A new approach to measuring Indian diet diversity: Healthy Eating Index

Mousumi Das
Institute of Financial Management & Research (IFMR), Chennai, India
World Bank, South Asia Region, India

Suresh Babu
International Food Policy Research Institute, Washington D.C.

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Corresponding author: mousumi.das@ifmr.ac.in, mousumii.das@gmail.com
Outline

• Focus on dietary diversity in the international context
• Reduced focus in India – both from measurement and policy priorities
• Healthy Eating Index – Conceptualized based on the Healthy Food Diversity Index (Drescher et al. 2007 – *Journal of Nutrition*) - Indian Food Pyramid
• Axiomatic properties
• Illustration – 2009 - 2012
• Application
  • Updating the food component of the Indian poverty line
  • Identification of the beneficiaries; redesigning policies and programs; cash v/s in-kind transfers
The International Perspective

• International healthy diet recommendations - Consumption of a diverse basket of food items

• Improves nutritional status, leads to a reduced incidence of cancer and mortality

• As the German diversity guideline puts it:

  “Enjoy the great variety of food. There is no healthy, unhealthy or even forbidden food. It is the quantity, selection, and combination of food that matters”
The International Perspective

• Complete diet - macro and micro nutrients (Ruel, 2002)
• Fall in diet diversity - increase in the proportion of malnourished (Block et al., 2004 and Torlesse et al., 2003)
• What has this led to? - Triple burden of malnutrition - underweight, overweight and micro nutrient deficiency diseases (Gómez et al., 2013) - SDG (Goal 2 – hunger, food & nutrition security)

Food systems and diets : Foresight Report

– Poor diet is the number one risk factor driving the world’s disease burden
– Three billion people from 193 countries now have low quality diets
Current practices - Worldwide

• Dietary guidelines based on five food groups was used as a main nutrition education tool until 1996
  
  Vegetables and legumes/beans, Fruit
  Grain (cereal) foods, mostly wholegrain and/or high cereal fibre varieties, Lean meats and poultry, fish, eggs, tofu, nuts and seeds and legumes/beans
  Milk, yoghurt cheese and/or alternatives, mostly reduced fat

• Food based dietary guidelines (FBDGs) - promote desirable and culturally acceptable eating behaviour - advice on foods, food groups and dietary patterns to provide the required nutrients to the general public to promote overall health and prevent chronic diseases.
  
  - Plates, pyramids, planet: FCRN
Food Pyramids Worldwide

HEALTHY EATING PLATE

- Use healthy oils (like olive and canola oil) for cooking, on salad, and at the table. Limit butter. Avoid trans fat.
- The more veggies – and the greater the variety – the better. Potatoes and French fries don’t count.
- Eat plenty of fruits of all colors.

STAY ACTIVE!

Harvard T.H. Chan School of Public Health
The Nutrition Source
www.hsph.harvard.edu/nutritionsource

WATER

- Drink water, tea, or coffee (with little or no sugar).
- Limit milk/dairy (1-2 servings/day) and juice (1 small glass/day). Avoid sugary drinks.

- Eat a variety of whole grains (like whole-wheat bread, whole-grain pasta, and brown rice). Limit refined grains (like white rice and white bread).

- Choose fish, poultry, beans, and nuts; limit red meat and cheese; avoid bacon, cold cuts, and other processed meats.

U.S. Food Guide Pyramid

- Maintain balance between food intake and physical activity.

Healthy Eating Index, India
What 83 national food-based dietary guidelines (FBDGs) recommend

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Low-income (2 out of 31 countries)</th>
<th>Low-middle-income (12 out of 51 countries)</th>
<th>Upper-middle-income (26 out of 53 countries)</th>
<th>High-income (43 out of 80 countries)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do they explicitly recommend eating a varied diet?</td>
<td>Green</td>
<td>Blue</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Do they recommend to reduce sugar consumption?</td>
<td>Red</td>
<td>Blue</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Do they recommend to reduce salt consumption?</td>
<td>Blue</td>
<td>Red</td>
<td>Green</td>
<td>Blue</td>
</tr>
<tr>
<td>Do they recommend to reduce or moderate meat consumption?</td>
<td>Red</td>
<td>Green</td>
<td>Blue</td>
<td>Red</td>
</tr>
<tr>
<td>Do they recommend to eat more fruits and vegetables?</td>
<td>Red</td>
<td>Blue</td>
<td>Red</td>
<td>Red</td>
</tr>
<tr>
<td>Do they mention milk?</td>
<td>Blue</td>
<td>Red</td>
<td>Green</td>
<td>Blue</td>
</tr>
<tr>
<td>Do they mention fish?</td>
<td>Blue</td>
<td>Red</td>
<td>Green</td>
<td>Blue</td>
</tr>
</tbody>
</table>

Healthy Eating Index, India
contd...
Deaths avoided by applying dietary guidelines

Source: Compiled by the authors, based on data in Springmann et al. (2016), supplementary data
The Indian context

• Food security policies (PDS) - generally focus on calorie intake - despite a decline (Deaton and Dreze, 2009)
• Initial years – calorie intake was justified – poverty and hunger
• Despite the fall in calorie intake no focus on other dimensions/measures - food based dietary guidelines
• National Food Security Act, 2013
  – Cereal and calorie dominance - calorie security (PDS)
The Indian context

• Calorie intake – food component of the poverty line – identification of beneficiaries for the world’s largest food distribution program (PDS)

• Triple burden of malnutrition

• Warranted - **Focus on dietary diversity measures in policy making** - Over/under identification
What are the measures?

Shannon/Entropy Index \( (E) = -\sum_{i=1}^{n} w_i (\ln w_i) \)

\( i=1,2,\ldots,n \), \( n \) is the total number of food items, \( w \) denotes the share of expenditure/quantity consumed on the \( i^{th} \) food item


Count measures and Simpson Index - From a nutritional perspective equal consumption of all food items is not desired.
Healthy Food Diversity Index (HFD)
Drescher et al. (2007)

- German Nutrition Society (DGE) recommended nutrition circle
- Number, distribution and health value of food items consumed
- Health value for food items
- Healthy foods should be consumed in higher shares than unhealthy ones
- Highest index value has to be assigned to a situation where an individual consumes recommended food group shares
contd...

• Modify the Entropy Index so that the value of the index increases if the distribution of foods moves in favor of healthier products
• Shares are calculated on the basis of the DGE reference values for nutrient intake
• Reference values for nutrient intake are achieved on average over a 7-day period
• Health value of the main food groups ($G_b$) was assessed according to the percentage consumption recommendation shown in the nutrition circle
• Shares can be summed up in three groups: 73% plant foods, 25% animal foods, 2% fats and oils; 4\textsuperscript{th} dimension of beverages excluded as interested in caloric foods
• Assessment of food subgroups ($G_w$), the qualitative dimension of the pyramid sides is quantified
• Each side is divided into 5 different subgroups
• Pyramid is an isosceles triangle, assumption that 5 subgroups have the same heights on all sides
• Percentage of each subgroup within the upper group is calculated
contd...

• Dependent on the positions of foods in the pyramid as well as on the affiliation to a main food group (plant foods, animal foods, fats, and oils)
• The food pyramid illustrates the qualitative dimension within these 3 food groups by the hierarchy of foods
• Plant food group as an example, most valuable (healthy) subgroups such as vegetables and fruits are placed at the bottom, less valuable (unhealthy) subgroups such as cakes and sweets at the top
Graphical representation

Nutrition circle

Plant food group side of the food pyramid
Designing weights

• Combination of the subgroup shares \((G_w)\) with the main group shares \((G_b)\) yield health factors \((hf = G_w * G_b)\) for 15 different subgroups

• Health value of an individual’s food basket was assessed by multiplying the quantitative shares of single foods in terms of weight\((s_i)\) on total quantities with their corresponding health factor\((hf_i)\)

• The output is called health value: \(hv = \sum hf_i * w_i\)

• Maximum health value is 0.26
• Division of $hv$ by its maximum ensures that $hv$ is bounded between 1 and nearly 0

• Healthy Food Diversity (HFD)-Index

$$HFD = (1 - \sum w_i^2) \times hv$$

• Multiplication of the Berry-Index with the health value ensures that neither a high $hv$ nor a high BI alone yield a high HFD-Index

• The HFD-Index, bounded between 0 and $1 - 1/n$, has the following properties:

  (1) If the distribution between hf groups of the pyramid does not change, it increases with the growing number of food items; it increases the more equally the food items are distributed within the hf-groups
contd…

(2) If distribution between hf groups of the pyramid does change in favor of healthy (unhealthy) food groups, it increases (decreases)

- HFD-Index is able to differentiate between healthy and unhealthy food diversity over all food groups based on real observable diets without omitting unhealthy foods

- Energy-adjusted correlations with diet quality indicators
  - Nutrient Adequacy Ratio (NAR) is the ratio of a subject's nutrient intake to the estimated average requirement
  - Pearson’s correlation analyses, where individuals’ HFD were correlated with nutrient supply and biochemical parameters
Axiomatic properties

• Choice of Entropy Index (E) - generalized Hannay-Kay (1977) class of concentration indices

• Properties (Chakravarty and Eichhorn, 1991):
  • **Symmetry**: Households are differentiated only on the basis of their level of consumption
  • **Zero output independence**: Value of E remains unchanged even if households with zero consumption are included or excluded
  • **Normalization**: For similar consumption patterns E is the reciprocal of n
Axiomatic properties

- **Homogeneity**: Homogeneous of degree zero and value depends only on $w_i$

- **Output transfers**: If there is a transfer of consumption from a non-poor to a poor household then $E$

- **Replication**: If similar type of households are replicated $m$ times in the sample then $E' = E^* (1/m)$
Indian Food Pyramid

Recommendation of a Balanced Diet for Adult Man
(Sedentary): National Institute of Nutrition (NIN)

Healthy Eating Index, India
# Weight matrix - Adult Man

## Balanced Diet for Adult Man (Sedentary)

<table>
<thead>
<tr>
<th>Food group</th>
<th>Portion Size (in gms)</th>
<th>No. of portions</th>
<th>Total in gms (Veg/Non-veg)</th>
<th>Weight in percent (Veg/Non-veg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fats/Oils</td>
<td>5</td>
<td>5</td>
<td>25</td>
<td>2.14/2.19</td>
</tr>
<tr>
<td>Sugar</td>
<td>5</td>
<td>5</td>
<td>25</td>
<td>2.14/2.19</td>
</tr>
<tr>
<td>Milk &amp; Milk products</td>
<td>100</td>
<td>3</td>
<td>300</td>
<td>25.64/26.32</td>
</tr>
<tr>
<td>Pulses(vegetarian)</td>
<td>30</td>
<td>2</td>
<td>60</td>
<td>5.13</td>
</tr>
<tr>
<td>Pulses(non-vegetarian)</td>
<td>30</td>
<td>1</td>
<td>30</td>
<td>2.63</td>
</tr>
<tr>
<td>Vegetables</td>
<td>100</td>
<td>3</td>
<td>300</td>
<td>25.64/26.32</td>
</tr>
<tr>
<td>Fruits</td>
<td>100</td>
<td>1</td>
<td>100</td>
<td>8.55/8.77</td>
</tr>
<tr>
<td>Cereals and millets</td>
<td>30</td>
<td>12</td>
<td>360</td>
<td>30.80/31.58</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>1170/1140</td>
<td>100/100</td>
</tr>
</tbody>
</table>

Healthy Eating Index, India
## Weight matrix - Adult Woman

<table>
<thead>
<tr>
<th>Food group</th>
<th>Portion Size (in gms)</th>
<th>No. of portions</th>
<th>Total in gms (Veg/Non-veg)</th>
<th>Weight in percent (Veg/Non-veg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fats/Oils</td>
<td>5</td>
<td>4</td>
<td>20</td>
<td>1.87/1.92</td>
</tr>
<tr>
<td>Sugar</td>
<td>5</td>
<td>4</td>
<td>20</td>
<td>1.87/1.92</td>
</tr>
<tr>
<td>Milk &amp; Milk products</td>
<td>100</td>
<td>3</td>
<td>300</td>
<td>28.04/28.85</td>
</tr>
<tr>
<td>Pulses(vegetarian)</td>
<td>30</td>
<td>2</td>
<td>60</td>
<td>5.61</td>
</tr>
<tr>
<td>Pulses(non-vegetarian)</td>
<td>30</td>
<td>1</td>
<td>30</td>
<td>2.88</td>
</tr>
<tr>
<td>Vegetables</td>
<td>100</td>
<td>3</td>
<td>300</td>
<td>28.04/28.85</td>
</tr>
<tr>
<td>Fruits</td>
<td>100</td>
<td>1</td>
<td>100</td>
<td>9.35/9.62</td>
</tr>
<tr>
<td>Cereals and millets</td>
<td>30</td>
<td>9</td>
<td>270</td>
<td>25.23/25.96</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>1070/1040</td>
<td>100/100</td>
</tr>
</tbody>
</table>
Data - NSS

- Nationally representative 61\textsuperscript{st}, 66\textsuperscript{th} and 68\textsuperscript{th} round household consumption expenditure survey (July 2004 - June 2005, July 2009 - June 2010 and July 2011 - June 2012)
- Sample size - 79298, 59097 and 59683 (rural India); 45346, 41697 and 41968 (urban India)
- Expenditure in quantity consumed for the food groups: cereal, cereal substitutes, pulses & pulse products, milk & milk products, sugar, salt, edible oil, egg, fish & meat, vegetables, fruits(fresh and dry), spices, and beverages
Data - NSS

- Recall period - edible oil, egg, fish & meat, vegetables, fruits, spices, beverages and processed foods - seven days and for other food items 30 days
- Appropriate conversion of food items to kilograms - Majumdar et al (2012)
- Regular wage/salary earning, self-employed in non-agriculture
## Identification

### Percentage of households above the cut-off (Rural India)

<table>
<thead>
<tr>
<th></th>
<th>Cereals</th>
<th>Pulses</th>
<th>Milk</th>
<th>Vegetables</th>
<th>Fruits</th>
<th>Fats</th>
<th>Sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-05</td>
<td>87.11</td>
<td>13.19</td>
<td>18.19</td>
<td>0.32</td>
<td>4.53</td>
<td>1.21</td>
<td>83.45</td>
</tr>
<tr>
<td>2009-10</td>
<td>99.32</td>
<td>19.59</td>
<td>25.08</td>
<td>1.4</td>
<td>7.25</td>
<td>2.19</td>
<td>72.05</td>
</tr>
<tr>
<td>2011-12</td>
<td>98.66</td>
<td>27.35</td>
<td>28.01</td>
<td>0.35</td>
<td>7.89</td>
<td>2.06</td>
<td>77.41</td>
</tr>
</tbody>
</table>

*Healthy Eating Index, India*
## Identification

### Percentage of households above the cut-off (Urban India)

<table>
<thead>
<tr>
<th>Year</th>
<th>Cereals</th>
<th>Pulses</th>
<th>Milk</th>
<th>Vegetables</th>
<th>Fruits</th>
<th>Fats</th>
<th>Sugar</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-05</td>
<td>85.18</td>
<td>13.57</td>
<td>21.63</td>
<td>0.3</td>
<td>3.32</td>
<td>1.19</td>
<td>73.15</td>
</tr>
<tr>
<td>2009-10</td>
<td>95.83</td>
<td>26.96</td>
<td>40.43</td>
<td>1.1</td>
<td>10.3</td>
<td>3.8</td>
<td>80.47</td>
</tr>
<tr>
<td>2011-12</td>
<td>95.53</td>
<td>36.86</td>
<td>42.57</td>
<td>0.61</td>
<td>12.16</td>
<td>4.13</td>
<td>84.15</td>
</tr>
</tbody>
</table>
Discussion

• Deficiency in consumption of pulses, milk, sugar and fats in both rural and urban India - working age population & sedentary lifestyle

• Positive significant correlation with existing measures (count, Simpson & Entropy)

• Way ahead - Correlation - Quantity and nutrient intake based indices

• Decomposition across social, religious, and region based groups
Discussion

• National Food Security Act - cash vs in-kind transfers
• An immediate policy implication - re-estimation of the food component of the poverty line - culture & social habits
• Food supply – consumption of a healthy diet – Kuyper et al. (2017) – region specific analysis
  
  For example quite surprising that price of say fish highest in the area with the highest production due to lack of cold storage facilities – fall in consumption of protein based food items – fall in diet diversity.

  Need to focus on other strategies - cold storage, promotion of production of eggs, fish & meat, nutritious cereals like jowar & bajra rather than just cereals

• Data gaps - individual level, need to compute equivalents, no panel data