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The Cost of Nutritious Food in South Asia

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Abstract

The high cost of nutritious foods can worsen poor diets and nutrition outcomes especially among low-income households. Yet little is known about the spatial and temporal patterns of the cost of nutritious diets in South Asia, where malnutrition in multiple forms remains high. Using existing food price data from Sri Lanka, Pakistan, Afghanistan, and India, two methods are applied to assess the affordability of nutritious foods: Cost of a Recommended Diet (CoRD) and Nutritious Food Price Index (NPI). The analysis finds that the cost of a nutritious diet is 38 percent higher in Sri Lanka using CoRD compared to the cost of a (calorie-based) diet that meets basic food needs, and 15 percent higher in Afghanistan. In addition, CoRD varies across cities due to variability in the price of dairy and vegetables. Comparison of the NPI and the food Consumer Price Index (CPI) indicates that, for some countries, the price of a nutritious food basket varies more by season and has been increasing at a faster rate than the price of a typical food basket. This phenomenon is largely due to the variable cost of vegetables.

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1 Introduction

Around the world, the cost of nutritious foods, such as fruits, vegetables, and animal-source foods, is typically higher than the cost of less nutritious foods, such as oil and sugar. In some parts of the world, this gap in price has been increasing over time. Moreover, the cost of nutritious foods is more variable across geographic locations. Many nutritious foods are highly perishable and less tradable. As such, their prices are largely determined by local productivity and value chain efficiency (Headey 2017; Monsivais, Mclain, and Drewnowski 2010).

The relatively high cost of nutritious foods can affect nutrition outcomes. While price elasticities differ across countries and foods, higher relative prices can generally result in reduced consumption of nutritious foods (Miller, Yusaf, and Chow 2016; Andreyeva, Long, and Brownell 2010; Green et al. 2013). The cost of nutritious diets has also been linked to the quality of overall diets and to nutrition outcomes, such as stunting and obesity (Beydoun, Powell, Chen, and Wang 2011; Grossman, Tekin, and Wada 2013; Headey 2017). Importantly, the poor are more likely affected by the higher cost of nutritious foods. They are more sensitive to prices, and as such are likely to choose cheaper, energy-dense diets (Miller, Yusaf, and Chow 2016; Green et al. 2013; Darmon and Drewnowski 2015). While the cost of healthy and unhealthy foods is not the only factor determining diets and nutrition outcomes, it is an important one and likely more binding for the poor than the non-poor.

Our study focuses on understanding the cost of nutritious diets in South Asia, a region highly affected by malnutrition in all its forms.[1] The region has among the highest burdens of child undernutrition in the world, with 36 percent stunted and 16 percent wasted (UNICEF, WHO, and World Bank 2017).[2] Stunting rates are not only high, but they are also highest among the poor. While there are multiple causes of malnutrition, the coexistence of undernutrition, micronutrient deficiencies, and markers of diet-related disease signal that poor diets are widespread.[3] It is likely that cost plays a significant role in access to nutritious diets.

We adapt policy-coherent and easily tractable methods to measure the trends and spatial variation in the cost of nutritious diets. Developed as part of the Indicators of Affordability of Nutritious Diets in Africa (IANDA) project, the adapted methods use existing price-monitoring and nutrition data from government statistical agencies. The first method, calculating the Cost of a Recommended Diet (CoRD), estimates the cost of meeting food-based dietary guidelines (FBDGs) using food prices and national FBDGs.[4] The second measure, the Nutritious Food Price Index (NPI), tracks changes in the price of nutritious foods by reweighting the standard food Consumer

[1] Looking at micronutrient deficiencies in South Asia, 42 percent of children under age five are vitamin A deficient and 49 percent of women are anemic; the figures are greater in India and Pakistan. Looking at overconsumption and diet-related non-communicable disease, 24 percent of women are overweight, more than 25 percent of adults have raised blood pressure, and the region has one of the highest rates of raised blood glucose (9–10 percent) (Development Initatives 2017).

[2] Stunting is a measure of low height for age, an indicator of chronic undernutrition; wasting is a measure of low weight for height, an indicator of acute malnutrition.

[3] In South Asia, 13 percent of people experience severe food insecurity (FAO, 2017). Many more lack access to adequate diets. Only 23 percent of young children aged 6–23 months receive minimum dietary diversity (at least four of seven food groups), with 15 percent in Bhutan, 22 percent in India and Pakistan, 28 percent in Bangladesh and, 37 percent in Nepal (Development Initatives 2017).

[4] Food-based dietary guidelines are based on expert opinion and policy dialogue in country.

Price Index (CPI) using weights that reflect the nutrition value of food items, as opposed to ones that reflect spending on food items.

First, when considering a nutritious diet, we find that the cost of food might be more prohibitive than other calculations suggest. CoRD per individual per day totaled SL Rs 187 in Sri Lanka ($2.05 in 2011 $PPP), Prs 87 in Pakistan ($1.43 in 2011 $PPP), and Af 45 in Afghanistan.[5,6] Compared to the (calorie-based) food component of the poverty line, a CoRD-calculated diet cost 38 percent more in Sri Lanka and 15 percent more in Afghanistan. Using an alternative lower estimate of CoRD, we infer that 49 percent of individuals in Sri Lanka and 58 percent of individuals in Pakistan spend less on food than CoRD requires, suggesting that many might be unable to afford a recommended diet. Second, we find that variability in CoRD across cities (or districts) in a given country is driven more by variability in the price of vegetables and dairy than by variability in the price of other food groups. Local vegetable and dairy prices are more likely subject to local productivity trends as such products are perishable and difficult to transport. Third, a comparison of the NPI and the food CPI indicates that the price of a nutritious food basket is much more seasonal than the price of a typical food basket in India, Pakistan, and Afghanistan, but not in Sri Lanka. Fourth, in India and Pakistan, the price of a nutritious food basket has been increasing over the years in comparison with the price of a typical food basket. This sensitivity to seasonal factors and faster rising costs is largely due to fluctuations in the price of vegetables.

Nutritious diets must be affordable for the average citizen if policymakers are to effectively tackle malnutrition in South Asia. However, policy options are constrained by a lack of knowledge about where and when the cost of nutritious diets is high, where it is increasing, and which food groups are particularly unaffordable. We emphasize that largely due to the price of nutrient-rich, perishable foods, the cost of a recommended diet can be prohibitive and the cost of a nutritious food basket is rising faster than a typical basket in certain countries. At the same time, we offer accessible methods for policymakers to track price trends for nutritious foods by harnessing existing food cost data, and thereby make more informed policy decisions.

The remainder of this paper is organized as follows. In Section 2, we compare our methods to other measures to estimate the cost of nutritious food. We detail our methods in Section 3 and present results in Section 4. In Section 5, we present alternative calculations of CoRD using data from household surveys. We conclude in Section 6.

2 Other measures of the cost of nutritious diets

This paper contributes to and complements emerging work on the cost of nutritious diets. The aggregation of food price data into the food CPI can be a misleading indicator of the cost of nutritious diets, because expenditures are not necessarily related to nutrition needs. Therefore, a relatively crude but important first step has been to *disaggregate* the underlying price data for the CPI by looking at the prices of various food items separately. For example, using internationally comparable prices across 177 countries from the International Comparison Program (ICP),[7]

[5] Purchasing power parity (PPP) conversion factor is unavailable for Afghanistan. The data for Sri Lanka are from December 2017, for Pakistan from June 2017, and for Afghanistan from September 2017. Due to the different months being used, caution is advised in comparing calculations across countries.

[6] All dollar figures are in US dollars unless otherwise stated.

[7] http://www.worldbank.org/en/programs/icp.

calorie-price ratios show that the prices for healthy food categories are higher than those for unhealthy food categories (Headey 2017).[8]

Our methods, as well as other measures, consider *reaggregating* food price data to account for nutrition. One method reaggregates data to show an index of the cost of minimum dietary diversity, following the minimum dietary diversity score for women (MDD-W) (Masters et al. 2018). Several others calculate the cost of achieving nutrient adequacy (Deptford, Allieri, Childs, and Damu 2017; Cofer, Grossman, and Clark 1962; Masters et al. 2018). A prominent methodology among the latter is the Cost of the Diet (CoD), developed by Save the Children UK. CoD is a linear programming tool which uses available food price data, and models the cost of a theoretical, simulated diet (food basket) that satisfies nutrient requirements of a household at the minimal cost, based on the availability, price, nutrient content, and acceptability of local foods (Deptford, Allieri, Childs, and Damu 2017).[9] CoD has been calculated in various countries in South Asia. CoD tends to be higher than the cost of an energy only diet; it is also higher in certain seasons and varies across geographic location.[10]

Our calculations of CoRD and NPI build on the methodologies described above, with a few important differences. While Cost of the Diet bases its calculations on meeting essential vitamins and minerals, CoRD reaggregates food price information based on food-based dietary guidelines. Such guidelines are a representation of diets that include but also go beyond basic nutrients to encompass foods that aim at overall protection of health. The use of food-based dietary guidelines can improve policy coherence, by showing whether government recommendations for dietary intake based on expert opinion and in-country dialogue are affordable for consumers. In addition, our methods tap existing data and use simpler calculations, in contrast to the more stringent data requirements and linear programming method of the CoD approach. Countries may calculate CoRD and NPI from existing food price monitoring data, and track these easily with little added cost or expertise.

Few other studies have attempted to calculate the cost of dietary recommendations. One study that had calculated the cost of meeting dietary recommendations in the United States incorporated the cost of labor in food preparation, based on evidence that time constraints are an important factor in food choice (Mulik and Haynes-Maslow 2017). Accounting for the cost of labor in food preparation becomes important as the availability of fast foods and convenience foods, which tend

[8]Also, other work has found that across 15 countries in Asia and the Pacific, the price of food has increased faster than the overall CPI, and specifically the price of fruits and vegetables has increased faster than the rest of the overall food category (Dawe and Lee 2017).

[9] It was initially designed to improve behavior change communication efforts around diet quality, and has since been used for advocacy around the need for improved affordability of nutritious diets, for example in Fill the Nutrient Gap (FNG) analyses done by the World Food Programme (WFP 2017).

[10] In one district in Bangladesh, meeting nutrient needs was found to cost approximately $0.91; approximately 40–62 percent of households were found to be unable to afford a CoD-based diet, and the cost was higher in the lean season of the year (Chastre, Duffield, Kindness, LeJeune, and Taylor 2007). In Pakistan, 68 percent of households were unable to afford the minimum cost of a nutritious diet based on their current food expenditure, whereas only five percent of households were unable to afford the energy-only calorie poverty line diet. Non-affordability was highest in rural areas, while affordability was higher in Islamabad, despite the higher cost of food there (Pakistan, Ministry of Planning, Development & Reform, and WFP 2016). In Sri Lanka, the proportion of individuals who are unable to afford a nutritious diet is higher than those who are unable largely varies across provinces (WFP, MED and HARTI 2014). In Nepal, the cost of a CoD-based nutritious food basket also differs across agroecological zones (Biehl et al. 2016).

to be ultra-processed and displace healthy foods, rises in low- and middle-income countries (Monteiro et al. 2017).

3 Data and methodology

3.1 Data on food prices

For each country, from the National Statistics Office (NSO), we collect the list of food and nonalcoholic beverage items for which data are collected for the Consumer Price Index, along with expenditure weights for each item. At the national level and for a subnational level for which data are available, we collect prices per specified unit of each item for each month over time, preferably since the start of the current reference or base period for the CPI.[11] We have obtained CPI data in sufficient depth for four countries in South Asia: Afghanistan, India, Pakistan, Sri Lanka. We calculate the Nutritious Food Price Index for all four, but the Cost of a Recommended Diet in only three; we cannot calculate CoRD for India because we were not able to obtain raw prices for that country.

3.2 Cost of the Recommended Diet (CoRD)

Food-Based Dietary Guidelines (FBDGs)

We reviewed food-based dietary guidelines (FBDGs) for the eight countries in the South Asia Region: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. This was done to obtain quantitative dietary guidance and enable calculation of CoRD. The CoRD indicator was developed as part of the Indicators of Affordability of Nutritious Diets in Africa project, funded by an Innovative Methods and Metrics for Agriculture and Nutrition Actions (IMMANA) grant from UKAid, in 2017.

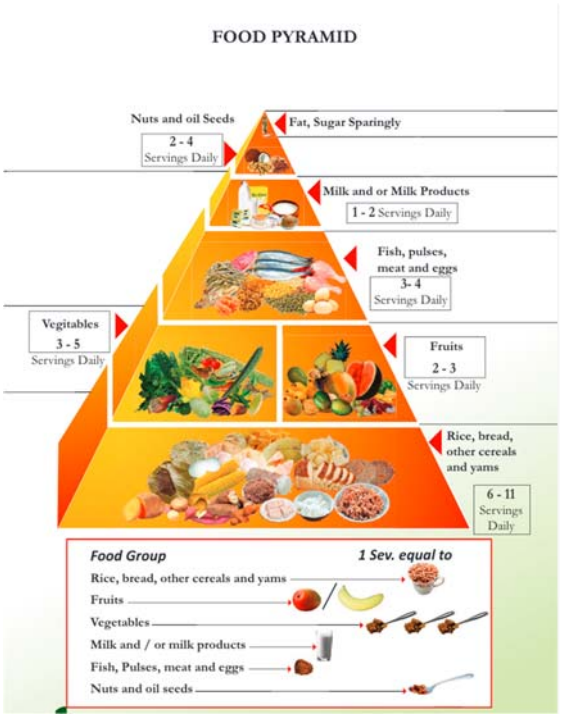
Five countries have their own guidelines or some version of guidelines. Nepal has key messages on what constitutes a nutritious diet but no pictorial food guide. Afghanistan has key messages and a food guide, but no quantitative amounts or guidelines document yet available. Bangladesh, India, and Sri Lanka have quantitative guidelines. Figure 1 shows an example of quantitative guidelines from Sri Lanka.

The five countries' dietary guidelines were sourced from a repository of food-based dietary guidelines maintained by the Food and Agriculture Organization of the United Nations (FAO).[12] We analyzed these guidelines in two steps: first, an analysis of the key messages, and second, an analysis of the food guide and the full guidelines document if available.

[11] Consumer Price Index data for India were retrieved from the Ministry of Statistics and Programme Implementation (http://www.mospi.gov.in/). Data for Pakistan came from the Pakistan Bureau of Statistics; those for Afghanistan from the Central Statistics Organization, National Accounts Department, Price Statistics unit; and those for Sri Lanka from the Department of Census and Statistics, Prices and Wages Division.

[12] Available at: http://www.fao.org/nutrition/education/food-dietary-guidelines/home/en/.

Figure 1: Sri Lanka Food Guide



Source: Food Based Dietary Guidelines for Sri Lankans 2011.

Among these countries, the guidelines share some similarities in how they categorize foods. All countries include starchy staples, vegetables, fruits, pulses, dairy foods, other animal-source foods (fish, meat, eggs), and fats and oils within their groupings. In addition, three countries include sugar and sweets as a food group to limit. Nuts and seeds are grouped together with pulses in the dietary guidelines of Afghanistan, while they are grouped together with fats and oils in the guidelines of India and Sri Lanka, and not mentioned in those of Bangladesh or Nepal. Excluding the sweets category, most countries have six food groups: starchy staples, vegetables, fruits, "protein foods" (pulses, fish, meat, eggs), dairy, and fats and oils.[13]

Three countries – Bhutan, Maldives, and Pakistan – currently do not have their own FBDGs. To allow for cross-country comparison and to calculate the cost of a recommended diet for these countries, we developed a set of regional food-based dietary guidelines based on similarities among and averages of the national dietary guidelines of the other five countries. CoRD can then be calculated for each country in South Asia using the regional food-based dietary guidelines. To calculate CoRD, it is necessary to assign recommended quantitative amounts to each food group. For this step, we rely on the FBDGs from Bangladesh, India, and Sri Lanka, which are the only three in the region with quantitative guidelines. Table 1 shows the regional dietary guidelines generated from these countries' national dietary guidelines.

[13] Afghanistan has six, splitting the protein foods into two categories: "pulses" and "meat/fish/eggs"; Nepal has four, lumping "vegetables and fruit" into one category; and India has three, lumping into categories "vegetables and fruit," "cereals and pulses," and "dairy and animal foods."

Table 1: National Food-Based Dietary Guidelines by Food Group, and Decisions for Regional Food-Based Dietary Guidelines

Food Group	Bangladesh		India		Sri Lanka		Average		Decision for Regional FBDG
	Min	**Max**	**Min**	**Max**	**Min**	**Max**	**Min**	**Max**	
Starchy staples	270g (dry)	450g (dry)	270g (dry)	600g (dry)	300g (dry)	550g (dry)	280g	533g	Use India's guideline amounts (widest range); require 2 unique starches *Serving size = 30g* *Min servings = 9* *Max servings = 20*
Vegetables	300g (at least 100g DGLV	600g	300g (at least 100g DGLV)	300g (at least 100g DGLV)	3 cups (raw) = 90–390g	5 cups (raw) = 150–650g	300g	433g	Use Bangladesh's guideline amounts (widest range); require 3 unique vegetables, including one DGLV *Serving size = 100g* *Min servings = 3* *Max servings = 6*
Fruits	100g (one citrus, one vit A-rich)	300g (one citrus, one vit A-rich)	100g	100g	1 whole (120g)	2 whole (240g)	107g	213g	Use rounded average, 100–200g; require 2 unique fruits *Serving size = 100g* *Min = 1* *Max = 2*
Pulses/Fish/ Meat/Eggs	1/3–1/2 c (60–100g) pulses + 1 piece fish or meat (50g?)	½ c pulses (100g) + 4 piece fish or meat (200g?)	60g pulses DG says aim for 100–200g/ week fish, but no flesh food required (50g/serving)	120g pulses DG says don't exceed 3 eggs/week	3 servings fish, pulses, meat or eggs (90g total)	4 servings fish, pulses, meat or eggs (120g total)	70g pulses or 50–90g ASF	107g pulses or 120–200g ASF	Use Sri Lanka's guideline amounts (clearest and most comprehensive across protein sources). Require 2 unique protein sources and do not require meat. *Serving size = 30g for pulses, 50g for meat/fish/egg* *Min = 3* *Max = 4*
Dairy	100–150ml	200ml	300ml	300ml	200ml	400ml	200ml (or 60g milk powder)	300ml (or 90g milk powder)	Use mean, 200–300ml; require 1 dairy source (e.g., powdered milk, fresh milk, or yogurt) *Serving size = 100ml (or 30g milk powder)* *Min = 2* *Max = 3*
Fats and Oils	30g	60g	20g	40g	2 servings nuts or oilseeds (30g total)	4 servings nuts or oilseeds (60g total)	30g	60g	Use mode, 30–60g *Serving size = 15g* *Min = 2* *Max = 4*

Source: Compiled by authors from *Dietary Guidelines for Bangladesh* 2013; *Dietary Guidelines for Indians – A Manual* 2011; *Food Based Dietary Guidelines for Sri Lankans* 2011.
Note: Bangladesh and Sri Lanka use the same image for their food pyramids, although recommended servings differ slightly.

Cost of a Recommended Diet (CoRD) calculation

The Cost of a Recommended Diet, or CoRD, is a method to add up the prices of the recommended amounts for each food group. CoRD estimates the lowest daily cost of achieving the recommended diet for an individual. First, each food in the CPI list, typically organized by COICOP categories (an international system of Classification of Individual Consumption Purpose), is categorized according to the food groups established under the FBDGs (see Table 2). Second, duplicate foods are eliminated; for example, it is not uncommon for a country to measure several different kinds of the same staple, for example rice (local), rice (imported), rice (local inferior). Only the lowest-cost duplicate item is kept. Third, all item prices are converted into price per edible serving, which is calculated by multiplying the price of a food item by the following:

$$price\ conversion\ factor = \frac{grams\ per\ serving}{unit\ of\ food\ item} / edible\ portion$$

where grams per serving is based on the regional FBDG (see Table 1 above) and unit of food item is given in the CPI data from the NSO.

Table 2: Guide for Grouping Food and Beverage Items into FBDG Categories

FBDG categories	COICOP categories included
Starchy staples	01.1.1 - Bread and cereals
	01.1.7 – Vegetables: Only starchy root crops such as potatoes, sweet potatoes, yam
Vegetables	01.1.7 – Vegetables: All vegetables except pulses and starchy roots
Fruits	01.1.6 – Fruit: All fruit except nuts and seeds
Protein foods (Pulses/Fish/Meat/Eggs)	01.1.7 – Vegetables*:* Only pulses
	01.1.2 – Meat
	01.1.3 - Fish and seafood
	01.1.4 - Milk, cheese and eggs*:* Eggs only
Dairy	01.1.4 - Milk, cheese and eggs*:* Milk and cheese only
Oils	01.1.5 - Oils and fats *(*excluding margarines/vanaspati*)*
None	01.1.8 - Sugar, jam, honey, chocolate, and confectionery 01.1.9 - Food products n.e.c. (not elsewhere classified) 01.2.1 - Coffee, tea, and cocoa 01.2.2 - Mineral waters, soft drinks, fruit, and vegetable juices

Note: Occasionally an item is misclassified in a country's CPI lists (for example, baby formula or ice cream is classified as dairy); the detailed rules for COICOP classifications are used for categorizing foods into FBDG categories.

Fourth, for each food group we take the average of the two items with the lowest price per serving. We choose more than one low-cost item, because FBDGs are based on the concept of diversity among and within food groups. For the vegetables group, the three cheapest items are selected,

one of which must be a dark green leafy vegetable (DGLV), as specified in the regional FBDGs.[14] Fifth, the average price per serving for each food group is multiplied by the average of the lower- and upper-bound serving recommendations for that food group, generating the cost for each food group.[15] Finally, to calculate CoRD, the cost for each food group is added up.

3.3 Nutritious Food Price Index (NPI)

The basic concept of the NPI is to reweight the CPI food items using weights which reflect the nutritional quality of food items (using nutritional quality scores), as opposed to expenditure weights.

Nutritional quality scores

Various nutritional quality scores can be used as the basis for nutritional quality weights. We use NuVal scores, which are scores from 1–100 based on an algorithm (Overall Nutritional Quality Index, ONQI) that puts components of food that are positive for health (nutrients, fiber, and phytochemicals) in the numerator and components that are negative for health (salt, sugar, trans fats, saturated fats, and cholesterol) in the denominator (Katz, Nijke, and Faridi 2009). In addition, the result is adjusted by macronutrient factors (such as fat quality, protein quality, and glycemic load) and a dietary "trajectory score." The trajectory score is based on whether consuming the food item is a significant step toward meeting healthy diet patterns, calculated using density of nutrients and other positive food components in the food item. The scores were validated by comparing their rankings to independent subjective rankings by a panel of nutrition experts. Criticism of NuVal scores include that the algorithm is not publicly available, and that the method of dividing positive dietary components by negative ones causes large changes in scores if there are few components in a food, and small changes if there are many components.[16]

NPI calculation

The length of food CPI lists varies across countries, and within each country the length of food lists for each COICOP group also varies. For example, the number of food items in the vegetables grouping might be lower than the number of food items in the cereals grouping. Our calculation method avoids a systematic link between the NPI and the number of food items in a COICOP grouping. Instead of calculating the NPI based on the nutritional value score for each food item, we average the NPI scores within a COICOP group and create an index based on the averaged nutritional score of the COICOP groups.

[14] Other research calculating the cost of meeting dietary guidelines has used average prices of all items in the food group category (Mulik and Haynes-Maslow 2017). We chose the lowest-cost items to avoid price changes due to the addition or removal of a very expensive item in the dataset; an alternative is to select the median cost items.

[15] The choice to use the average of the minimum and maximum recommendations is not trivial. In our context, the diets generated in calculating CoRD, which averages the minimum and maximum recommendations, make sense. Our CoRD-generated basket meets 85 percent of the estimated average requirement (EAR) for energy for a 30-year-old male (2,731 kcal) in Afghanistan, 99 percent of the requirement for Pakistan, and 101 percent for Sri Lanka. Importantly, it also meets the estimated average requirement (EAR) for a set of essential micronutrients.

[16] NuVal scores for 80 food items were accessed on April 25, 2017. Since that time, the publicly available portal which includes NuVal scores for all foods items has become unavailable. Thus, for items that we did not already have scores for, the score is based on similar items available in our limited database of 80 food items.

First, we create *nutritional value weights* for each COICOP group. We take the average nutritional score across food items for each COICOP group. To generate the group weights, the COICOP group scores are normalized so that they sum to one. Second, we create an *unweighted price index* for each COICOP group. We take the average of the item-wise indexes within a given COICOP group to generate a COICOP group index.[17] Third, for each time point, we calculate the NPI or the *weighted average* price index across COICOP groups, using as weights the nutritional value weight for each group. Note that the NPI reflects the change in food price based on nutritional value, unrelated to actual purchasing behaviors. It is thus a normative measure (based on what is most nutrient-dense) rather than a descriptive one (what people actually consume).[18]

4 Results and discussion

4.1 The varying cost of a recommended diet across geographic location

We calculate the cost of a CoRD-based nutritious diet (daily cost per individual per day) using food price data from Sri Lanka for December 2017, from Pakistan for June 2017, and from Afghanistan for September 2017. For these respective months in 2017, the cost of such a diet was SL Rs 187 ($2.05 in 2011 $PPP) in Sri Lanka, 87 Prs ($1.43 in 2011 $PPP) in Pakistan, and 45 Af in Afghanistan.[19] We caution against comparing these values across countries because the costs were measured during different months. Our CoRD estimates suggest that the cost of food might be more prohibitive than other calculations show. Back-of-the-envelope calculations suggest that the cost of a CoRD-based diet is higher than that for the official (calorie-based) food component of the official poverty line. Specifically, it was higher than the cost of the food component of the poverty line by 38 percent in Sri Lanka and by 15 percent in Afghanistan.[20] We caution, however, that for Sri Lanka, the data is from December 2017 which tends to have a higher price level. In any case, this indicates that policymakers may be underestimating the cost of basic food needs if we instead consider food-based dietary guidelines as a benchmark diet. The CoRD estimate is important because FBDGs constitute official government guidance, suggesting diets that all people should consume, and nutrition education programs are often based on such guidelines.

The lowest-cost foods in each group will vary by season; the foods selected using our specific data provide a snapshot of the composition of the recommended diet. In Sri Lanka, the lowest-cost items (per serving edible portion, December 2017) for starchy staples were white rice and red rice; for protein foods, red lentils (red dal) and soya beans; for dairy, fresh cow milk and condensed

[17] If item-wise indexes are unavailable, but item-wise prices are, then we calculate the indexes by taking the percent difference in the price of the item in a given month-year with the price in the base month-year, and then adding 100.

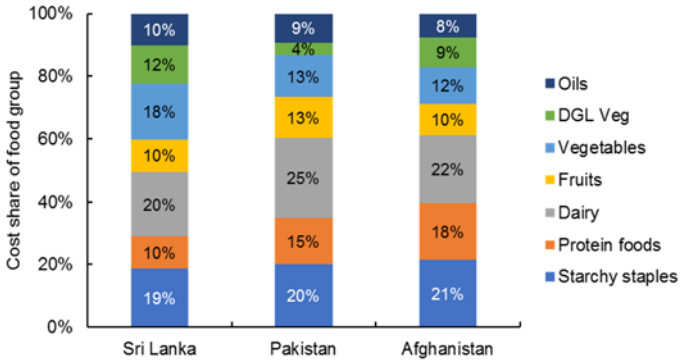
[18] For Afghanistan, the price indexes are only available for COICOP groups and not for each individual food item. Such price indexes already reflect the expenditure weights for each food item within a COICOP group. While we can calculate some version of the NPI using these price indexes, the resulting NPI will not be purely normative as the price indexes implicitly integrate expenditure weights into their calculation. In effect, such an NPI would be a hybrid of the standard CPI and the NPI, combining a normative and descriptive measure, making it less intuitively interpreted.

[19] For Sri Lanka and Pakistan, we use the 2011 PPP$ conversion factor specific for food and nonalcoholic beverages. The PPP$ conversion factor is unavailable for Afghanistan.

[20] In Sri Lanka, the food component of the poverty line (using a nutritional anchor of 2,030 calories) was valued at 128 rupees per person per day in 2016. We inflate this using the Colombo CPI (6.6 percent increase in December 2017) to get 136 rupees per person per day in December 2017. In Afghanistan, the food component of the poverty (using a nutritional anchor of 2,100 calories) was valued at 23 afghanis per person per day in 2007. We inflate this using the national CPI (with base in April 2015, suggesting an increase of 1.7 times between September 2007 to September 2017) to get 39 afghanis per person per day in September 2017. Note, however, that the cost of basic food needs is lower than the calories included in the recommended diet.

milk; for fruits, mangoes (vilad) and papaya; for vegetables, plantain flower and squash (kekiri); for dark green leafy vegetables (DGLV), sweet potato leaves (kankun); and for oils, coconut oil and vegetable oil. In Pakistan, the lowest-cost items (per serving edible portion, June 2017) for starchy staples were wheat and rice; for protein foods, red lentils (masoor) and black gram; for dairy, curd and fresh unboiled milk; for fruits, watermelon (turbooz) and muskmelon (kharbooza); for vegetables, onion and eggplant (brinjal); for dark green leafy vegetables, only spinach is available (in the data); and for oils, cooking oil (pakwan) and mustard oil.[21] In Afghanistan, the lowest-cost items (per serving edible portion, September 2017) for starchy staples were corn and barley; for protein foods, peshawry dried peas and vetches; for dairy, fresh cow milk and imported packaged milk; for fruits, watermelon and melon; for vegetables, radish and turnip; for dark green leafy vegetables, only spinach is available (in the data); and for oils, local butter and imported vegetable oil.

Figure 2: Share of Cost of Each Food Group in CoRD



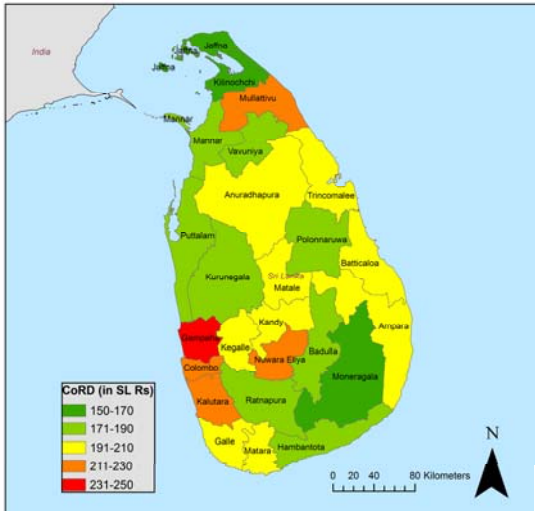
Source: Authors' calculations using food price data from Sri Lanka for December 2017, from Pakistan for June 2017, and from Afghanistan for September 2017.
Note: "DGL Veg" = dark green leafy vegetables.

Figure 2 shows that while starchy staples account for a sizeable share part of CoRD, they do not exceed a fourth of the total cost. Other food groups also play a large role in the share of CoRD. In Sri Lanka, the three groups with the largest shares of CoRD are vegetables including DGLV (39 percent), dairy (25 percent), and starchy staples (23 percent). In Pakistan, these are dairy (21 percent), starchy staples (17 percent), and vegetables including DGLV (14 percent), closely followed by protein food (12 percent). In Afghanistan, these are vegetables including DGLV (15 percent), starchy staples (14 percent), and dairy (14 percent), closely followed by protein foods (12 percent). The oils and fats group takes a low share of CoRD; five percent in Afghanistan, eight percent in Pakistan, and 12 percent in Sri Lanka. Fruits also take a smaller share of CoRD in the seasons measured.[22] Again, we caution against comparing these shares across countries due to the different months we use for each of these countries.

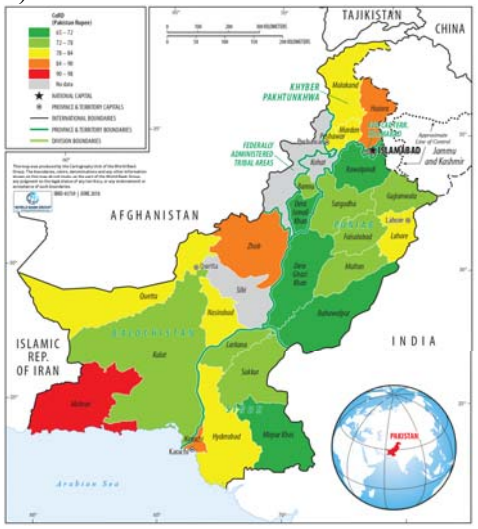
[21] We find that prices for dark green leafy vegetables, a required part of the vegetable recommendations in FBDGs, are seasonally missing in Pakistan. Missing data points suggest that either the food items measured (in this case a single food item, "spinach") may be missing from the market, or that the food group (dark green leafy vegetables more generically) is missing from the market. Further information on national CPI methodology is needed to draw clear conclusions on (a) whether the item is specific to a single food, or reflects any dark green leafy vegetables available in the market, and (b) how missing data points are handled. We expect that in many such cases, national statistics organizations impute the price of missing items. Therefore, CPI data may not be a reliable source of information on availability of certain foods in markets.
[22] Recall however that in the season modeled, melons are the cheapest fruit, and due to their high water content, melons are very low-cost per serving. In other seasons, different fruits may account for a higher cost share of CoRD.

Figure 3: CoRD Across Geographic Location in Sri Lanka, Pakistan, and Afghanistan

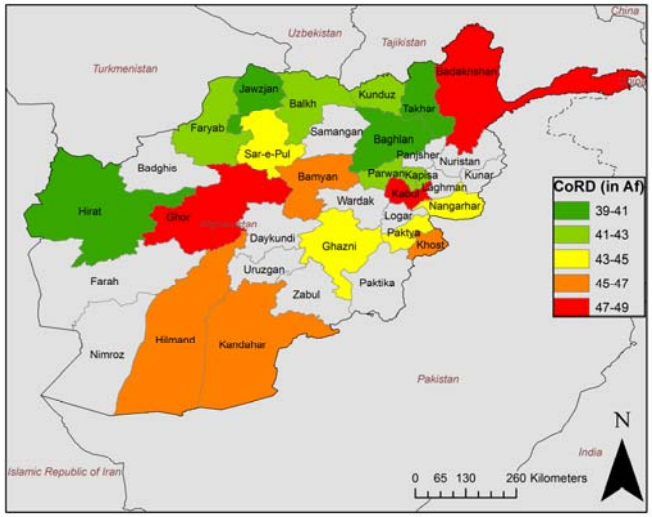
a) Sri Lankan districts



b) Pakistan divisions



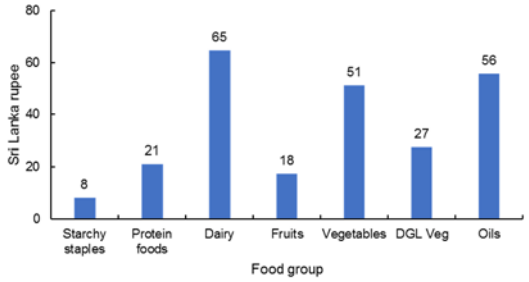
c) Afghanistan provinces



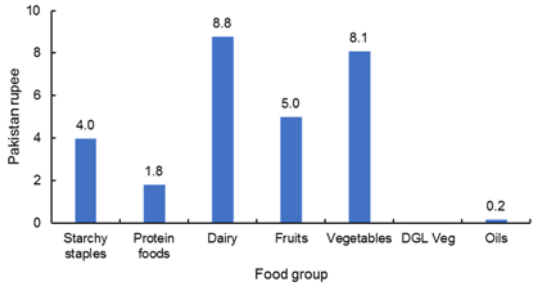
Note: For Sri Lanka, CoRD was calculated for 25 districts using data from December 2017. For Pakistan, CoRD was calculated for 40 cities using data from June 2017, and then each city was mapped to a division. For Afghanistan, CoRD was calculated for 20 cities using data from September 2017, and then each city was mapped to one of the 32 provinces.

Figure 4: Variance Across Geographic Location for Each Food Group Cost in CoRD

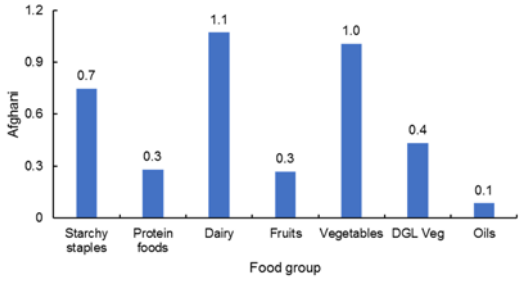
a) Sri Lanka across districts



b) Pakistan across cities



c) Afghanistan across cities



Source: Authors' calculations using food price data from Sri Lanka for December 2017, from Pakistan for June 2017, and from Afghanistan for September 2017.
Note: "DGL Veg" = dark green leafy vegetables.

To gauge how CoRD varies across geographic locations within each country, we calculate CoRD for each of the 25 districts in Sri Lanka, the 40 cities in Pakistan, and the 20 cities in Afghanistan for which data are available. We use nominal food prices to demonstrate that CoRD varies across space in each of the countries (see Figure 3). The differences in CoRD can be considerable. In Sri Lanka, the cost of a recommended diet is SL Rs 150 in Jaffna while it exceeds SL Rs 215 in Kalutara, Colombo, and Gampaha districts. In Pakistan, the cost of a recommended diet is less than Prs 70 in Dera Ismail Khan, Dera Ghazi Khan, and Sahiwal divisions, while it is more than Prs 90 in Rawalpindi, Makran, and Islamabad divisions. In Afghanistan, the cost is lowest in Jowizjan (Af 39) and highest in Kabul (Af 48) and Badakshan (Af 49).

Note that CoRD is a calculation of the *cost* of nutritious diets. This is not exactly a measure of the *affordability* of nutritious diets in each province or division. Such a measure would entail looking at incomes alongside the cost of nutritious diets. Nonetheless, our initial calculations demonstrate that the cost of nutritious diets, based on nominal food prices, varies within a country.

We look a little more closely into which food groups drive the variability in CoRD across different geographic locations. We calculate the variance in cost across cities for each of the food groups that comprise CoRD (see Figure 4). We find that in Sri Lanka the variances in the cost of the recommended intake of dairy, vegetables, and oils are much larger than those in the cost of starchy staples, a variance of over five to six times more. Quite similarly, in Pakistan and Afghanistan variance of the cost for dairy and vegetables are also higher than for other food groups, about double the variance of starchy staples in Pakistan, for example. Combined with the fact that the share of dairy and vegetables to CoRD is large in each of these countries (i.e., over 50 percent of CoRD for Sri Lanka), we deduce that much of the variability in CoRD across districts or cities is driven by differing dairy and vegetable prices. This is consistent with the idea that such highly perishable products are difficult and costly to transport.[23] Across countries, the variance in protein food prices is relatively low. This could be driven by easy tradability of non-animal sources of proteins (i.e., legumes).

Across countries, some differences in relative variances exist. Only Sri Lanka registers a relatively high variance in oils and fat costs across districts; this could be because missing units for some of the fats in the Sri Lanka food list reduced the types of fat the model could select for this analysis, with some of the missing units comprising cheaper sources of fat. In Afghanistan, the variance in the cost of starchy staples across cities is relatively high, indicating that markets for cereals are less integrated.

4.2 The increasing and seasonal cost of nutritious food

To understand how the cost of nutritious foods has changed over time, we calculate the NPI for Sri Lanka, Pakistan, Afghanistan, and India. We use monthly data for Sri Lanka from January 2013 to December 2017, for Pakistan from July 2008 to June 2017, for Afghanistan from March

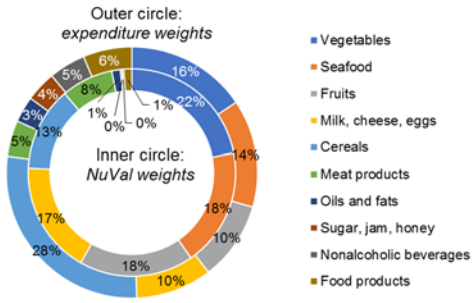
[23] The price of dark green leafy vegetables in Pakistan is unavailable for the city-based calculations. As such, these vegetables are excluded from the city-based CoRD calculations.

2011 to October 2016 (after which the CPI was rebased), and for India from January 2014 to August 2017.[24]

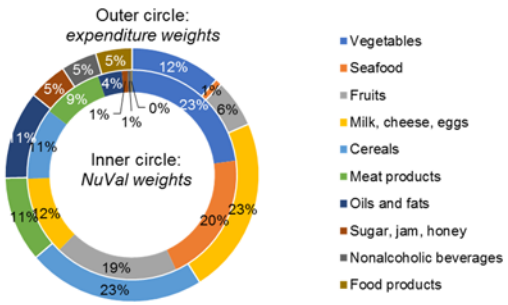
We first compare nutritional weights and expenditure weights. Fruits and vegetables (including legumes), followed by fish, have the highest nutritional weights, while oils and particularly sugars and beverages have very low nutritional weights. In Pakistan (see Figure 5b), the nutritious food basket consists mostly of nutrient-dense foods. Fruits and vegetables account for about two-fifths of the basket, animal-source foods account for another two-fifths, while cereals and oils account for one-fifth. In contrast, in the typical food basket in Pakistan, cereals account for approximately one-quarter of expenditures; oils, sugars, beverages, and other food products account for another one-quarter; and nutrient-dense fruits, vegetables, and animal-source foods account for approximately half. The composition of a nutritious food basket will differ slightly by country (based on which items make up the COICOP group), while the typical food basket will differ markedly by country (see Figure 5).

Figure 5: NuVal and Expenditure Weights

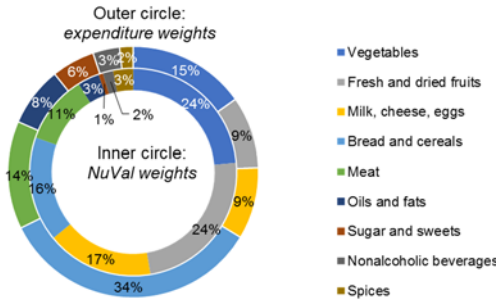
a) Sri Lanka



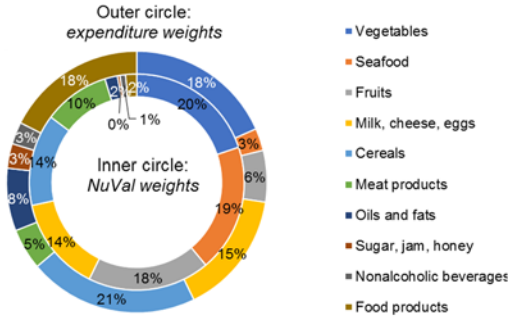
b) Pakistan



c) Afghanistan



d) India



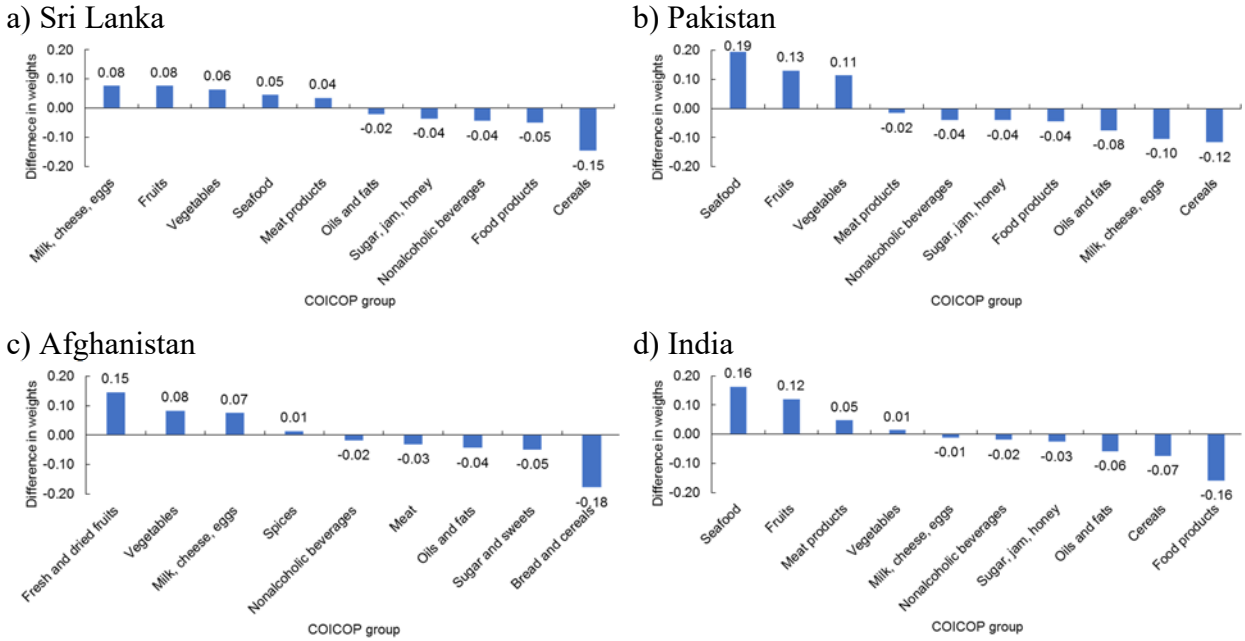
Source: NuVal weights: authors' calculations; expenditure weights: authors' calculations using expenditure weights collected from country NSOs.
Note: Nuval weights reflect the relative nutritious value of a certain food group in a food basket; expenditure weights reflect the relative volume of a certain food group counsumed by people in a food basket.

Figure 6 presents the differences in the nutritional weights and expenditure weights for each country. The data indicate that expenditures on certain food might be lower relative to the nutrient

[24]As mentioned above, for Afghanistan we only have access to the price index at the COICOP level (not at the food item level), which implicitly includes the CPI expenditure weights. As such, the NPI calculation for Afghanistan will be a hybrid between the NPI and CPI. Caution should be exercised in interpreting the Afghanistan results.

density they would provide; this is the case for fruits (in all four countries), for vegetables and legumes (except in India), for fish and seafood (except in Afghanistan, which does not include fish), and for dairy and eggs (in Sri Lanka and Afghanistan, but not in Pakistan and India). On the other hand, expenditures for other categories might be high relative to nutritional value, such as for cereals, oils and fats, and sugary products. This suggests that the food environment has emphasized calories, leading to the overconsumption of breads and cereals in the overall food basket.

Figure 6: Difference in NuVal and Expenditure Weights



Source: NuVal weights: authors' calculations; expenditure weights: authors' calculations using expenditure weights collected from country NSOs.

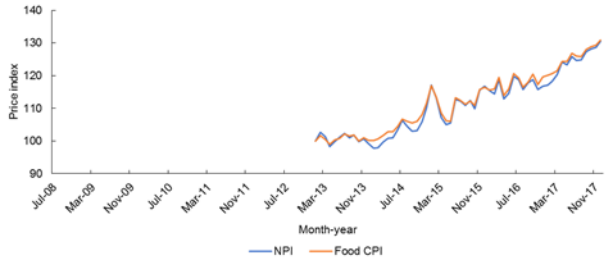
To compare how prices of a typical food basket and of a nutritious food basket change over time, we plot the NPI alongside the food CPI for each of the four countries (see Figure 7).[25] The food CPI displays seasonality and shows an overall increasing trend in food prices. Our calculations indicate that nominal food prices (food CPI) increased by 30 percent between 2013 and 2017 in Sri Lanka, doubled between 2008 and 2017 in Pakistan, increased by 33 percent between 2011 and 2017 in Afghanistan, and increased by 42 percent between 2012 and 2017 in India. In Pakistan and Afghanistan, food prices tend to rise in April, with another smaller price spike in October for Pakistan. In India, food prices generally increase between July and October. The NPI similarly depicts a seasonality and a general increase over time in the price of *nutritious* foods.

More interestingly, the NPI deviates from the food CPI in two important ways. Figure 8 plots the monthly difference between the two indexes. First, for all countries except Sri Lanka, the seasonal spike in prices is higher for the Nutritious Food Price Index than for the food CPI.

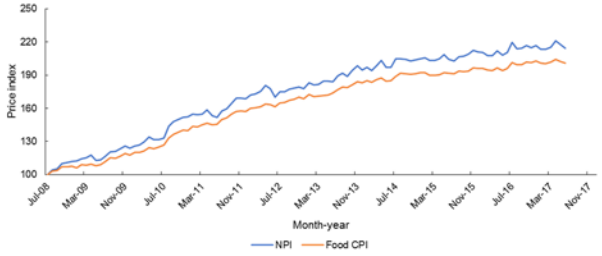
[25] To generate a form of food CPI, we use fixed base period weights. The food CPI measure we use averages the item-wise price indexes within COICOP groups and takes the weighted sum of these COICOP-level indexes. The weights used are the COICOP-level weights, which are the sum of the item-wise expenditure weights. Our calculation of the food CPI allows for comparability with our calculation of the NPI.

Figure 7: Nutritious Food Price Index (NPI) and Food Consumer Price Index (Food CPI)

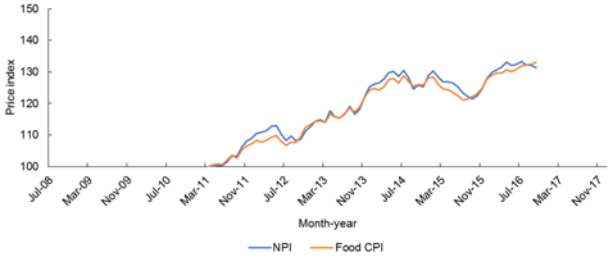
a) Sri Lanka



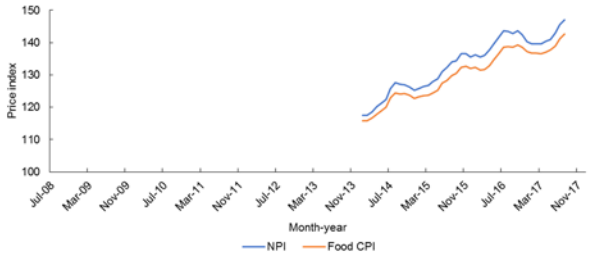
b) Pakistan



c) Afghanistan



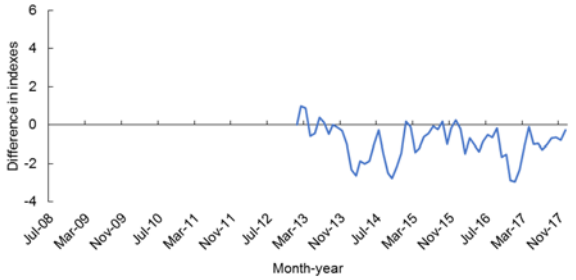
d) India



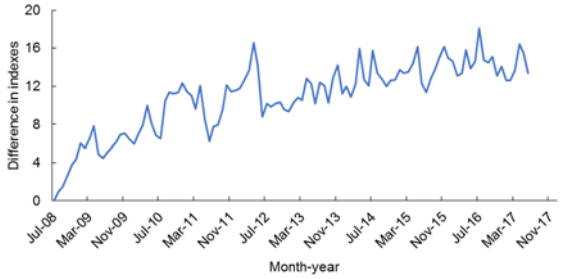
Source: Authors' calculations using CPI data from Sri Lanka, Pakistan, Afghanistan, and India.
Note: For Afghanistan, the NPI is a hybrid of the NPI and CPI. The data available for Afghanistan only included the index at the COICOP level.

Figure 8: Nutritious Food Price Index (NPI) Minus Food Consumer Price Index (Food CPI)

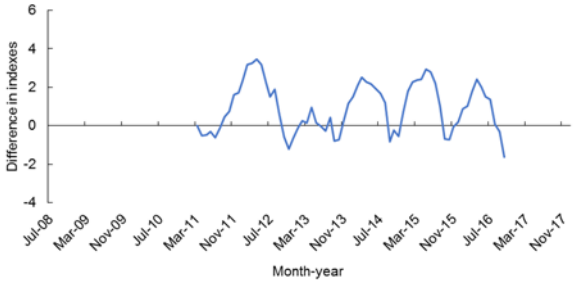
a) Sri Lanka



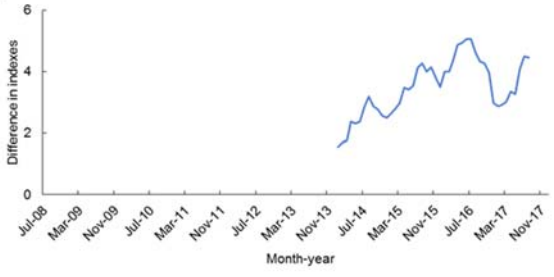
b) Pakistan



c) Afghanistan



d) India



Source: Authors' calculations using CPI data from Sri Lanka, Pakistan, Afghanistan, and India.

Seasonality can thus have a bigger impact on prices for foods that are higher in nutritional value. This could have to do with the perishability of more nutrient-dense foods, which makes them harder to store throughout the year; it may also indicate that efforts to curb food price seasonality need to focus more on nutrient-dense, perishable foods than they currently do. The gap between

the two types of indexes during periods of seasonal price hikes is about 2-4 index points for Pakistan and Afghanistan, and is smaller for India. Second, for Pakistan and to some degree for India, the gap between NPI and the food CPI is increasing across years.

We further look into which specific food groups are driving the seasonality gap and the increasing overall gap between NPI and the food CPI for certain countries (see Appendix Figure A1). For countries where a gap between NPI and the food CPI exists, we find that the trends in vegetable and legume prices are driving the gap.

Interestingly, in Sri Lanka vegetable prices have fallen (in 2013 and 2014) relative to the base year, while prices for dairy and eggs have not been rising at a rapid rate. These trends seem to be muting the difference between NPI and the food CPI in Sri Lanka. In Pakistan, the overall food CPI increase is mostly driven by rising prices for meat products, fruits, vegetables, sugar, and other food products. The seasonality is mostly driven by the price of vegetables and fruits. Unsurprisingly, much of the differences between NPI and the food CPI are due to the price of vegetables (and fruits).

In Afghanistan, as in Pakistan, the price of oils and fat are the most stable and unchanged, but unlike in Pakistan, cereal prices in Afghanistan have gradually increased. Cereals are more heavily weighted in the food CPI than in the NPI, so theoretically, the cereal price increase should lead to a faster increasing food CPI than NPI. However, the increase in other food groups that are more heavily weighted in the NPI (such as fruits) cancels out the overall gap between food CPI and NPI. What we do observe in Afghanistan is a seasonal gap between food CPI and NPI. Thus, vegetables seem to be driving the difference between NPI and the food CPI, since the price of vegetables is seasonal but has not increased over time.[26] In India, prices have increased the fastest for vegetables, fruits, seafood, and meat products, and slowest for beverages, sugar, and oils and fats. Not only have vegetable and pulse prices been increasing the fastest, these prices have also been the most seasonal. Thus, the more subdued gap between NPI and food CPI in India is not so much due to a weak link between vegetable prices and seasonality, but rather due to the smaller difference in the nutritional and expenditure weights for vegetables and pulses in India, relative to those for Pakistan and Afghanistan.

5 Extension to CoRD: Using household survey data in Sri Lanka and Pakistan

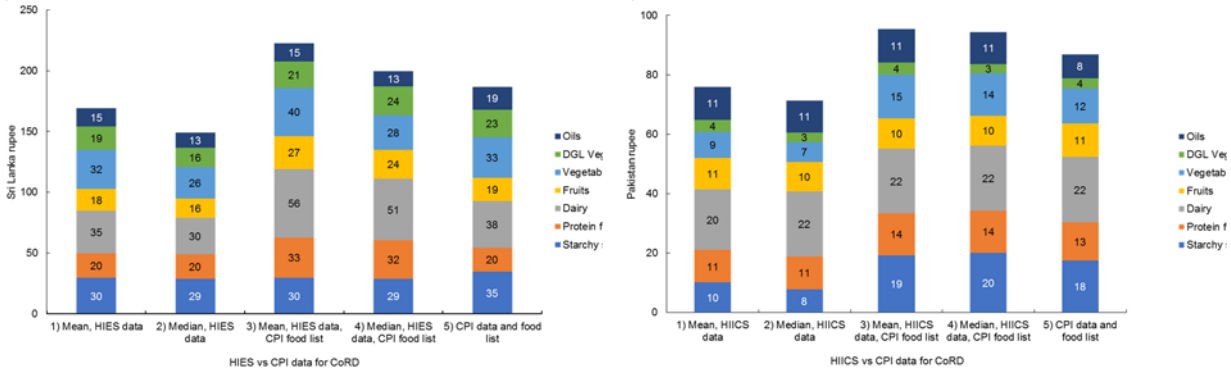
This main proof of concept in this paper is to demonstrate that data from existing price monitoring systems can easily be used to measure and understand the cost of nutritious food across time and geographic locations. In calculating CoRD we had used food prices collected by the NSO in selected markets (cities) to calculate the CPI. The main concern, however, is that these prices might not be a good representation of the actual prices experienced by certain consumers, especially those living in remote rural areas. An alternative to CPI data would be to use food prices from household surveys (deduced from the unit values in a consumption module). Household surveys are less ideal for real time price monitoring as they are administered less frequently (for example, every five years, as opposed to monthly for the CPI). But they are nationally representative as well as representative at some subnational level.

[26] We also caution that the Afghanistan results are not directly comparable to the Pakistan and India results, because, due to data limitations, the Afghanistan NPI is a hybrid between the NPI and the food CPI.

We explore the use of unit values from household surveys in calculating CoRD. We use the Sri Lanka 2016 Household Income and Expenditure Survey (HIES) and the Pakistan 2015–16 Household Integrated Income Consumption Survey (HIICS). For each country, we calculate CoRD using 1) average unit values (across households), 2) median unit values, and 3) average and 4) median unit values but with (3) and (4) restricted to select the same (lowest-cost) food items selected when using the prices from CPI data. Note that the latter two calculations do not necessarily select the same food items as the first and second calculations, because the food lists from the Sri Lanka 2016 HIES and the Pakistan 2015–16 HIICS are very similar to but not exactly the same as the CPI food lists.[27]

Figure 9: CoRD Using Household Survey Unit Values Versus CPI Price Data

a) Sri Lanka HIES 2016 b) Pakistan HIICS 2015–16



Source: Authors' calculations using CPI data from Sri Lanka and Pakistan and household survey data (Sri Lanka HIES 2016 and Pakistan HIICS 2015-16).

Note: 1) CoRD results derived using HIES (for Sri Lanka)/HIICS (for Pakistan) data sources and HIES/HIICS food list with average food prices being used; 2) CoRD results derived using HIES/HIICS data source and HIES/HIICS food list with median food prices being used; 3) CoRD results derived using HIES/HIICS data source but CPI food list with average food prices being used; 4) CoRD results derived using HIES/HIICS data source but using the CPI food list with median food prices being used; 5) CoRD results derived using CPI data. "DGL Veg" = dark green leafy vegetable.

Figure 9 compares CoRD when calculated using household survey data (HIES or HIICS) with the cost using CPI price data. The fifth (last) bar in both graphs is the base CoRD calculation using CPI price data. The same three patterns emerge for both Sri Lanka and Pakistan. First, the CoRD estimated using household survey data is *lower* than when using CPI data (compare the first and second bars to the fifth bar). The household survey data allows for identification and selection of cheaper items from its food list. CoRD using average unit values is lower than the CPI-based CoRD by 10 percent in Sri Lanka and by 12 percent in Pakistan. In Sri Lanka, the lower estimate is driven by slight differences (about 3– 5 rupees) across all food groups, except for protein foods, fruits, and vegetables for which the estimated cost is similar for household survey and CPI data. In Pakistan, the lower estimate is largely driven by a difference in the cost of starchy staples, followed by smaller differences in estimates of the cost of protein foods and dairy between the household survey and CPI data.

[27] In Sri Lanka, the HIES has 136 food items and the CPI data has 145 food items. In Pakistan, the HIICS has 69 items and the CPI data has about 50 items.

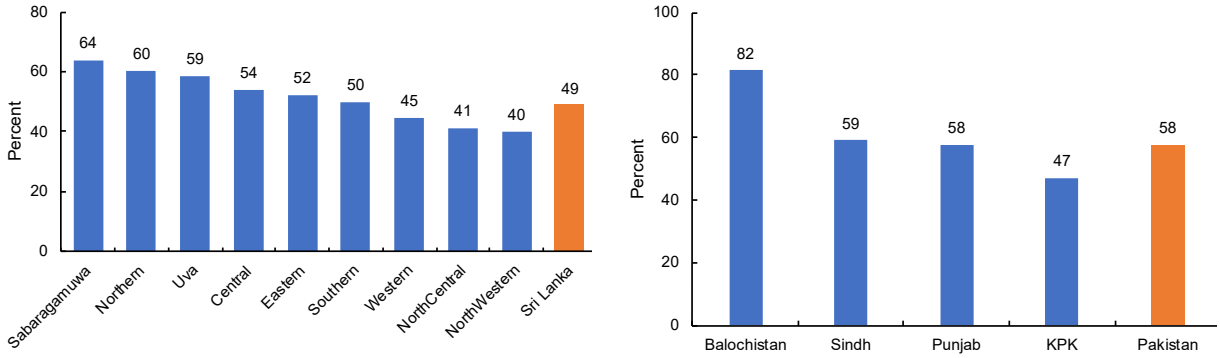
Second, CoRD estimated using the household survey data, but which is restricted to select the same food items that the CPI data select, is *higher* than the CoRD estimated using the CPI data (compare the third and fourth bars to the fifth bar). That is, the food items selected by the CPI price data are more expensive when estimated using household survey unit values. Calculating CoRD using average unit values (with the same CPI-selected items) is higher than the CPI-based CoRD by 19 percent in Sri Lanka and by 10 percent in Pakistan. Third, using median unit values always results in a lower CoRD than using average unit values, as using the median diminishes the influence of outliers (compare the first bar to the second bar, and the third bar to the fourth bar).

One of the key advantages of using household survey data is our ability to get closer to the concept of affordability. Specifically, we can calculate the proportion of individuals whose current food expenses fall below CoRD. We interpret this as the proportion of individuals who potentially cannot afford to pay for the kind of food that comprise a nutritious diet, based on how much they currently spend on food.

Ultimately, we choose to calculate CoRD calculated using median unit values from household survey data. This allows us to use a precise measure (eliminating outliers in unit values) and to be consistent in data sources (comparing food expenses to CoRD both taken from the same dataset). Note that CoRD calculated using median unit values is also our lowest estimate of CoRD across methods and datasets. As such, we will be presenting our lowest-bound estimate of individuals who cannot afford CoRD. In Sri Lanka, we use the per capita spatially adjusted food expenses (at the district level). In Pakistan, we use the per adult equivalent spatially adjusted food expenses (at the PSU level).[28]

Figure 10: Percent of Population with Food Expenses Falling Below National CoRD

a) Sri Lanka 2016 b) Pakistan 2015–16



Source: Authors' calculations using Sri Lanka HIES 2016 and Pakistan HIICS 2015-16.

Figure 10 shows the proportion of the population who spend less on food than the cost of a nutritious diet, as calculated using CoRD in Sri Lanka and Pakistan, and across their provinces. In Sri Lanka, 49 percent of the population spends less on food than CoRD. It is highest in Sabaragamuwa province (64 percent) and lowest in Northwestern province (40 percent). In

[28] Population weights are used to calculate means.

Pakistan, 58 percent of the population spends less on food than CoRD. It is highest in Balochistan province (82 percent) and lowest in KPK (47 percent).[29]

6 Conclusion

We find that the cost of food can be particularly prohibitive when considering a recommended healthy and nutritious diet. We further find that prices of the most nutrient-dense foods are rising faster, and are more seasonally and spatially variable, than those of energy-dense, low-micronutrient foods. The main factor behind this trend is shifting prices for vegetables. Changes in vegetable prices also account for the differences in the cost of a nutritious diet across geographic locations.

The most energy-dense foods (cereals, oils and fats, sugars) generally had the most stable prices, showing the least inflation, seasonality, and regional variation, except for in Afghanistan where the price of cereals is regionally variable. Energy-dense foods generally have a longer shelf life for storage and transportation than nutrient-dense foods, which tend to be highly perishable. Food security and agriculture policies have emphasized energy-dense foods for the last several decades. The findings of our paper suggest that food security and agriculture policies need to focus more on nutrient-dense foods, which are relatively unaffordable throughout the year but particularly during price spikes in certain seasons and regions. In particular, policymakers can reduce the cost and price volatility of nutritious diets by taking steps to reduce vegetable prices and their sensitivity to seasonal factors, and by improving the integration of markets particularly for vegetables and other perishable, nutrient-dense foods.

The most nutrient-dense foods are missing from a majority of diets around the world (Micha, Kalantarian, and Wirojratana 2012). This has high costs to human health and productivity. Malnutrition and dietary risks are the top two factors in the global burden of disease (GDB 2016 Risk Factor Collaborators 2017). Our results suggest that there may be strong economic reasons why consumers consume little of the most nutrient-dense foods: They simply cannot afford it. If policymakers want to improve diet quality and nutrition in South Asia, they must implement more policies and take more action to improve affordability of vegetables, legumes, fruits, and animal-source foods.

A strength of our analytical approach is that countries can track the cost of nutritious diets quite easily using existing food price monitoring systems of national statistics organizations. Spatial trends and price inflation can be monitored by calculating CoRD and NPI. CoRD in particular is important for policy coherence, providing a means to monitor the price of diet patterns that meet national guidelines. However, to estimate CoRD we are limited to the foods contained in the Consumer Price Index food list, which may not include the most nutritionally important foods or the cheapest foods. Comparison with household expenditure survey prices suggest that indeed, there may be cheaper sources of nutritious foods available than those contained in the CPI list. Using the median-cost food items in a longer list of foods, rather than the lowest-cost food items

[29] An alternative calculation would be to calculate CoRD for each province and compare this to nominal per individual food expenses (not spatially adjusted). Results of this alternative method are presented in Appendix Figure A2. Using this method, the proportion of individuals who spend less on food than CoRD increases; in Sri Lanka 56 percent of individuals spend less on food than CoRD and in Pakistan 65 percent of individuals spend less on food than CoRD.

in a shorter list, may provide a better estimate of the actual cost of diverse recommended diets.[30] Another limitation is that raw price data are not always publicly released. As such, the countries themselves may be in the best position to monitor the cost of nutritious diets, as their governments routinely collect and analyze food price data.

Countries can take several key actions to strengthen and expand monitoring of the cost of nutritious food. On the methodological side, policymakers and experts can use the CoRD in a similar way as NPI to track trends across time, with perhaps a more intuitive interpretation. Time trends are best seen using CPI data, which are collected on a weekly or monthly basis, but they can also be analyzed over longer spans of time using household expenditure survey data, which are collected approximately every five years. International organizations could partner with national statistics offices to conduct cross-country monitoring of these trends. To inform programs at the country level, there may be interest to track the cost of nutritious diets using these straightforward methods.[31]

[30] Another limitation is that we have not compared the price of healthy foods to all types of unhealthy foods.

[31] Ministries of food and agriculture, which often have a mandate to assure food security, may also have a stake in tracking these metrics. While not explored in this paper, these ministries often have their own market information system by which they collect food prices.

References

Andreyeva, Tatiana, Michael W. Long, and Kelly D. Brownell. 2010. "The Impact of Food Prices on Consumption: A Systematic Review of Research on the Price Elasticity of Demand for Food." *American Journal of Public Health* 100 (2): 216–22.

Beydoun, May A., Lisa M. Powell, Xiaoli Chen, and Youfa Wang. 2011. "Food Prices Are Associated with Dietary Quality, Fast Food Consumption,and Body Mass Index among U.S. Children and Adolescents." *The Journal of Nutrition* 141 (2): 304–11.

Biehl, Erin, Rolf D. Klemm, Swetha Manohar, Patrick Webb, Devendra Gauchan, and Keith P. West. 2016. "What Does It Cost to Improve Household Diets in Nepal? Using the Cost of the Diet Method to Model Lowest Cost Dietary Changes." *Food and Nutrition Bulletin* 37 (3): 247–60.

Chastre, Claire, Arabella Duffield, Heather Kindness, Sonya LeJeune, and Anna Taylor. 2007. *The Minimum Cost of a Healthy Diet: Findings from Piloting a New Methodology in Four Study Locations.* Fairfield, CT: Save the Children.

Cofer, Eloise, Evelyn Grossman, and Faith Clark. 1962. *Family Food Plans and Food Costs, Home Economics Research Report Volume 20.* Washington, DC: USDA: U.S. Department of Agriculture, Agriculture Research Service, Consumer and Food Economics Research Division,

Darmon, Nicole, and Adam Drewnowski,. 2015. "Contribution of Food Prices and Diet Cost to Socioeconomic Disparities in Diet Quality and Health: A Systematic Review and Analysis." *Nutrition Reviews* 73 (10): 643–60.

Dawe, D., and J. Lee. 2017. Fruit and Vegetable Prices are Rising in Asia and the Pacific. FAO Regional Office for Asia and the Pacific.

Deptford, Amy, Tommy Allieri, Rachel Childs, Claudia Damu, Elaine Ferguson, Jennie Hilton, Paul Parham, Abigail Perry, Alex Rees, James Seddon, and Andrew Hall. 2017. "Cost of the Diet: A Method and Software to Calculate the Lowest Cost of Meeting Recommended Intakes of Energy and Nutrients from Local Foods." *BMC Nutrition* 3 (26): 1–17.

Development Initatives. 2017. *Global Nutrition Report 2017: Nourishing the SDGs.* Bristol, UK: Development Initiatives: Development Initiatives.

FAO (Food and Agriculture Organization of the United Nations). 2017. *Regional Overview of Food Security and Nutrition: Asia and the Pacific.* Bangkok: FAO Regional Office for Asia and the Pacific.

Fulgoni, V., D. R. Keast, and A. Drewnowski. 2009. "Development and Validation of the Nutrient-Rich Foods Index: A Tool to Measure Nutritional Quality of Foods." *Journal of Nutrition* 139 (8) 1549–54.

GBD 2016 Risk Factor Collaborators. 2017. Global, Regional, and National Comparative Risk Assessment of 84 Behavioural, Environmental and Occupational, and Metabolic Risks or Clusters of Risks, 1990–2016: A Systematic Analysis for the Global Burden of Disease Study 2016. *The Lancet 390* (10100): 1345–422.

Green, Rosemary, Laura Cornelsen, Alan D. Dangour, Rachel Turner, Bhavani Shankar, Mario Mazzocchi, and Richard D. Smith. 2013. "The Effect of Rising Food Prices on Food Consumption: Systematic Review with Meta-Regression." *BMJ* 346: f3703.

Grossman, Michael, Erdal Tekin, and Roy Wada. 2013. "Food Prices and Body Fatness Among Youths." NBER Working Paper 19143, National Bureau of Economic Research, Cambridge, MA.

Han, E., and L. Powell. 2011. "Effect of Food Prices on the Prevalence of Obesity among Young Adults." *Public Health* 125 (3): 129–35.

Headey, D. 2017. "The Relative Price of Healthy and Unhealthy Foods in 177 Countries." IFPRI unpublished manuscript.

Katz, D. L., V. Y. Njike, Z. Faridi, L. Q. Rhee, R. S. Reeves, D. J. Jenkins, and K. T. Ayoob. 2009. "The Stratification of Foods on the Basis of Overall Nutritional Quality: The Overall Nutritional Quality Index." *American Journal of Health Promotion* 24 (2): 133–43.

Masters, William A., Yan Bai, Anna Herforth, Daniel Sarpong, Fulgence Mishili, Joyce Kinabo, and Jennifer Coates. 2018. "Measuring the Affordability of Nutritious Diets in Africa: Novel Price Indexes for Diet Diversity and Cost of Nutrient Adequacy." *American Journal of Agricultural Economics (forthcoming).*

Micha, R., S. Kalantarian, P. Wirojratana, T. Byers, G. Danaei, I. Elmadfa, E. Ding, E. Giovannucci, J. Powles, S. Smith-Warner, M. Ezzati, D. Mozaffarian, Global Burden of Diseases, Nutrition and Chronic Disease Expert Group. 2012. "Estimating the Global and Regional Burden of Suboptimal Nutrition on Chronic Disease: Methods and Inputs to the Analysis. *European Journal of Clinical Nutrition* 66 (1): 119–29.

Miller, Victoria, Salim Yusaf, Clara K. Chow, Mahshid Dehghan, Daniel J. Corsi, Karen Lock, Barry Popkin, Sumathy Rangarajan, Rasha Khatib, Scott A. Lear, Prem Mony, Manmeet Kaur, Viswanathan Mohan, Krishnapillai Vijayakumar, Rajeev Gupta, Annamarie Kruger, Lungiswa Tsolekile, Noushin Mohammadifard, Omar Rahman, Annika Rosengren, Alvaro Avezum, Andres Orlandini, Noorhassim Ismail, Patricio Lopez-Jaramillo, Afzalhussein Yusufali, Kubilay Karsidag, Romaina Iqbal, Jephat Chifamba, Solange Martinez Oakley, Farnaza Ariffin, Katarzyna Zatonska, Paul Poirier, Li Wei, Bo Jian, Chen Hui, Liu Xu, Bai Xiulin, Koon Teo, and Andrew Mente. 2016. "Availability, Affordability, and Consumption of Fruits and Vegetables in 18 Countries Across Income Levels: Findings from the Prospective Urban Rural Epidemiology (PURE) Study. *The Lancet* 4 (10); 695–703.

Monsivais, Pablo, Julia McLain, and Adam Drewnowski. 2010. "The Rising Disparity in the Price of Healthful Foods: 2004–2008. *Food Policy* 35 (6): 514–20.

Monteiro, Carlos Augusto, Geoffrey Cannon, Jean-Claude Moubarac, Renata Bertazzi Levy, Maria Laura C. Louzada, and Patricia Constante Jaime. 2018. "The UN Decade of Nutrition, the NOVA Food Classification and the Trouble with Ultra-Processing." *Public Health Nutrition* 21 (1): 5–17.

Mulik, Kranti, and Lindsey Haynes-Maslow. 2017. "The Affordability of MyPlate: An Analysis of SNAP Benfits and the Actual Cost of Eating According to the Dietary Guidelines." *Journal of Nutrition Education and Behavior* 49 (8): 623–31.

Pakistan, Ministry of Planning, Development & Reform, and World Food Programme. 2016. *Minimum Cost of the Diet Pakistan.* Report, Islamabad.

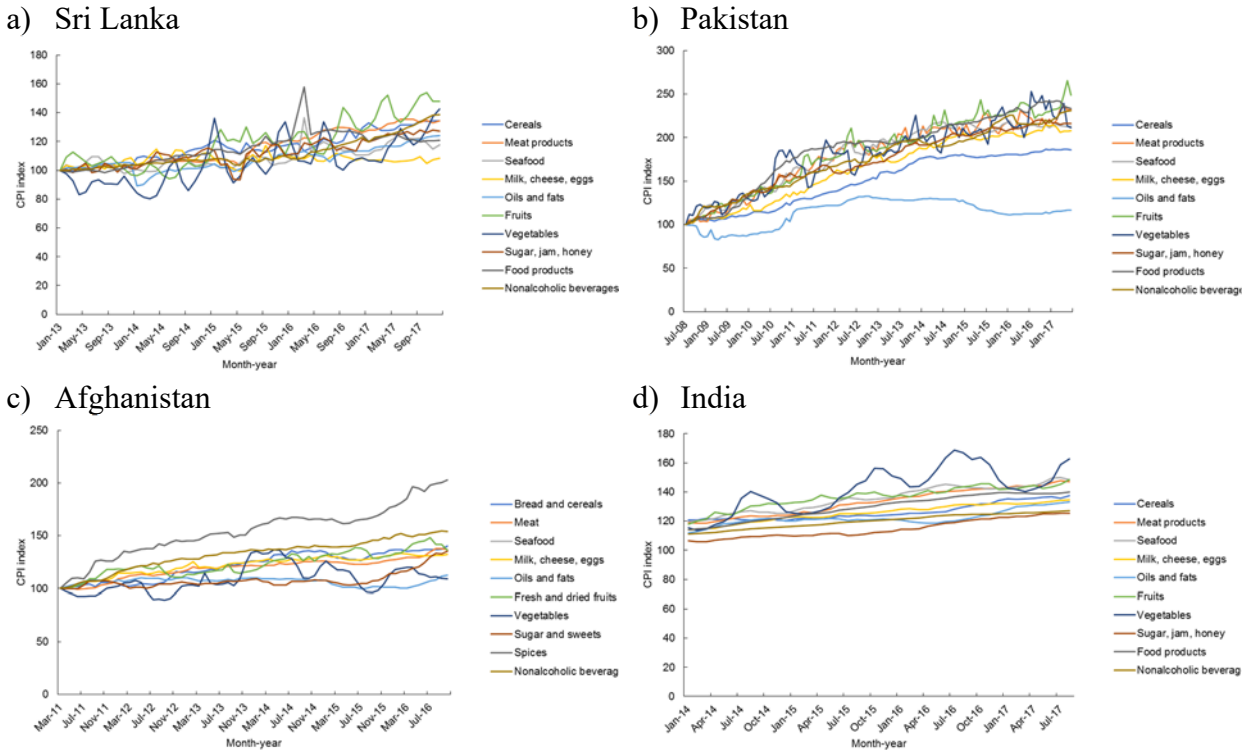
UNICEF, WHO, and World Bank. 2017. *Joint Child Malnutrition Estimates 2017 Edition-Interactive Dashboard.* Available at https://data.unicef.org/resources/joint-child-malnutrition-estimates-2017-edition-interactive-dashboard/.

World Food Programme (WFP), MED and Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI). 2014. *Minimum Cost of Diet Sri Lanka.* Sri Lanka: WFP.

WFP (World Food Programme). 2017. *Fill the Nutrient Gap Tool.* Available at https://www.wfp.org/content/2017-fill-nutrient-gap?_ga=2.86790555.2011256344.1518424351-1082568425.1480515367.

Appendix

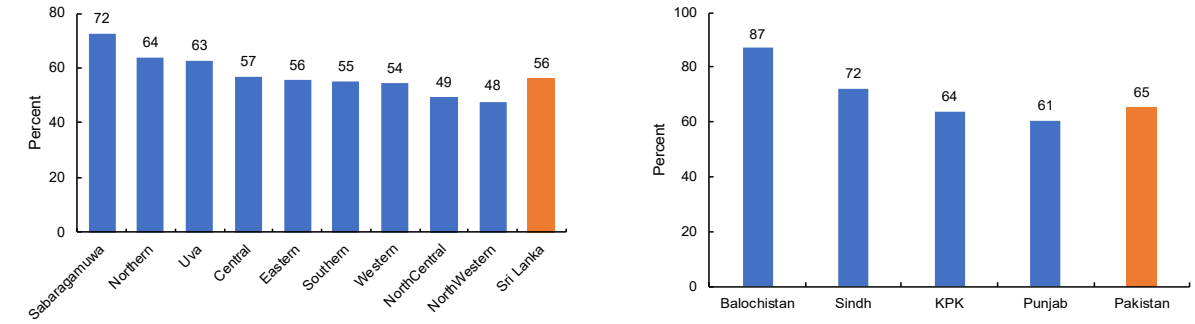
Figure A1: CPI by COICOP Group Across Countries



Source: Authors' calculations using CPI data from Sri Lanka, Pakistan, Afghanistan, and India.

Figure A2: Percent of Population with Food Expenses Falling Below National CoRD

Using province-level CoRD and nominal food expenses (not spatially adjusted)



Source: Authors' calculation using Sri Lanka HIES 2016 and Pakistan HIICS 2015-16.

Note: Province-level CoRD and nominal food expenses (not spatially adjusted) were used to calculate the percentages.