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IFPRI Discussion Paper 01999

February 2021

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, as compared with 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. In rural areas, the government should support improving nutrition-sensitive agricultural production. Although the World Food Programme has a sustained presence in the country, uplifting households from severe hunger, active 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

ACKNOWLEDGMENTS

The authors are very grateful to Dr. John Ulimwengu and Dr. Wim Marivoet from the International Food Policy Research Institute (IFPRI) for making the data available. The first author would like to thank Prof. Sheryl Hendricks, Prof. John Mburu, Dr. John Ulimwengu, and Dr. Wim Marivoet for their mentorship in the food and nutrition security field, and the African Economic Research Consortium and University of Nairobi for various trainings. The second author would like to thank the Oxford Poverty and Human Development Initiative for required training, Prof. Wang Xiaolin and Dr. Shekhar Shah for their encouragement and support, and Xavier University Bhubaneswar for office space during the initial phase of the work. An earlier version of the paper was selected for presentation at the World Economic Congress 2020 (called off due to COVID-19) and presented at the online Agriculture for Nutrition and Health (A4NH) Academy Week 2020. Support from the CGIAR Research Program on Policy, Institutions, and Markets (PIM), as well as the CGIAR Research Program on Agriculture for Nutrition and Health (A4NH), is gratefully acknowledged. The World Health Organization does not endorse the article.

ABBREVIATIONS

AF	Alkire-Foster
DRC	Democratic Republic of the Congo
HCES	Household Consumption Expenditure Survey
F2F	farmer-to-farmer
FAO	Food and Agriculture Organization of the United Nations
IDP	internally displaced person
IFPRI	International Food Policy Research Institute
MPI	Multidimensional Poverty Index
NDI	nutrition deficiency index
PM2A	Preventing Malnutrition in Children Under 2 Approach
SDG	Sustainable Development Goal
WFP	World Food Programme

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 favorable (DHS 2014). The numbers are higher than those of neighboring countries (DHS 2014). 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. Intake of calories is as important as that of micronutrients to reduce the impact of a plethora of diseases, as well as 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 favor 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 to 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 that are 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 with in the DRC to improve nutritional outcomes. 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, with a focus 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 loss of lives, wealth, land, and other crucial components for vital living, as well as 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 neighboring 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 favorite 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 situation of food insecurity 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, as well as 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 strands of the literature. The first draws from the poverty and inequality literature and the second from the different pathways in the space of agriculture and nutrition that can lead to positive nutritional outcomes. The final strand is literature based on the objective of attaining the United Nations Sustainable Development Goals (SDGs). All the strands are interrelated and indicate that a reduction of multidimensional poverty in the agriculture-nutrition nexus can lead to food security and the attainment of multiple SDGs.

The recent poverty and inequality literature have extensively discussed the need for multidimensional measures in estimating the number of poor and identifying 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, which in turn lead 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 policy making, and for the design and implementation of multisectoral nutrition-sensitive interventions (Shekar et al. 2015).

Poverty is reflected not only in monetary measures but also in a reduction in 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 the measurement of 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 for comparison of 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 not just to the deficiency in intake of one nutrient but to the interaction of many deficiencies. Unfortunately, due to certain data limitations, we cannot examine the intake of fat, which is very important for the absorption of certain vitamins.

The second strand 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 a number of strategies and their effectiveness for improving nutritional outcomes in South Kivu. The key objective of the study 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. This result calls for an examination of the way the different pathways interact, operate, and can bring forth the best results.

Some of the SDGs that are crucial in the context of 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 as well as 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 the situation of nutritional poverty and food insecurity 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 the collection of data, 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 of the (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, with a purpose of seeking 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, in order to safeguard the significance of inferences made from the households' budget data.

3. METHODOLOGY

The AF methodology is used for measuring multidimensional poverty (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 at the same time, 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. The deprivation profiles (in our case, 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 in relation to various indicators of poverty. 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 both the incidence and the intensity of nutrition deprivation, as compared with the popular Household Dietary Diversity Score, which measures the number of food groups consumed usually on a daily or weekly or fortnightly basis (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.

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 population who are poor (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 these:

- Decomposition by population group: It can be broken down by geographic area, ethnicity, or other subgroups of a population, to show the composition of nutrition poverty within and among these groups.
- Breakdown by dimension or indicator: It can be broken down to show which types of nutrition deprivation are contributing to nutrition poverty within groups.
- Monitoring of 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 in the dimensions and indicators of nutrition poverty directly and quickly, making it an effective monitoring tool.
- Complementarity with 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 1/18 each. In total, we consider 14 different nutrients for construction of the NDI.

Table 1: Dimension, deprivation cutoff, and weighting matrix

Dimension	Deprivation cutoff	Weight
Calories	Deprived if intake is less than 2,750 kcal	1/6
Protein	Deprived if intake is less than 50 g	1/6
Calcium	Deprived if intake is less than 1,000 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 mg NE	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 B_{12}	Deprived if intake is less than 2.4 mcg	1/18
Vitamin D	Deprived if intake is less than 10 mcg	1/18
Vitamin B_6	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

Source: Authors.
Note: NE = niacin equivalents.

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 households that are multidimensionally nutrition-poor and also 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 households that are both nutrition-poor and deprived in 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 shown by the ratio of the raw headcount to the maximum number of rural households (Table 2(a)), more than 94 percent of households were deprived in the intake of nutrients such as thiamine, vitamin D, and vitamin E in 2005. In 2012, more than 96 percent of the households were deprived in the same nutrients. Households performed well on the intake of nutrients such as vitamin C and vitamin A. As far as the censored headcount ratio is concerned, only 8 percent of the households were deprived in the intake of vitamin A.

An in-depth analysis of the data reveals that the country is in a serious nutrition crisis. Almost 40 percent of the population was still deprived in calorie intake in 2012, with an increase of 8 percentage points only. This finding exists despite the fact that 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).

Table 2(a): Raw and censored headcount ratios, rural DRC

Dimension	Indicator	Raw headcount		Censored headcount	
		2005	2012	2005	2012
Calories	Deprived if intake is less than 2,750 kcal	40.63	48.27	40.55	48.16
Protein	Deprived if intake is less than 50 g	39.60	42.90	39.60	42.89
Calcium	Deprived if intake is less than 1,000 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 mg NE	49.70	55.79	47.45	53.70
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	8.50	8.30
Vitamin B_{12}	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 B_6	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

Source: Authors calculations based on HCES DR Congo.
Note: NE = niacin equivalents.

A similar story holds for urban DRC as far as the intake of the different macronutrients, micronutrients, vitamins, and minerals is concerned (Table 2(b)). 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 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(b): Raw and censored headcount ratios, urban DRC

Dimension	Indicator	Raw headcount		Censored headcount	
		2005	2012	2005	2012
Calories	Deprived if intake is less than 2,750 kcal	57.22	59.10	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 1,000 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 mg NE	63.42	63.24	61.95	62.17
Iron	Deprived if intake is less than 27.4 mg	85.24	87.76	68.06	70.80
Vitamin A	Deprived if intake is less than 600 mcg	5.85	11.76	5.66	11.08
Vitamin B_{12}	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 B_6	Deprived if intake is less than 1.3 mg	37.20	37.04	37.20	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

Source: Authors calculations based on HCES DR Congo.
Note: NE = niacin equivalents.

b. Discussion on Aggregated Measures

A comparison of the key aggregated measures across regions and across values of k is important. As for the headcount ratio (H), or the incidence of households that experience nutrition poverty, with a rise in the cutoff (k), the proportion of the nutritionally deprived decreases in both 2005 and 2012 (Table 3(a)). The fall is greatest when the cutoff rises from 30 to 40. However, the absolute value of the deprived, as measured by H, is greater in 2012 than in 2005, a dismal finding. 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)

Cutoff (*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	0.40	0.46
50	50.10	55.79	78.06	79.92	0.39	0.45
60	41.15	47.68	83.38	84.47	0.34	0.40
70	33.39	39.33	88.08	88.87	0.29	0.35
80	26.12	32.51	91.69	91.79	0.24	0.30

Source: Authors calculations based on HCES DR Congo.

A similar finding is observed for urban DRC for the headcount ratio, the intensity of nutrition deprivation, and the overall value of NDI (Table 3(b)). However, as discussed in the comparative analysis of rural and urban DRC for the raw and censored headcount ratios, urban DRC continues to perform worse than rural DRC.

Table 3(b): Aggregated measures (urban)

Cutoff (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	79.30	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	36.90	34.04	92.45	92.70	0.34	0.32

Source: Authors calculations based on HCES DR Congo.

Cutoff of 40, Rural 2005

For 2005, the highest proportion of households are nutritionally deprived in the regions of Tshuapa, South Kivu, and Sankuru (Table 4(a)). The proportion is the lowest in the regions of Mongala 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 (cutoff) = 40

Region	Headcount ratio (H)	Intensity of nutrition deprivation (A)	Nutrition deficiency index (NDI)
Bas-Uele	0.31	0.72	0.22
Equateur	0.26	0.71	0.19
Haut-Katanga	0.32	0.68	0.22
Haut-Lomami	0.53	0.76	0.40
Haut-Uele	0.45	0.74	0.34
Ituri	0.54	0.74	0.40
Kasai	0.54	0.8	0.44
Kasai-Central	0.62	0.79	0.49
Kasai-Oriental	0.52	0.65	0.34
Kongo Central	0.58	0.73	0.42
Kwango	0.80	0.77	0.62
Kwilu	0.65	0.81	0.53
Lomami	0.50	0.79	0.40
Lualaba	0.45	0.74	0.33
Mai-Ndombe	0.51	0.70	0.36
Maniema	0.45	0.74	0.33
Mongala	0.23	0.64	0.15
North Kivu	0.44	0.78	0.34
North Ubangi	0.44	0.71	0.31
Sankuru	0.87	0.84	0.72
South Kivu	0.87	0.83	0.73
South Ubangi	0.39	0.71	0.28
Tanganyika	0.45	0.70	0.32
Tshopo	0.35	0.70	0.25
Tshuapa	0.72	0.79	0.57

Source: Authors calculations based on HCES DR Congo.

Cut off of 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 (Table 4(b)). 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, Kinshasa's 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, Kinshasa. It is the lowest for the regions of North Ubangi, Mongala, 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 the livelihood opportunities of the population. However, the two regions have an almost equal share of expenditure on food, of around 80 percent (Mirindi et al. 2019). Marivoet and others (2019) found that Kinshasa had the highest Food Consumption Score but one of the lowest calorie intakes. Maniema exhibited one of the lowest Food Consumption Scores but the highest calorie intake. The northwestern part of the country, comprising the regions of South Ubangi, Mongala, and North Ubangi, is one of the best-performing regions, with the lowest value on the 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 that in most of the other regions. However, a similar claim cannot be made for the intake of the 14 different nutrients that we analyze.

Table 4(b): Urban 2005, by region, when *k* (cutoff) = 40

Region	Headcount ratio (*H*)	Intensity of deprivation (*A*)	Nutrition deficiency index (NDI)
Bas-Uele	—	—	—
Equateur	0.60	0.81	0.49
Haut-Katanga	0.62	0.72	0.45
Haut-Lomami	—	—	—
Haut-Uele	0.62	0.68	0.42
Ituri	0.77	0.8	0.62
Kasai	0.76	0.77	0.59
Kasai-Central	0.57	0.72	0.41
Kasai-Oriental	0.74	0.73	0.54
Kinshasa	0.91	0.86	0.78
Kongo Central	0.77	0.80	0.61
Kwango	0.71	0.76	0.54
Kwilu	0.69	0.79	0.54
Lomami	0.57	0.76	0.43
Lualaba	0.76	0.74	0.56
Mai-Ndombe	—	—	—
Maniema	0.39	0.73	0.28
Mongala	0.34	0.79	0.27
North Kivu	0.58	0.69	0.40
North Ubangi	0.36	0.74	0.26
Sankuru	—	—	—
South Kivu	0.82	0.81	0.66
South Ubangi	0.53	0.74	0.39
Tanganyika	—	—	—
Tshopo	0.78	0.77	0.59
Tshuapa	—	—	—

Source: Authors calculations based on HCES DR Congo.
Note: — = data not available.

Cutoff of 40, Rural 2012

For 2012, the rural provinces of DRC with the highest levels of nutrition poverty are those of South Kivu, Tanganyika, and Sankuru (Table 5(a)). The lowest levels are 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* (cutoff) = 40

Region	Headcount ratio (*H*)	Intensity of deprivation (*A*)	Nutrition deficiency index (NDI)
Bas-Uele	0.47	0.77	0.36
Equateur	0.56	0.77	0.43
Haut-Katanga	0.57	0.75	0.43
Haut-Lomami	0.64	0.78	0.5
Haut-Uele	0.48	0.64	0.31
Ituri	0.63	0.76	0.48
Kasai	0.53	0.75	0.39
Kasai-Central	0.78	0.8	0.63
Kasai-Oriental	0.71	0.74	0.53
Kinshasa	—	—	—
Kongo Central	0.67	0.77	0.52
Kwango	0.67	0.83	0.56
Kwilu	0.4	0.76	0.31
Lomami	0.72	0.83	0.6
Lualaba	0.71	0.8	0.56
Mai-Ndombe	0.66	0.8	0.53
Maniema	0.49	0.76	0.37
Mongala	0.37	0.74	0.27
North Kivu	0.32	0.65	0.21
North Ubangi	0.48	0.72	0.35
Sankuru	0.83	0.84	0.7
South Kivu	0.86	0.81	0.69
South Ubangi	0.67	0.82	0.55
Tanganyika	0.84	0.92	0.78
Tshopo	0.49	0.71	0.35
Tshuapa	0.34	0.75	0.25

Source: Authors calculations based on HCES DR Congo.
Note: — = data not available.

Cutoff of 40, Urban 2012

For urban DRC in 2012, the nutrition deprivation levels are the highest in South Kivu, Kasai-Oriental, and Haut-Lomami, and lowest in Mongala, Tshuapa, and Tshopo (Table 5(b)). 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, at 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 with 2005 (Table 4(b)), 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 Kasai and Kasai-Central.

Table 5(b): Urban 2012, by region, when *k* (cutoff) = 40

Region	Headcount ratio (*H*)	Intensity of deprivation (*A*)	Nutrition deficiency index (NDI)
Bas-Uele	0.75	0.8	0.6
Equateur	0.61	0.78	0.47
Haut-Katanga	0.77	0.73	0.56
Haut-Lomami	0.84	0.84	0.71
Haut-Uele	0.71	0.77	0.55
Ituri	0.7	0.72	0.5
Kasai	0.59	0.7	0.41
Kasai-Central	0.78	0.79	0.62
Kasai-Oriental	0.89	0.77	0.69
Kinshasa	0.75	0.76	0.57
Kongo Central	0.77	0.8	0.62
Kwango	0.61	0.8	0.48
Kwilu	0.74	0.8	0.59
Lomami	0.75	0.76	0.57
Lualaba	0.8	0.79	0.63
Mai-Ndombe	0.82	0.83	0.68
Maniema	0.52	0.74	0.38
Mongala	0.35	0.7	0.24
North Kivu	0.67	0.74	0.49
North Ubangi	0.65	0.79	0.51
Sankuru	0.58	0.79	0.46
South Kivu	0.92	0.85	0.78
South Ubangi	0.67	0.75	0.5
Tanganyika	0.58	0.85	0.49
Tshopo	0.48	0.68	0.33
Tshuapa	0.41	0.65	0.27

Source: Authors calculations based on HCES DR Congo.

On the Distribution of H, A, and NDI

A comparison of the box plots for the 2005 and 2012 rural uncensored headcount ratio reveals a rise in the nutrient poverty 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 halved, with the presence of a few outliers. The box plot for the aggregate NDI shows a change in profile from 2005 to 2012 similar to that of the headcount ratio. For urban DRC, the median headcount ratio was higher than the rural value in 2005. Over time, the median value of the urban headcount ratio slightly rose, with the interquartile range and skewness remaining the same. The distribution of intensity for urban DRC is much more spread-out than 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

[1] Detailed box plots are available on request. Corresponding authors: S.BABU@CGIAR.org; MOUSUMI DAS <das.mousumi.res@gmail.com>

have been ineffective in improving nutritional outcomes in both rural and urban DRC.

c. Performance across Regions (Incidence of Nutrition Deprivation)[2]

Rural Regions

An analysis by region across the intake of different nutrients reveals many interesting findings.[3] For rural DRC in 2005, calorie deprivation is the highest in the region of 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 the regions of Bas-Uele, Mongala, and Haut-Katanga, with less than 20 percent. Thus, the performance on the consumption of macronutrients in DRC is very poor.

As for micronutrients, calcium deficiency is the highest among the households of South Kivu, Kasai-Central, and Kasai-Oriental. It is the lowest in Equateur and Mai-Ndombe. The range of the distribution 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 of the 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

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[2] Detailed tables are available on request. Corresponding authors: S.BABU@CGIAR.org; MOUSUMI DAS <das.mousumi.res@gmail.com>

[3] 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.

percent, except for Haut-Katanga and Mongala. For vitamin D, the deprivation is more than 90 percent in most of the regions, except for Bas-Uele.[4] The deprivation profile for vitamin B_6 has a wide range, of almost 60 percentage points. The regions with lower levels of vitamin B_6 impoverishment 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 overall one of the best-performing regions is that the fewest conflicts are reported in this region (UNICEF Learning for Peace 2015).

Urban Regions

For 2005, calorie deprivation is the highest in the regions of 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 the provinces of North Ubangi and North Kivu. 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 the provinces of 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 the regions of Kinshasa, Ituri, Tshopo, and Kongo Central. Iron deficiency is the highest in the provinces of 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

[4] 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).

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 in 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 the intake of vitamin C. 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 after food, households have very little left to spend on other goods and services. 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 a variety of goods and services, but these are of poor quality, as reflected by the poor nutritional status. One plausible reason why urban DRC performs poorly as 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 2005

In the rural censored headcount for 2005, the distribution of the deprivation profile for the intake of different nutrients is generally positively skewed, except for calories and folate (Table 6(a)). The median value for most of the nutrient distributions is more than 40 percent, which implies that the population is mostly undernourished in the intake of both macro- and micronutrients. The average proportion of nutrient deprivations experienced by nutrient-poor households, or the censored headcount ratio, has the following high and low points by dimension and region for 2005: Calorie deprivation is the highest in the region of South Kivu and lowest in Mongala, Haut-Katanga, and Tshopo. The highest protein deprivation is observed in Kwango, South Kivu, and Kwilu, and the lowest in Kasai-Oriental (less than 10 percent). The provinces of South Kivu, Kasai-Central, and Kwilu house the most calcium-deprived, and Equateur and Mongala the least. Zinc impoverishment is the highest in the provinces of South

Kivu, Kwango, and Kwilu. It is the lowest in Mongala and Equateur, at slightly less than 30 percent. Folate deprivation of 50 percent and greater is observed in the regions of Kwilu, Kasai-Oriental, and Kasai-Central. The least folate-deprived regions are those of Mongala, Haut-Katanga, and Equateur. Almost 80 percent of the households are deprived in thiamine intake, with the least deprived regions being Mongala, Equateur, and Haut-Katanga, at less than 30 percent. The highest proportion of households impoverished in niacin intake is in South Kivu. Mongala and Haut-Katanga again rank the best. The shortfall in vitamin A intake is generally very low across most regions, at less than 15 percent. Only Kwango and South Kivu have vitamin A deprivations of 30 percent or more. Impoverishment in vitamin B_{12} intake is the highest in the regions of South Kivu and Kwango. Mongala and Equateur perform the best. South Kivu and Kwango perform worst in vitamin D intake, with more than 80 percent of households impoverished. Mongala and Equateur again perform the best. More than 50 percent of households are deprived in vitamin B_6 intake in South Kivu. Mongala, Kasai-Oriental, and Haut-Katanga perform the best, with less than 5 percent deficient. Vitamin C intake is less than 5 percent in the provinces of Mongala, Haut-Uele, Equateur, Tshopo, South Ubangi, and Kongo Central. It is the highest in South Kivu, at around 42 percent. The deprivation profile for vitamin E follows a distribution similar to that of vitamin B_{12}. The most deprived regions are South Kivu, Kwango, and Kwilu. The least deprived are Equateur and Haut-Katanga, with the values peaking at around 30 percent.

Table 6(a): Performance across regions—rural censored, 2005

Region	Calories	Protein	Calcium	Zinc	Folate	Thiamine	Niacin	Vitamin A	Vitamin B_{12}	Vitamin D	Vitamin B_6	Vitamin C	Vitamin E
Bas-Uele	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
Haut-Lomami	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
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
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
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
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
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
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
Mai-Ndombe	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
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
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
Sankuru	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
Tanganyika	—		—	—	—	—	—	—	—	—	—	—	—
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
Tshuapa	—	—	—	—	—	—	—	—	—	—	—	—	—

Source: Authors calculations based on HCES DR Congo.
Note: — = data not available.

Urban Censored 2005

In the urban censored headcount for 2005, the nutrient intake deprivation is a mix of positively and negatively skewed profiles (Table 6(b)). Profiles are positively skewed for vitamin C, vitamin B_6, and folate, and negatively skewed for the rest. For most of the plots, except for vitamin B_6, vitamin C, and vitamin A, the median value is 50 percent and greater, and it almost reaches 80 percent. This proves that the urban sector performs worse than the rural sector. Except for the intake of vitamin A, none of the regions perform remarkably on the intake of any of the nutrients. Almost 30 percent of the households are deprived in the intake of different nutrients in most of the regions.

Table 6(b): Performance across regions—urban censored, 2005

Region	Calories	Protein	Calcium	Zinc	Folate	Thiamine	Niacin	Iron	Vitamin A	Vitamin B_{12}	Vitamin D	Vitamin B_6	Vitamin C	Vitamin E
Bas-Uele	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
Haut-Lomami	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
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
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
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
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
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
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
Mai-Ndombe	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
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
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
Sankuru	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
Tanganyika	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
Tshuapa	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Source: Authors calculations based on HCES DR Congo.
Note: — = data not available.

Rural Censored 2012

The situation does not improve in rural DRC in 2012 (Table 7(a)) as compared with 2005 (Table 6(a)). In fact, 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 7(a): Performance across regions—rural censored, 2012

Region	Calories	Protein	Calcium	Zinc	Folate	Thiamine	Niacin	Iron	Vitamin A	Vitamin B_{12}	Vitamin D	Vitamin B_6	Vitamin C	Vitamin E
Bas-Uele	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
Haut-Lomami	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
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
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
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
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
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
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
Mai-Ndombe	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
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
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
Sankuru	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
Tanganyika	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
Tshuapa	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Source: Authors calculations based on HCES DR Congo.
Note: — = data not available.

Urban Censored 2012

There is an improvement from 2005 to 2012 in the condition of urban DRC, as shown in the censored headcounts (Table 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 a symmetric distribution. The vitamin B_6 deprivation profile provides a healthier picture than those of the other nutrients.

Table 7(b): Performance across regions—urban censored, 2012

Region	Calories	Protein	Calcium	Zinc	Folate	Thiamine	Niacin	Iron	Vitamin A	Vitamin B_{12}	Vitamin D	Vitamin B_6	Vitamin C	Vitamin E
Bas-Uele	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
Haut-Lomami	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
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
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
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
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
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
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
Mai-Ndombe	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
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
North Ubangi	58.08	45	61.15	65	45.77	65	59.23	62.69	0	61.15	65	36.92	23.46	65
Sankuru	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
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
Tanganyika	—	—	—	—	—	—	—	—	—	—	—	—	—	—
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
Tshuapa	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Source: Authors calculations based on HCES DR Congo.
Note: — = data not available.

e. Contribution of Dimensions to NDI

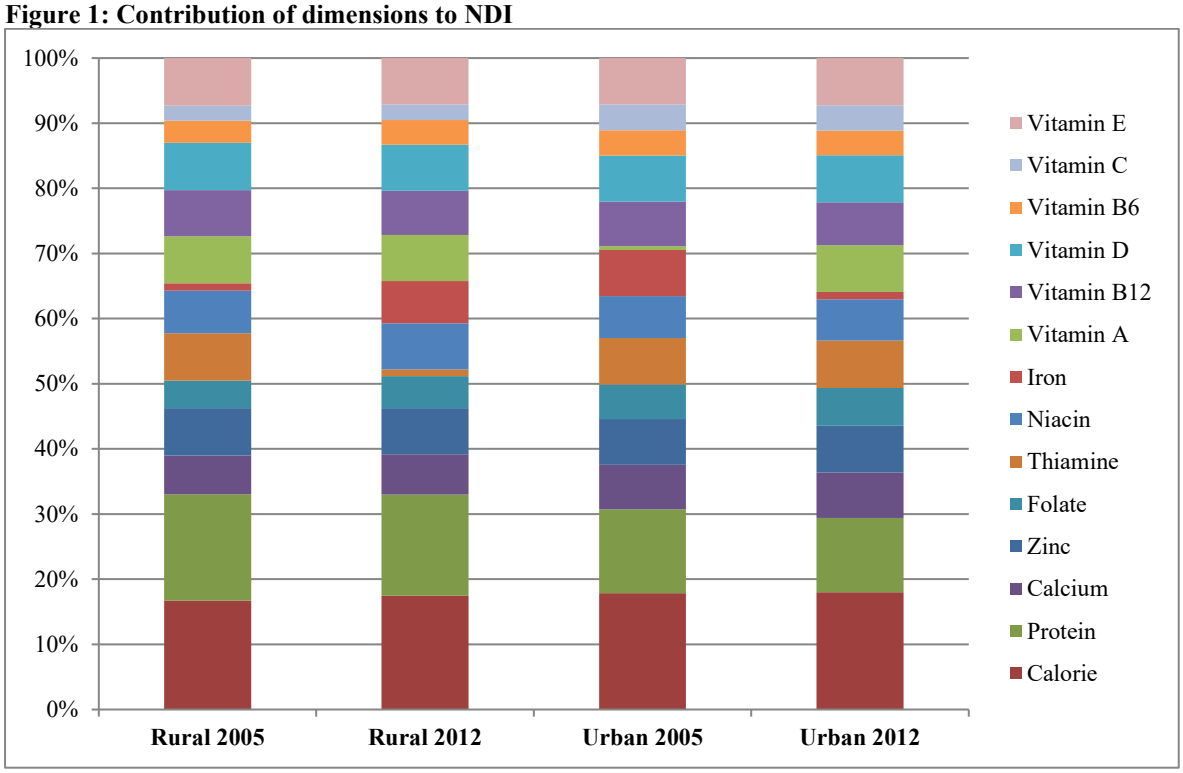
For rural DRC in 2005, the highest contribution to nutritional deprivation (as measured by the NDI) is that of the major nutrients, calories and protein, at around 16 percent each (Table 8 and Figure 1). The lowest contribution is that by iron. In 2012, the highest contribution is again made by calories 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 that of calories and protein.

Table 8: Contribution of dimensions to raw headcount ratio, censored headcount ratio, and nutrition deficiency index

Dimension	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
Calories	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	7.00
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	1.00	7.11	7.25
Niacin	49.70	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	8.50	8.30	5.66	11.08	7.20	7.06	0.59	7.21
Vitamin B_{12}	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 B_6	24.54	31.34	37.20	37.04	24.54	31.33	37.20	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	3.90
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

Source: Authors calculations based on HCES DR Congo.

Figure 1: Contribution of dimensions to NDI



Source: Authors calculations based on HCES DR Congo.

This finding remains the same when we examine the disaggregated results across different regions in both the sectors in 2005 and 2012 (Tables 9(a), 9(b), 10(a), and 10(b)).

Table 9(a): Contribution of dimensions to NDI, rural 2005

Dimension	Bas-Uele	Equateur	Haut-Katanga	Haut-Lomami	Haut-Uele	Ituri	Kasai	Kasai-Central	Kasai-Oriental	Kinshasa	Kongo Central	Kwango	Kwilu	Lomami	Lualaba	Mai-Ndombe	Maniema	Mongala	North Kivu	North Ubangi	Sankuru	South Kivu	South Ubangi	Tanganyika	Tshopo	Tshuapa
Calories	-	12.37	12.51	-	12.92	16.66	14.67	13.35	11.96	-	12.42	12.64	12.81	13.43	10.51	-	11.99	12.6	14.99	15.14	-	18.54	13.17	-	10.9	-
Protein	-	10.74	13.68	-	14.26	13.68	15.07	13.7	3.68	-	16.7	19.5	16.04	9.74	10.32	-	13.21	13.1	11.09	7.78	-	13.12	10.19	-	15.2	-
Calcium	-	2.17	5.6	-	3.86	6.03	5.83	5.95	6.75	-	4.8	4.37	5.06	4.65	3.54	-	5.76	4.03	5.38	3.55	-	5.76	4.64	-	4.85	-
Zinc	-	0	1.04	-	0	0.79	1.15	0.98	0	-	0.36	3.5	0.36	0.34	1.85	-	0.03	0	1.35	0	-	2.02	0.08	-	0.11	-
Folate	-	4.88	6.78	-	5.38	6.78	6.34	6.07	6.6	-	6.38	6.85	5.76	4.93	4.84	-	6.26	6.72	5.51	5.18	-	6.15	5.55	-	6.39	-
Thiamine	-	1.95	1.95	-	1.61	3.05	5.09	4.97	6.44	-	2.62	3.71	4.58	3.3	3.22	-	4.87	1.51	2.55	2.73	-	3.1	3.23	-	3.74	-
Niacin	-	4.88	6.65	-	5.38	6.15	5.46	6.01	6.83	-	6.31	6.85	5.76	4.87	4.97	-	5.73	6.38	5.61	5.05	-	5.99	5.55	-	6.28	-
Iron	-	4.45	7.04	-	5.2	6.66	6.34	6.07	6.83	-	6.27	6.85	5.73	4.87	5	-	6.2	6.72	5.71	4.3	-	6.18	5.55	-	6.39	-
Vitamin A	-	4.88	7.04	-	5.38	6.74	6.34	6.07	6.83	-	6.38	6.85	5.76	4.93	5.03	-	6.23	6.72	5.71	5.18	-	6.15	5.55	-	6.39	-
Vitamin B12	-	4.88	7.04	-	5.38	6.78	6.34	6.01	6.83	-	6.38	6.85	5.76	4.93	5.03	-	6.26	6.72	5.71	5.18	-	6.18	5.55	-	6.39	-
Vitamin D	-	4.88	5.73	-	5.29	6.31	5.4	5.32	5.83	-	5.95	4.72	5.12	4.48	4.01	-	5.91	5.88	5.2	3.75	-	6.14	3.97	-	5.51	-
Vitamin B6	-	1.63	1.3	-	1.88	2.82	3.54	3.06	0.38	-	2.09	3.45	3.86	2.74	1.66	-	3.48	0.34	2.5	2.32	-	3.82	2.07	-	1.98	-
Vitamin C	-	0.22	2.61	-	0.09	1.67	3.57	3.01	3.6	-	0.34	2.28	1.2	1.57	2.1	-	1.54	0	2.83	1.36	-	3.04	0.25	-	0.22	-
Vitamin E	-	4.88	7.04	-	5.38	6.78	6.34	6.01	6.83	-	6.38	6.85	5.76	4.93	5.03	-	6.26	6.72	5.71	5.18	-	6.18	5.55	-	6.39	-

Source: Authors calculations based on HCES DR Congo.
Note: — = data not available.

Table 9(b): Contribution of dimensions to NDI, rural 2012

Dimension	Bas-Uele	Equateur	Haut-Katanga	Haut-Lomami	Haut-Uele	Ituri	Kasai	Kasai-Central	Kasai-Oriental	Kinshasa	Kongo Central	Kwango	Kwilu	Lomami	Lualaba	Mai-Ndombe	Maniema	Mongala	North Kivu	North Ubangi	Sankuru	South Kivu	South Ubangi	Tanganyika	Tshopo
Calories	—	15.79	17.35	—	7.29	15.92	15.27	15.78	14.02	—	15.78	16.25	14.08	15.76	14.92	—	12.88	10.74	16.67	17.91	—	16.96	16.41	—	13.94
Protein	—	14.39	9.12	—	13.24	11.57	13.09	14.89	11.37	—	12.62	14.55	14.65	13.62	13.5	—	12.2	14.87	5.38	12.56	—	13.21	13.48	—	14.03
Calcium	—	4.31	5.58	—	6.2	6.14	5.52	5.52	6.49	—	5.8	4.91	5.11	5.54	4.87	—	4.43	4.92	6.14	4.63	—	6.29	5.81	—	5.29
Zinc	—	0.97	2.1	—	0.03	0.98	0.81	0.44	0.21	—	0.67	1.06	0.65	1.48	1.91	—	0.54	0	0.54	0.03	—	0.34	0.4	—	0.26
Folate	—	6.07	6.25	—	6.78	6.16	6.65	6.15	6.55	—	6.09	5.76	6.33	5.98	6	—	5.43	5.75	6.36	6.36	—	6.37	6.11	—	6.37
Thiamine	—	3.87	5.02	—	2.37	2.76	5.12	4.8	6.13	—	3.43	4.34	4.54	5.08	4.54	—	3.81	3.55	1.43	2.87	—	3.62	5.45	—	3.45
Niacin	—	5.47	5.61	—	6.78	6.07	6.3	6.06	6.61	—	5.91	5.34	6.22	5.98	5.88	—	4.95	5.16	6.41	5.83	—	6.31	5.99	—	5.32
Iron	—	6.03	6.4	—	6.75	6.26	6.62	6.05	6.59	—	6.05	5.7	6.22	6	6	—	5.43	5.75	6.45	6.11	—	6.4	6.05	—	6.31
Vitamin A	—	6.07	6.35	—	6.78	6.26	6.65	6.15	6.61	—	6.09	5.78	6.29	6.04	6.08	—	5.4	5.75	6.54	6.36	—	6.4	6.11	—	6.37
Vitamin B_{12}	—	6.07	6.42	—	6.78	6.26	6.65	6.15	6.61	—	6.09	5.78	6.33	6.04	6.08	—	5.43	5.75	6.54	6.36	—	6.4	6.11	—	6.37
Vitamin D	—	5.45	5.21	—	6.59	5.81	5.68	5.71	5.79	—	5.56	5.4	5.76	5.54	5.25	—	5.23	5.3	6.09	5.11	—	6.15	5.63	—	5.2
Vitamin B_6	—	2.87	2.5	—	2.27	3.17	2.32	3.39	2.59	—	3.28	3.81	2.79	3.68	3.35	—	2.56	2.37	0.99	2.26	—	4.3	4.33	—	2.05
Vitamin C	—	1.14	2.92	—	0.06	1.95	1.99	1.82	2.19	—	1.29	2.1	1.87	3.46	2.72	—	0.77	0.72	0.45	0.06	—	3.66	2.3	—	0.18
Vitamin E	—	6.07	6.42	—	6.78	6.26	6.65	6.15	6.61	—	6.09	5.78	6.33	6.04	6.08	—	5.43	5.75	6.54	6.36	—	6.4	6.11	—	6.37

Source: Authors calculations based on HCES DR Congo.
Note: — = data not available.

Table 10(a): Contribution of dimensions to NDI, urban 2005

Dimension	Bas-Uele	Equateur	Haut-Katanga	Haut-Lomami	Haut-Uele	Ituri	Kasai	Kasai-Central	Kasai-Oriental	Kinshasa	Kongo Central	Kwango	Kwilu	Lomami	Lualaba	Mai-Ndombe	Maniema	Mongala	North Kivu	North Ubangi	Sankuru	South Kivu	South Ubangi	Tanganyika	Tshopo	Tshuapa
Calories	—	14.87	14.79	—	8.49	16.77	15.32	13.01	15.34	16.04	15.89	16.36	19.42	13.45	13.92	—	11.52	13.5	15.14	18.35	—	16.03	14.64	—	14.25	—
Protein	—	13.57	6.96	—	14.05	12	10.49	8.38	6.77	13.55	12.3	15.78	15.22	9.27	7.27	—	9.02	10.72	6.52	10.65	—	10.19	9.08	—	12.47	—
Calcium	—	5.83	6.83	—	6.34	6.22	6.67	5.88	7.14	6.14	5.87	3.42	5.82	5.54	6.03	—	4.87	4.63	5.37	6.51	—	5.96	4.61	—	5.86	—
Zinc	—	0.17	2.16	—	0	0.3	0.04	0.1	0.38	0.33	0.43	0.12	0.04	0.09	1.52	—	0.04	0	0.43	0.39	—	2.11	0	—	0.15	—
Folate	—	6.09	6.38	—	6.34	6.26	6.63	5.83	6.84	6.13	5.99	00000	6.73	5.63	5.89	—	5.07	5.03	5.69	7.1	—	5.84	5.2	—	6.16	—
Thiamine	—	5.31	6.12	—	2.34	3.11	6.19	4.79	7.14	6.07	3.84	3.033	4.72	4.18	5.26	—	4.12	3.84	1.83	6.51	—	3.68	3.48	—	5.05	—
Niacin	—	5.57	6.61	—	6.34	6.07	6.43	5.88	7.07	5.83	5.77	6.14	6.38	5.63	6.03	—	4.2	4.5	5.6	4.93	—	5.96	4.97	—	6.09	—
Iron	—	6.09	6.74	—	6.34	6.26	6.67	5.88	7.14	6.15	5.99	6.22	6.65	5.63	6.03	—	5.07	5.03	5.78	7.1	—	6.01	4.93	—	6.16	—
Vitamin A	—	6.09	6.83	—	6.34	6.26	6.67	5.88	7.14	6.14	5.91	6.3	6.69	5.63	6.03	—	5.11	5.03	5.82	7.1	—	6.01	5.2	—	6.16	—
Vitamin B_{12}	—	6.09	6.83	—	6.34	6.26	6.67	5.88	7.14	6.15	6.01	6.3	6.73	5.63	6.03	—	5.11	5.03	5.78	7.1	—	6.01	5.2	—	6.16	—
Vitamin D	—	5.83	5.32	—	6.25	6.26	5.75	5.13	6.09	5.7	5.7	5.15	6.38	5.42	4.71	—	4.71	4.9	5.41	4.73	—	5.42	4.2	—	5.94	—
Vitamin B_6	—	4.44	2.32	—	2.44	4.18	2.81	1.4	2.11	5.02	3.56	2.922	2.89	2.48	2.01	—	1.98	3.04	1.78	3.35	—	3.66	2.44	—	3.93	—
Vitamin C	—	2.78	4.29	—	0.2	4.26	5.23	2.79	6.39	5.8	2.78	1.42	1.18	2.33	3.53	—	0.75	0.79	1.38	3.55	—	4.66	0.45	—	0.45	—
Vitamin E	—	6.09	6.83	—	6.34	6.26	6.67	5.88	7.14	6.15	6.01	6.3	6.73	5.63	6.03	—	5.11	5.03	5.78	7.1	—	6.01	5.2	—	6.16	—

Source: Authors calculations based on HCES DR Congo.
Note: — = data not available.

Table 10(b): Contribution of dimensions to NDI, urban 2012

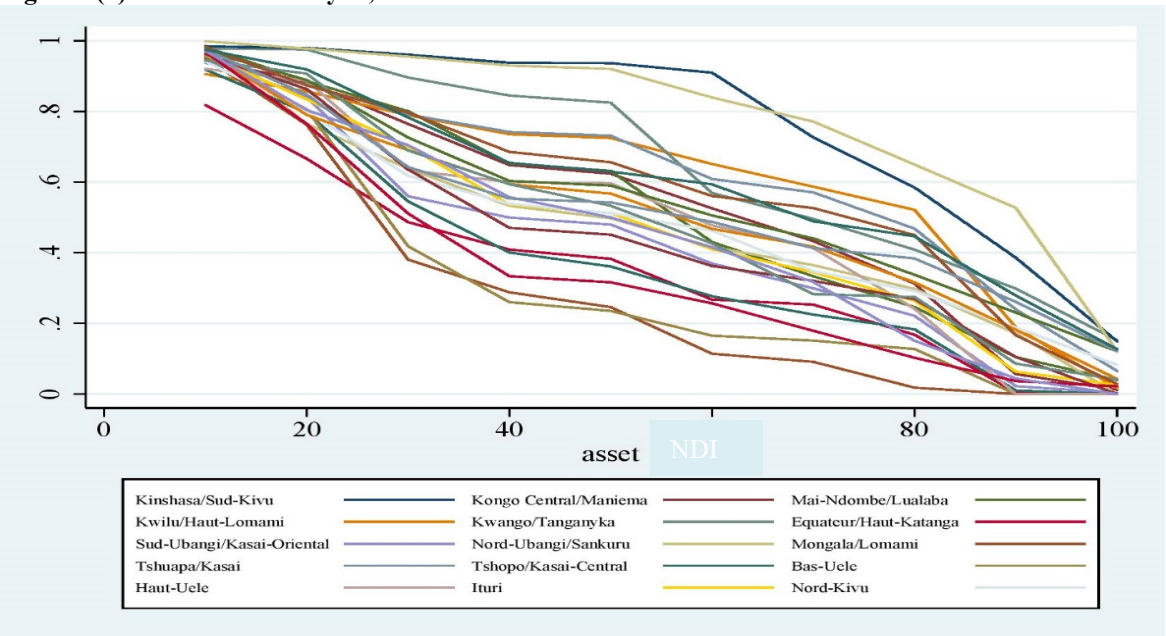
Dimension	Bas-Uele	Equateur	Haut-Katanga	Haut-Lomami	Haut-Uele	Ituri	Kasai	Kasai-Central	Kasai-Oriental	Kinshasa	Kongo Central	Kwango	Kwilu	Lomami	Lualaba	Mai-Ndombe	Maniema	Mongala	North Kivu	North Ubangi	Sankuru	South Kivu	South Ubangi	Tanganyika	Tshopo	Tshuapa
Calories	—	14.35	17.27	—	20.94	20.12	10.23	17.86	14.78	15.25	15.63	16.49	15.69	13.02	17.82	—	13.23	15.73	17.36	17.71	—	17.27	16.87	—	15.83	—
Protein	—	12.44	4.4	—	13.69	9.21	8.47	14.6	10.87	8.04	11.96	14.92	14.2	10.76	8.35	—	9.05	9.21	8.9	13.72	—	11.6	11.77	—	6.88	—
Calcium	—	5	6.59	—	7.7	7.84	5.94	7.89	6.73	6.3	6.18	5.24	5.74	6.24	6.1	—	5.31	5.75	6.12	6.22	—	6.04	5.74	—	5.39	—
Zinc	—	0.06	2.27	—	0	0.65	0	0.88	0.29	1.13	0.6	0.07	0.24	0.34	2.52	—	1.35	0	1.36	0	—	2.59	0.11	—	0.23	—
Folate	—	5.72	6.55	—	7.88	7.92	5.94	7.77	6.59	6.25	6.21	6.024	6.26	6.19	6.13	—	5.58	6.39	6.06	6.61	—	6.02	6.53	—	5.78	—
Thiamine	—	4.26	6.19	—	4.21	3.8	5.59	7.74	6.43	5.69	4.75	4.19	5.35	5.2	5.46	—	4.37	3.58	2.69	4.65	—	4.46	4.23	—	2.6	—
Niacin	—	5.23	5.12	—	7.88	7.03	5.94	7.83	6.7	5.73	5.98	5.89	6.17	6.11	4.36	—	4.1	5.75	5.9	6.22	—	5.89	5.85	—	3.98	—
Iron	—	5.72	6.65	—	7.88	7.92	5.97	7.92	6.73	6.31	6.22	5.96	6.22	6.24	6.16	—	5.63	6.27	6.18	6.37	—	6.04	6.45	—	5.81	—
Vitamin A	—	5.61	6.6	—	7.88	7.92	5.97	7.92	6.73	6.31	6.19	6.02	6.26	6.26	5.83	—	5.63	6.39	6.26	6.61	—	6.04	6.49	—	5.78	—
Vitamin B_{12}	—	5.72	6.68	—	7.88	7.92	5.97	7.92	6.73	6.32	6.22	6.02	6.28	6.26	6.16	—	5.63	6.39	6.24	6.61	—	6.04	6.53	—	5.85	—
Vitamin D	—	5.17	5.23	—	7.34	7.84	5.41	6.83	5.94	5.19	5.57	5.3	5.88	5.72	4.66	—	5.31	5.75	5.79	6.02	—	5.82	5.89	—	4.82	—
Vitamin B_6	—	3.37	2.52	—	5.82	3.56	2.06	4.26	3.17	3.51	4.43	2.95	3.09	2.83	3.77	—	2.75	2.17	2.57	3.75	—	4.2	3.85	—	1.49	—
Vitamin C	—	1.85	4.71	—	2.42	2.83	1.56	5.53	5.24	4.41	3.55	1.18	2.49	4.24	4.04	—	1.13	1.02	1.61	2.39	—	4.33	1.32	—	0.88	—
Vitamin E	—	5.72	6.68	—	7.88	7.92	5.97	7.92	6.73	6.32	6.22	6.02	6.28	6.26	6.16	—	5.63	6.39	6.24	6.61	—	6.04	6.53	—	5.85	—

Source: Authors calculations based on HCES DR Congo.
Note: — = data not available.

f. Dominance Analysis

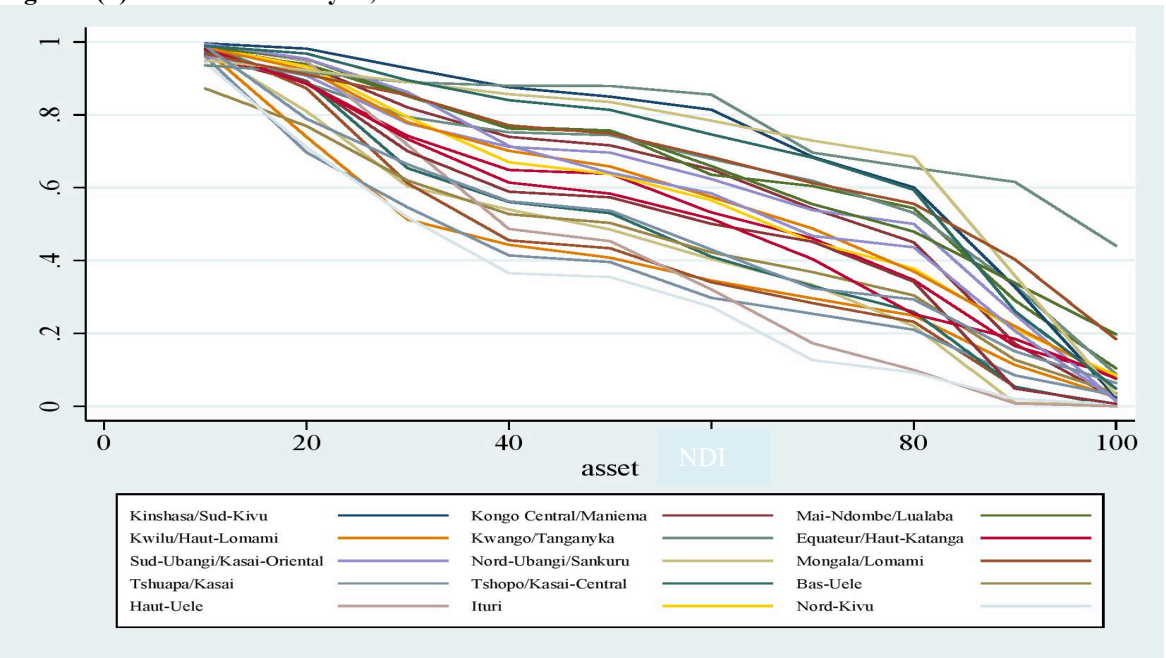
Kinshasa and South Kivu dominate the performance of all rural DRC regions, followed by Sankuru and North Ubangi, in both 2005 and 2012; further, Mongala is the best-performing in 2005 and North Kivu in 2012 for rural DRC (Figures 2(a) and 2(b)).

Figure 2(a): Dominance analysis, rural 2005



Source: Authors calculations based on HCES DR Congo.
Note: NDI = nutritional deficiency index.

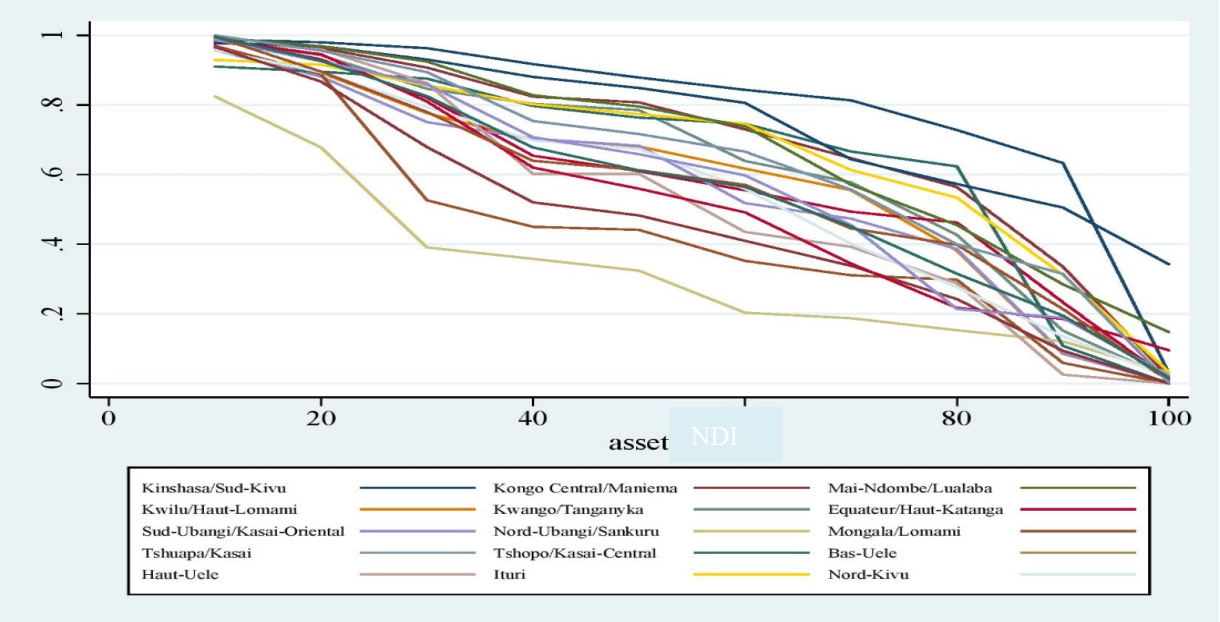
Figure 2(b): Dominance analysis, rural 2012



Source: Authors calculations based on HCES DR Congo.
Note: NDI = nutritional deficiency index.

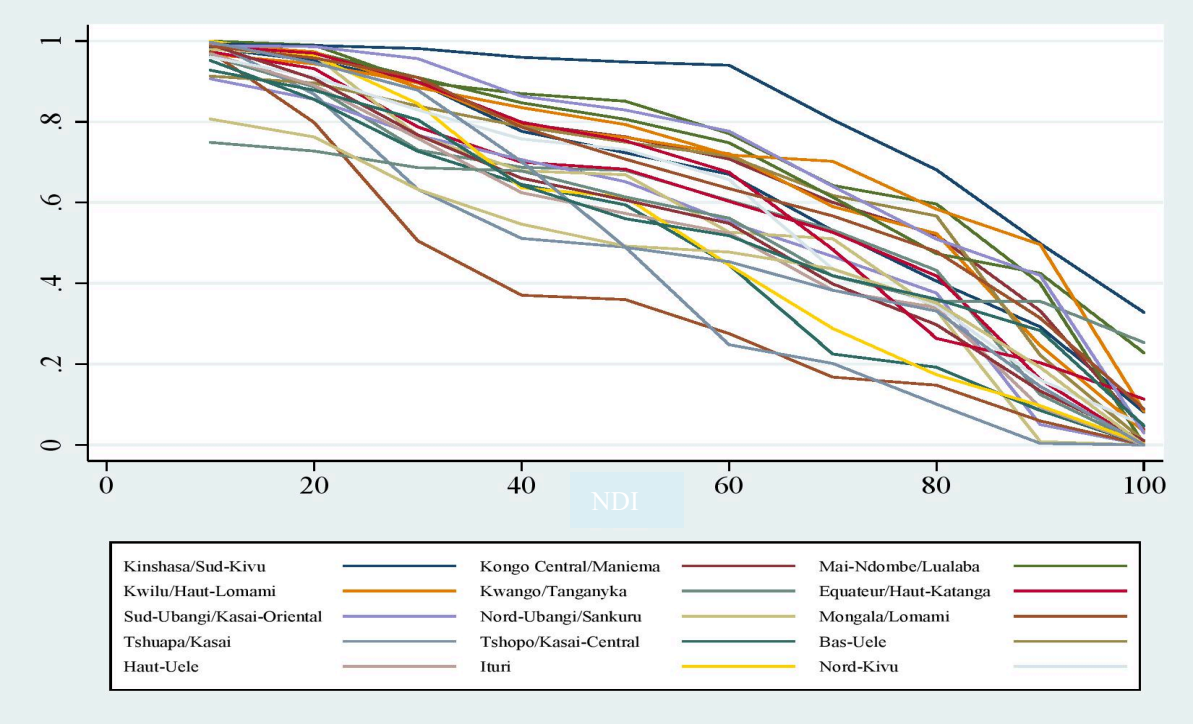
South Kivu dominates the performance of all regions of urban DRC in both 2005 and 2012, whereas Sankuru and Mongala are the best-performing regions in urban DRC in 2005 and 2012, respectively (Figures 3(a) and 3(b)).

Figure 3(a): Dominance analysis, urban 2005



Source: Authors calculations based on HCES DR Congo.
Note: NDI = nutritional deficiency index.

Figure 3(b): Dominance analysis, urban 2012



Source: Authors calculations based on HCES DR Congo.
Note: NDI = nutritional deficiency index.

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 both educational outcomes and food security (Ahmed and del Ninno 2002). This finding is substantiated by the fact that 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 stability of supply is severely jeopardized in the DRC due to the onslaught of humanitarian crises.

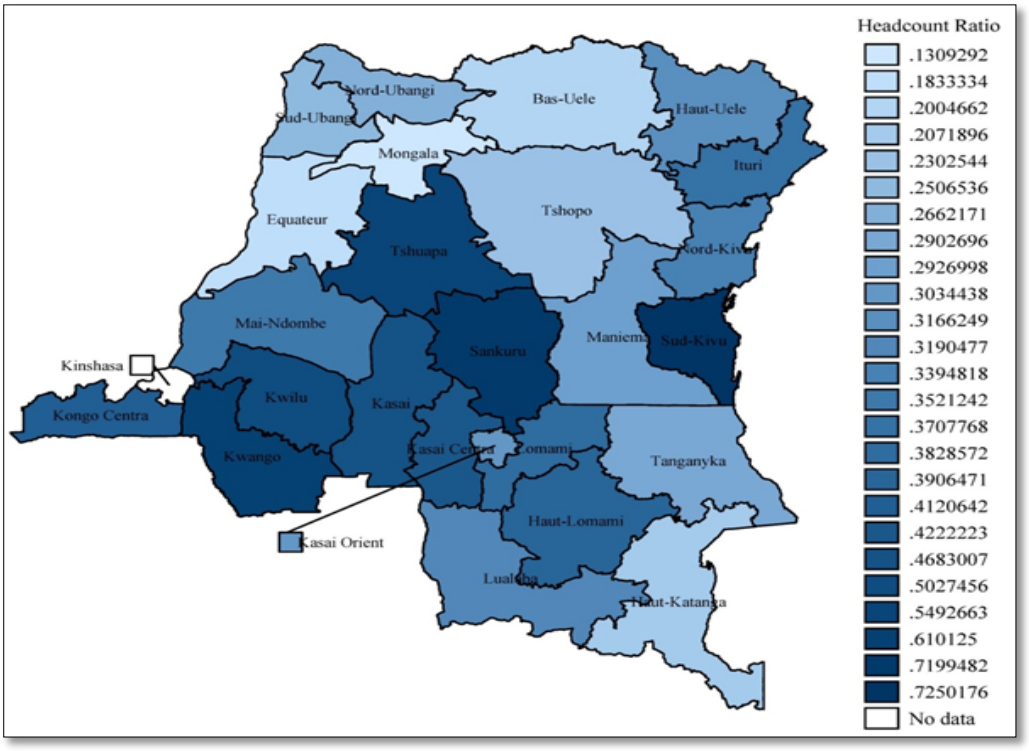
Our findings on the status of nutrition deprivation in each region are also in line with a World Bank study on the scaling up of different nutrition interventions in the DRC (Shekar et al. 2015). Some of the key cost-effective interventions are vitamin A supplementation, deworming, behavior change communication, 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. We observe a similarity between the nutritionally deprived regions according to our analysis and the high proportion of the population devoid of the benefits of the particular nutrition program. 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 in receiving the benefits of the above-mentioned interventions.

g. Spatial Mapping

A visual representation of nutritional deficiency is provided by the spatial maps in Figures 4(a), 4(b), 5(a), and 5(b). As corroborated by the index values, the pockets of high nutrition

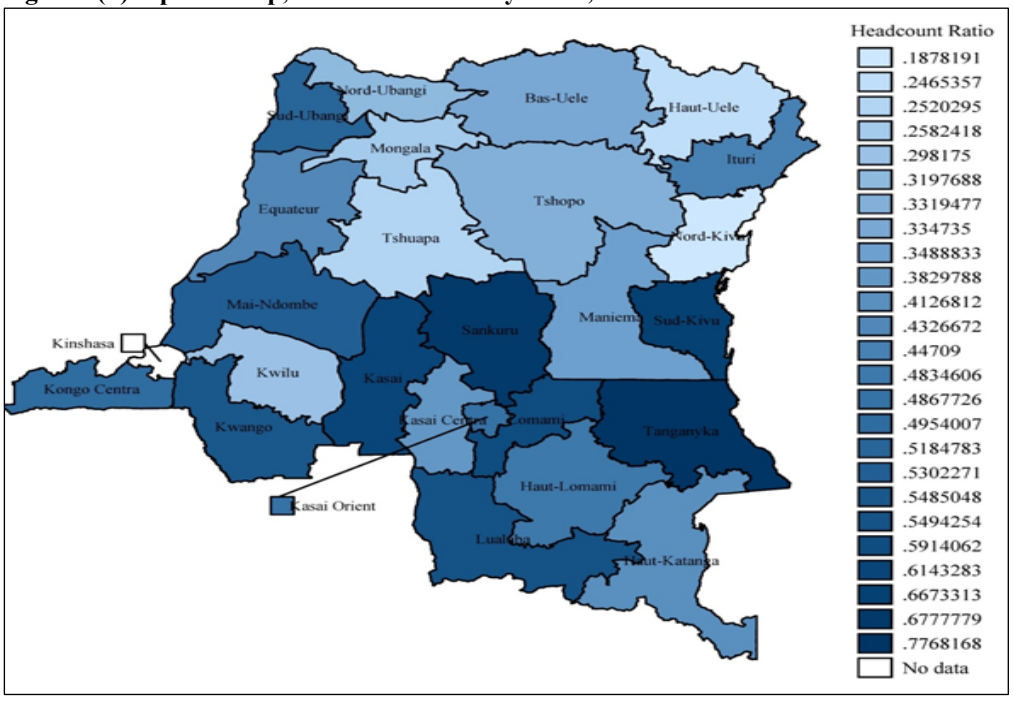
deprivation are the regions of central and southwestern DRC, both rural and urban, in both 2005 and 2012.

Figure 4(a): Spatial map, nutrition deficiency index, rural 2005



Source: Authors calculations based on HCES DR Congo.

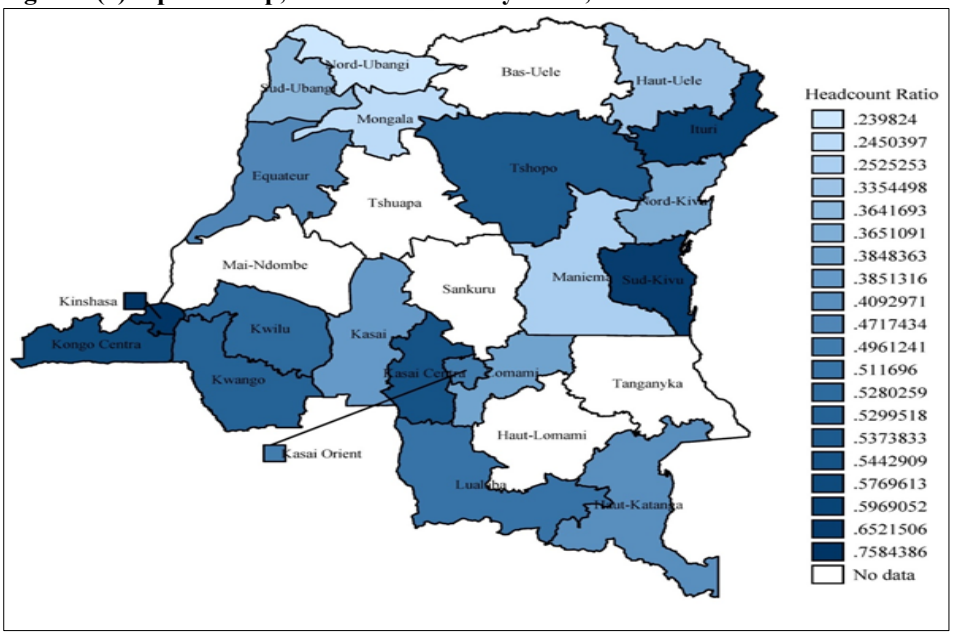
Figure 4(b): Spatial map, nutrition deficiency index, rural 2012



Source: Authors calculations based on HCES DR Congo.

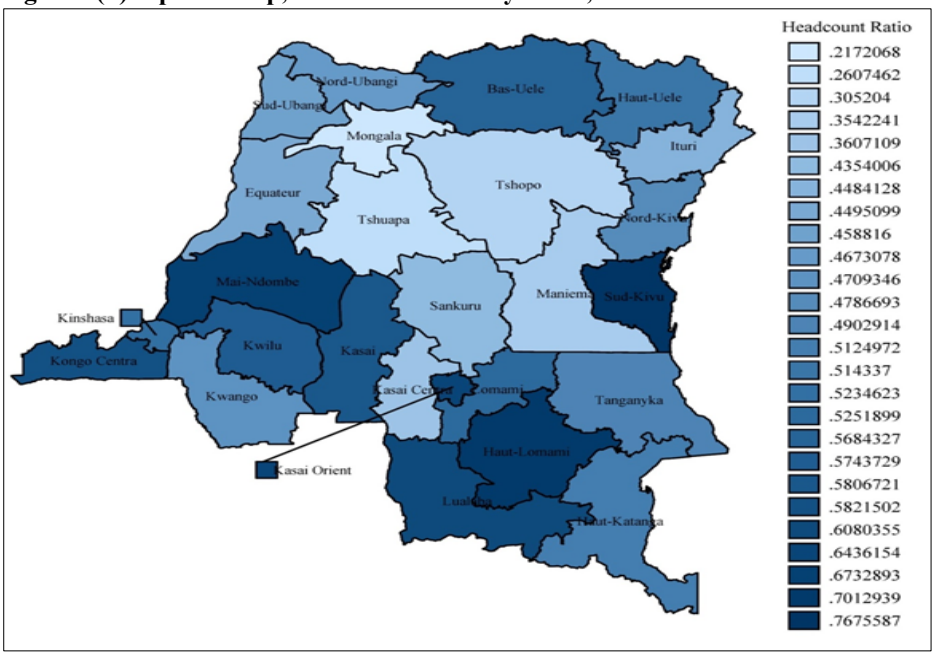
Regions located in northern DRC perform the best. Values on the multidimensional NDI vary from 0.13 to 0.73. For rural DRC, the extent of deprivation worsens in Tanganyika and Lualaba, and improves in Kasai Central and Kwilu, from 2005 to 2012. In fact, southern DRC performs worse on nutrition than on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

Figure 5(a): Spatial map, nutrition deficiency index, urban 2005



Source: Authors calculations based on HCES DR Congo.

Figure 5(b): Spatial map, nutrition deficiency index, urban 2012



Source: Authors calculations based on HCES DR Congo.

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 time 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 the regions of 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.

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 so that people consume a more diverse diet. In 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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