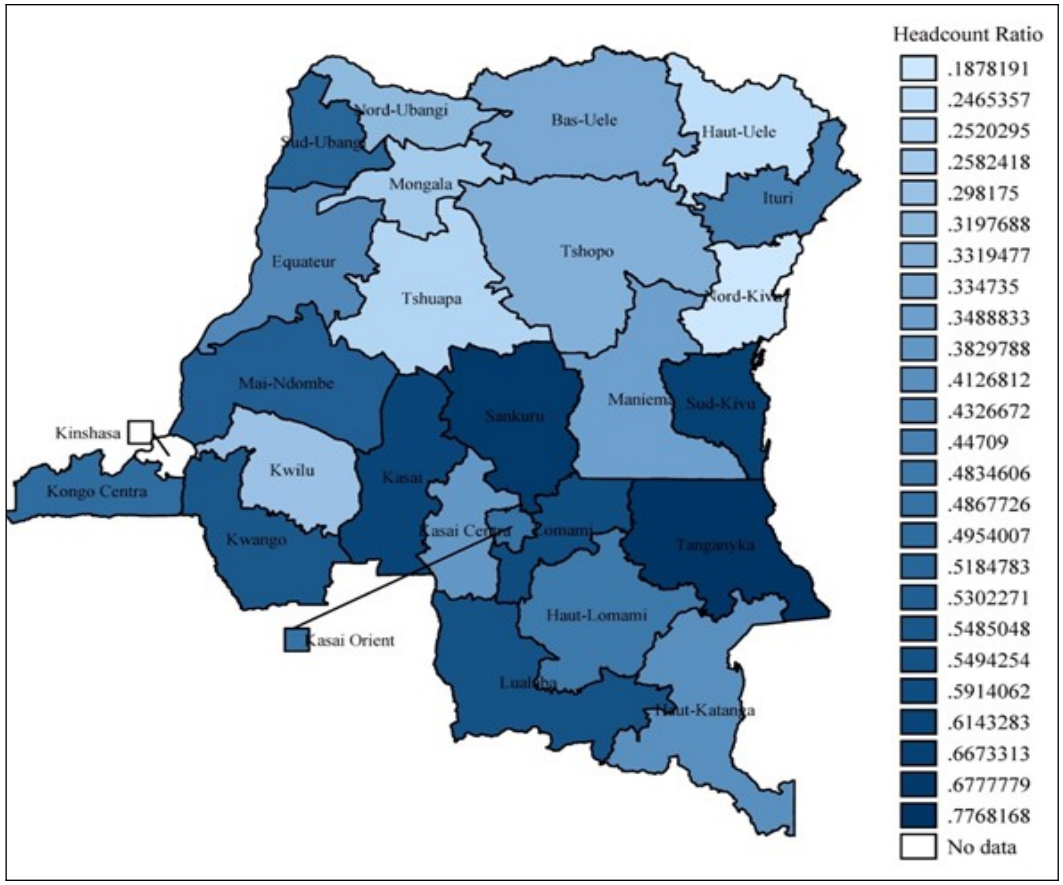

Headcount Ratio
.1309292
.1833334
.2004662
.2071896
.2302544
.2506536
.2662171
.2902696
.2926998
.3034438
.3166249
.3190477
.3394818
.3521242
.3707768
.3828572
.3906471
.4120642
.4222223
.4683007
.5027456
.5492663
.610125
.7199482
.7250176
No data
Bas-Uele
Haut-Uele
Ituri
Mongala
Tshopo
Equateur
Tshuapa
Mai-Ndombe
Maniema
Sud-Kivu
Sankuru
Kinshasa
Kwilu
Kasai
Kongo Centra
Kwango
Kasai Central
Lomami
Tanganyka
Haut-Lomami
Kasai Orient
Lualaba
Haut-Katanga

Figure 4(b): Spatial map, NDI Rural 2012



Regions located in northern DRC perform the best. Values on the multidimensional NDI vary from 0.13 to 0.73. For rural DRC, the extent of deprivation worsens in Tanganyika and Lualaba, and improves in Kasai Central and Kwilu from 2005 to 2012. Southern DRC performs worse on nutrition than on the other dimensions of multidimensional poverty, such as education.

Figure 5(a): Spatial map, NDI Urban 2005

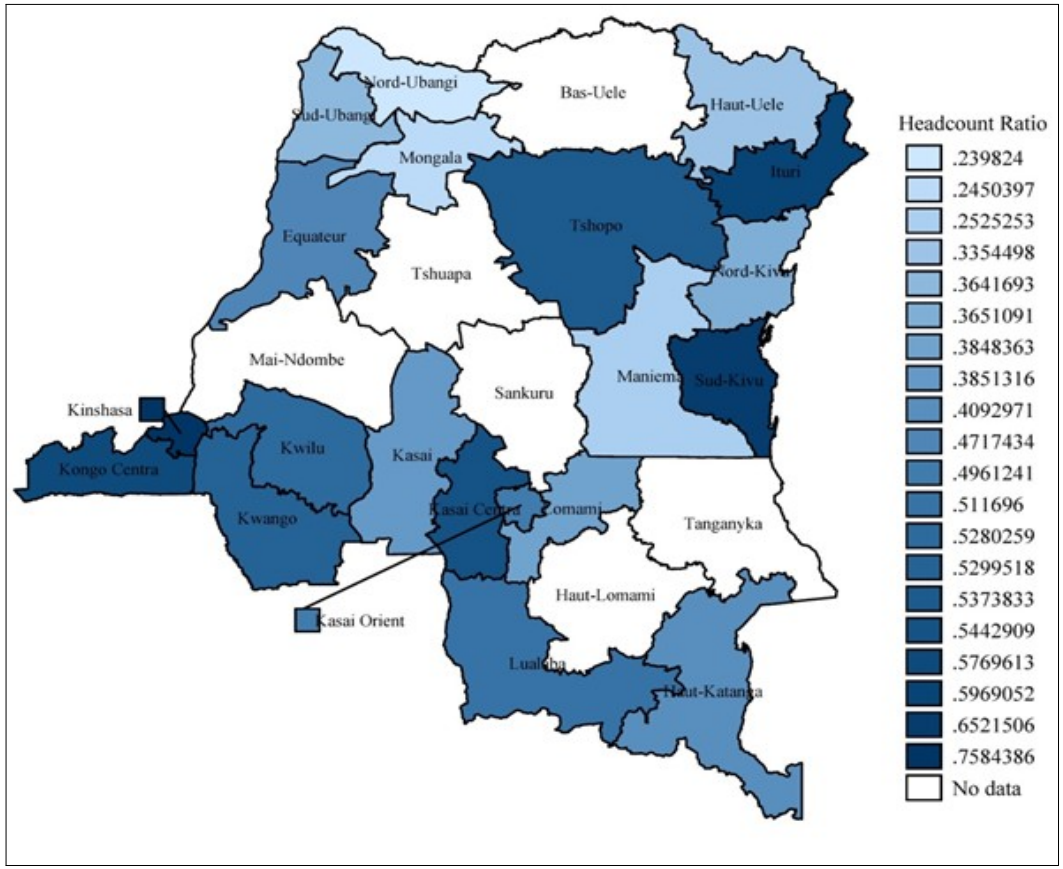
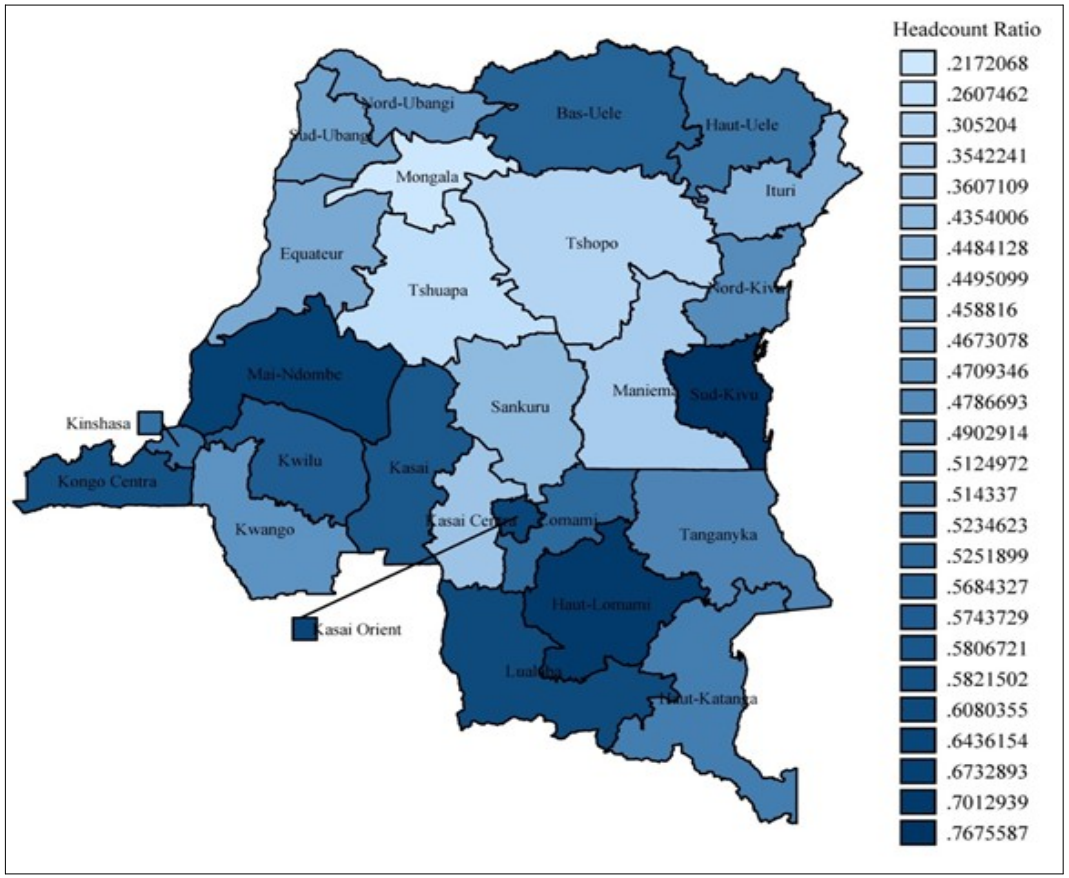


Figure 5(b): Spatial map, NDI Urban 2012



The region of Katanga (comprising Tanganyika, Lomami, Lualaba, Haut-Lomami, and Haut-Katanga) has the highest school dropout rate, of 31 percent (FHI 360 2020). Nutrition deprivation worsens in urban DRC over the period considered, specifically in the regions of Bas-Uele, Tshopo, North and South Ubangi, Mai-Ndombe, Tanganyika, and Haut-Lomami from 2005 to 2012. It improves in Tshopo, Ituri (a high-conflict and Ebola pandemic–affected region), Kinshasa, and Kwango. Overall, central DRC performs the best. Thus, the regions of Kasai, Kivu, and Tanganyika are exposed to violent conflicts, house the highest number of IDPs, and are severely undernourished. The WFP has laid a continuous focus on the uplifting of these regions.

Linkages, pathways and impacts of agricultural, food and nutrition policies on nutrition outcomes

We explore how different ag-nutri policies have affected agri-food commercialization, diversification and can contribute to nutrient intake. Table 6 below is based on the World Bank Study on Nutrition Smart Agriculture in the DRC (World Bank 2020). We also identify regions that are seriously deficient in a particular nutrient intake, as identified in column 6 but do not appear in the focus region of ag-nutri intervention. An empty cell implies that the areas in column 1 and seriously deprived regions of nutrient intake are prospective regions for implementing NSmart practices, as mentioned in column 6 match.

Table 6: Practices and Market Potential of Nutrition Smart Agriculture

Nutrition Smart Agriculture, Production Dimension						
Region	**NDI range**	**Stochastic dominance findings (R+U)**	**Practices and Technologies**	**Market potential**	**Contribution to nutrition**	**For possible intervention, seriously nutrient-deprived**
Kasais: Kasai Oriental, Kasai; West: Kongo Central, Kinshasa	R (0.77- 0.49) U (0.76 - 0.52)	Poor and average performing regions	Adoption of bio-fortified cassava	Small market size; expectation for market growth	Vitamin A	Haut Katanga, Lualaba, Maniema
West: Kongo Central, Kinshasa; Kasais: Kasai Oriental, Kasai; East: Ituri, South Kivu	R (0.77-0.49/0.25) U (0.76 - 0.52/0.41-0.47)	Poor and average performing regions	Adoption of bio-fortified beans	Small market size; expectation for market growth	Iron	
East: Ituri, South Kivu	R (0.25 - 0.41) U (0.41- 0.47)	Poor and average performing regions	Adoption of bio-fortified maize	Small market size; expectation for market growth	Vitamin A	Haut Katanga, Lualaba, Maniema
West: Kongo Central, Kinshasa	R (0.77 - 0.49) U (0.76 - 0.52)	Average performing regions	Adoption of Quality Protein Maize (QPM)	Positive outlook for commercial viability of the product; existing demand; small market size; expectation for market growth	Additional source of protein consumption	Kasai Central, South Kivu, Kwilu, Kwango
East: Ituri, South Kivu	R (0.25-0.41) U (0.41 – 0.47)	Average performing regions	Adoption of Orange Fleshed Sweet Potato (OFSP)	Small market size; expectation for market growth	Micronutrient deficiencies (mainly vitamin A)	Haut Katanga, Lualaba, Maniema
Kasais: Kasai Oriental, Kasai; East: Ituri, South Kivu; West (Kongo Central, Kwilu)	R (0.77 - 0.49) U (0.76 - 0.52)	Poor and average performing regions	Fish	Large market size; expectation for market growth; Positive market outlook; existing demand; Large market size; expectation for market growth	Micronutrient deficiencies (iron, zinc, and vitamin A), and provides an additional source of protein consumption	Haut Katanga, Lualaba, Maniema
Kasais: Kasai Oriental, Kasai; East: Ituri, South Kivu; West (Kongo Central, Kwilu)	R (0.77 - 0.49) U (0.76 - 0.52)	Poor and average performing regions	Production of fruits	Large market size; expectation for market growth	Micronutrient deficiencies (mainly vitamin A)	Haut Katanga, Lualaba, Maniema

East: Ituri, South Kivu	R (0.25-0.41) U (0.41 – 0.47)	Average performing regions	Adoption of Orange Fleshed Sweet Potato (OFSP)	Small market size; expectation for market growth	Micronutrient deficiencies (mainly vitamin A)	Haut Katanga, Lualaba, Maniema
Kasais: Kasai Oriental, Kasai; East: Ituri, South Kivu; West (Kongo Central, Kwilu)	R (0.77 - 0.49) U (0.76 - 0.52)	Poor and average performing regions	Fish	Large market size; expectation for market growth; Positive market outlook; existing demand; Large market size; expectation for market growth	Micronutrient deficiencies (iron, zinc, and vitamin A), and provides an additional source of protein consumption	Haut Katanga, Lualaba, Maniema
Kasais: Kasai Oriental, Kasai; East: Ituri, South Kivu; West (Kongo Central, Kwilu)	R (0.77 - 0.49) U (0.76 - 0.52)	Poor and average performing regions	Production of fruits	Large market size; expectation for market growth	Micronutrient deficiencies (mainly vitamin A)	Haut Katanga, Lualaba, Maniema
Kasais: Kasai Oriental, Kasai; East: Ituri, South Kivu; West (Kongo Central, Kwilu)	R (0.77 - 0.49) U (0.76 - 0.52)	Poor and average performing regions	Production of vegetables	Large market size; expectation for market growth	Micronutrient deficiencies (mainly iron and vitamin A in selected vegetables	Haut Katanga, Lualaba, Maniema
Kasais: Kasai Oriental, Kasai; East: Ituri, South Kivu; West (Kongo Central, Kwilu)	R (0.77 - 0.49) U (0.76 - 0.52)	Poor and average performing regions	Production of nuts (peanuts)	Large market size; expectation for market growth	Micronutrient deficiencies (mainly iron and zinc); provides additional source of protein consumption	
Kasais: Kasai Oriental, Kasai; East: Ituri, South Kivu; West (Kongo Central, Kwilu)	R (0.77 - 0.49) U (0.76 - 0.52)	Poor and average performing regions	Production of poultry	Large market size; expectation for market growth; limited competition	Micronutrient deficiencies (iron, zinc, and vitamin A), and provides an additional source of protein consumption	
Kasais: Kasai Oriental, Kasai; East: Ituri, South Kivu; West (Kongo Central, Kwilu)	R (0.77 - 0.49) U (0.76 - 0.52)	Poor and average performing regions	Production of pulses	Small market size; expectation for market growth	Micronutrient deficiencies (mainly iron) and may contribute to increased protein intake if consumed more	

Source: World Bank (2020) and authors calculations for the year 2012; R - Rural, U – Urban; based on stochastic dominance analysis regions are classified as better, average, and poor performing regions.

Our empirical findings support some of the recent interventions by different development partners across regions. Biofortification and NSmartAg menu of options by the World Bank in Kwilu, Kasais, Kivus, and Kongo Central. Value chain development for bananas and pisciculture in Kwilu and Kwango by the Enabel-Belgian Development Authority; for soybeans and beans in South Kivu by USAID. African Development Bank (AfDB) is the development partner for value chain development for various agro-products across Kinshasa, Ituri, Kivus, and Kasais. Most interventions are ongoing in the southern parts of DRC, which are the most nutrition deprived. The central part, which performs best, is also a focus region such as Mongala. Evidence shows that it is a better province, probably due to its proximity to the Congo River, rich in fish diversity, and fertile land due to its proximity to the forest ecosystem (CIAT 2014, Gergel et al 2020).

A lesser number of programs and interventions are present in the conflict-affected area of Ituri. The most plausible explanation is that in conflict regions, programs and interventions focus is on ensuring peace and stability instead of food security and nutrition directly (IPC Global Partners, 2017). Therefore, it is essential that in conflict regions, stakeholders put in place policies that will enable sufficient nutrient intake. Such initiatives will help attain SDGs 1, 2, 4, and 16 in a timely manner. Post-harvest value chain development in Kinshasa is much needed. The capital performs poorly in the intake of multiple nutrients due to the rising income inequality and dependence on food from provinces and importation. Moummi (2010) argues that the province of Kinshasa, as the country's political and economic capital, is possess better infrastructure and facilities for access to public services and higher employment than other provinces, which partly explains its relatively low level of poverty. But is characterized by an unequal distribution of wealth affecting the access to a nutritious diet. Our disaggregated analysis on nutrient deprivation across regions can guide the ag-nutri policy makers to identify the required region and nutrition-specific interventions. In most situations, the nutrition-specific interventions will be associated with peace and stability interventions, especially in conflict regions in the eastern part. In other provinces, nutrition-specific intervention should be paired with poverty alleviation and inequalities intervention, especially in cities. Due to conflicts and infrastructure-related issues, rural produce does not reach urban markets. Urban markets flood with imported food (WFP 2008). The urban population cannot afford the products and end up consuming high-calorie food items and subsequent nutritional deprivation. It also partly explains why urban DRC performs poorly compared to rural DRC.

5. CONCLUSION

In this paper, we construct an NDI for rural and urban DRC to understand the nutrition deprivation profile of households. Urban DRC performs worse than rural DRC. Conflict and Ebola-hit regions are the worst affected of the nutritionally deprived regions. Deficiency in calorie and protein intake contributes to the high values of the NDI. We find evidence of a double burden of malnutrition, with households lacking consumption of both macro- and micronutrients. South Kivu is the worst-performing of all regions and Mongala the best. The northern parts of DRC have fewer nutritionally deprived households than the central and southwestern parts. Our main policy recommendation is to help improve market access in urban areas to consume a more diverse diet. DIn rural areas, government support should be toward improving nutrition-sensitive agricultural production. Although the WFP has a sustained presence in uplifting households out of severe hunger, active participation by the government and collaboration with multiple stakeholders is called for. The recent COVID-19 pandemic has added to the woes globally and in the DRC, even though the case fatality ratio is low. Nutrition interventions should be streamlined with overall health system interventions. Poor governance is the prime cause of the DRC's dysfunctional health system (Ntembwa and Van Lerberghe 2015). Coordinated efforts are required to build a sustainable and healthy food system.

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