Comparison of food consumption in Indian adults between national and sub-national dietary data sources

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Abstract

Accurate data on dietary intake are important for public health, nutrition and agricultural policy. The National Sample Survey (NSS) is widely used by policymakers in India to estimate nutritional outcomes in the country, but has not been compared to other dietary data sources. To assess relative differences across available Indian dietary data sources, we compare intake of food groups across six national and sub-national surveys between 2004-2012, representing various dietary intake estimation methodologies, including household consumer expenditure surveys (HCESs), food-frequency questionnaires (FFQs), food balance sheets (FBSs), and 24-hour recall (24HR) surveys. We matched data for relevant years, regions, and economic groups, for ages 16-59. One set of national HCESs and the 24HRs showed a decline in food intake in India between 2004/2005-2011/2012, while another HCES and FBSs showed an increase. Differences in intake were smallest between the two HCESs (1% relative difference). Relative to these, FFQs and FBS had higher intake (13% and 35%), and the 24HR lower intake (-9%). Cereal consumption had high agreement across comparisons (average 5% difference), while fruit and nuts, eggs, meat and fish, and sugar had the least (120%, 119%, 56%, and 50% average differences, respectively). Spearman coefficients showed high correlation of ranked food group intake across surveys. The underlying methods of the compared data highlight possible sources of under- or over-estimation, and influence their relevance for addressing various research questions and programmatic needs.

Introduction

Accurate data on dietary intake are important for several policy areas, including nutrition, agriculture, and public health. Three types of sources are generally used for estimating food consumption in populations: food balance sheets (FBSs), household consumer expenditure surveys (HCES), and individual intake surveys[1,2]. The Food and Agriculture Organisation (FAO) calculates annual FBSs for countries, which estimate national-level availability of major food commodities, as a function of production, imports, exports, and adjustments for waste. HCESs are conducted on a frequent basis by national statistics offices, using nationally representative sampling frames, and collect data on household-level purchases of a comprehensive set of food commodities. Individual intake surveys come in a variety of designs, including food frequency questionnaires (FFQs), 24-hour recall (24HR) surveys, and weighed food records. These surveys are generally regarded as providing more accurate individual-level estimates of food consumption than FBS or HCES, though they are more difficult and expensive to conduct, and thus are more commonly used on specific study populations rather than at national levels[1]. The choice of data type used by researchers and policymakers often depends on availability.

Much nutritional research has focused on India, where historically high rates of under-nutrition, as well as growing over-nutrition, impose heavy burdens on health and development[3-5]. Several data sources exist in the country on dietary intake, and they have been variously used to study and describe, for example, consumption of major food groups and associated changes over time[4,6-10], absolute micronutrient intake[11], and health outcomes related to nutritional intake[12,13], among others[14,15].

Specifically, the Indian government's National Sample Survey (NSS) HCESs have been used to describe the country's dietary transition from the 1980s to 2000s[4,7]. It has been suggested that

74 several stages of transition with varying characteristics have unfolded in the country[6,9], though on
75 the whole, diets have seen a decline in cereals, and an increase in calories from vegetable- and
76 animal-source fats. Alongside changes in food consumption over these years, recent estimates
77 show that in 2014, about 27% of Indian adults were overweight, while 39% of children under 5
78 were stunted[16]. Despite India's growing economy, reductions in undernutrition have been
79 materialising slowly[17].
80
81 However, challenges remain in using Indian dietary data to explain nutritional trends and drivers.
82 Overall trends in dietary intake across time are still not fully clear, partly due to a lack of reliable
83 data[8]. The NSS has shown a steady and counterintuitive decrease in consumed calories since the
84 1980s to 2010 as incomes have grown, with a small rebound in caloric intake only in the last
85 available data year of 2012[8,18]. Evidence suggests the recent decreasing caloric trends in these
86 data may be a function of some underestimation in this survey, such as not fully accounting for
87 increased consumption of food outside the home[19,20].
88
89 Measuring food consumption is generally a difficult exercise[21], and studies have shown that the
90 choice of data methodology applied to a given population can affect the resulting intake
91 estimates[20,22-25]. Intake data are therefore often compared against an alternative method for a
92 given sample or population for the purposes of validation, or to determine relative differences
93 between the compared methods[2,22-26]. Despite researchers' and policymakers' reliance on the NSS,
94 it has not been compared to other sources of dietary data in the country.
95
96 We compare intake of major food groups using six national and sub-national sources of Indian food
97 consumption, representing various dietary intake estimation methods, and assess the impact of
98 these methods on relative differences in food consumption.

Methods

Data

National Sample Survey (NSS)

The NSS is an annual, nationally representative HCES, representing a random sample of households across the country. The questionnaire records the quantity and value of approximately 250 food and beverage items purchased in the last 30 days, among other consumer goods[18,27]. We used rounds 61, 66, and 68 of the survey, conducted between July and June of 2004-5, 2009-10, and 2011-12, respectively, to match the years of data collection as close as possible to our other compared data sources. We additionally compare the 2011-2012 data from an alternative NSS survey format (named "type 2") that was recently implemented and used 7-day recall for meats, eggs, oils, fruits, and vegetables (though it retained a 30-day recall for cereals, pulses, and sugar)[27].

India Health and Development Survey (IHDS)

The IHDS was a nationally representative HCES, conducted over two waves in 2004-2005 and 2011-12. It recorded, among other socioeconomic and health indicators, the quantity and value of purchased food groups in the last 30 days, such as vegetables, meats, and legumes, as well as several commonly-consumed individual items, such as rice and wheat[28].

FAO food balance sheets (FBSs)

The FAO's FBSs provide a picture of food availability at the national level, and approximate per capita food availability by dividing national estimates by the total population[1]. We retrieved data for the years 2004, 2005, 2011, and 2012 from the FAOSTAT database[29].

National Nutrition Monitoring Bureau (NNMB) rural surveys

123 The National Nutrition Monitoring Bureau conducts periodic surveys in ten Indian states, using
124 multi-stage random sampling of households, and following the NSS sampling frame. The surveys
125 recorded individual-level intake within households using one 24HR survey[30]. The raw data from
126 these surveys were not available, though NNMB reports provide mean individual-level intake of
127 food groups by age for rural areas. We used these reported data for adults aged 18 and above,
128 from the surveys conducted on rural populations during 2004-2005 and 2011-2012[31,32].
129
130 *Indian Migration Study (IMS)*
131 The IMS was a health and nutrition study conducted in 2005-2007, which surveyed factory workers
132 in the four urban centres of Hyderabad, Bangalore, Nagpur and Lucknow, and their siblings living in
133 rural areas, the majority of whom resided within the same Indian state as the urban centre. The
134 survey used a FFQ of 184 dishes and food items, and recorded the frequency of intake and number
135 of servings of each item in the one-year period prior to the survey. The study also collected recipes
136 for each of the FFQ items, separately for rural and urban areas of each study site[33].
137
138 *Andhra Pradesh Child and Parent Study (APCAPS)*
139 APCAPS is a prospective birth cohort study of households in 29 peri-urban villages of Ranga Reddy
140 district in the Indian state of Telangana (previously Andhra Pradesh) that earlier took part in a food
141 supplementation trial involving pregnant women and their offspring (1987-90). It uses a FFQ of 98
142 dishes and food items, based on the IMS FFQ and further refined for use in the APCAPS study
143 setting. Here we used the third follow-up wave, which included children and their parents,
144 conducted between 2010-2012[34]. The first wave was excluded as it did not collect detailed data on
145 intake, while the second wave had a smaller sample size consisting of only children.
146

All data sources accounted for seasonality by using aggregated annual data or conducting fieldwork throughout the year (NSS, IHDS, FBS, NNMB), or by specifically recording the variation in intake by time of year (IMS, APCAPS). A summary of data sources, including sample sizes, is presented in Table 1.

Analysis

We compare intake of major food groups, in grams/person/day, between survey types, matching for relevant year of survey, regions, sex, and economic groups, where available. HCESs were used as the reference comparison against other methodologies (though strictly to assess relative differences rather than as a source of validation) due to the larger number of HCES datasets and the ability to match across the years and regions of other survey types. Food groups compared were cereals, pulses, dairy (including butter), vegetable oils, meat (including fish), eggs, fruits and nuts, and vegetables (including root vegetables). Beverages were excluded. Intake was calculated for adults aged 16-59, for men and women combined (NNMB data were only available for ages 18 and over), though stratification by age was not possible for FAO data.

Household expenditure surveys were converted to individual intake using Indian caloric requirement adjustment factors based on age and sex[32], and we used household weights to scale up to the national level. In the NSS data we additionally adjusted for high-income households which provide food to poorer households in exchange for labour or services, based on a standard methodology recommended by the NSS[18]. We converted intake of the IMS and APCAPS FFQ items into individual food intake using the recipe sheets generated for these surveys, and aggregated these foods into food groups. Intake of each food group in the IMS data was additionally adjusted based on the validation of the IMS against a series of three 24HR surveys[26]. Data from the FAO and NNMB surveys were extracted from publicly-available reports, and aggregated into the relevant

food groups. FAO data were averaged for the years 2004-5, and 2011-12, to match the corresponding NSS and IHDS survey rounds. The IMS (conducted during 2005-7) and APCAPS (2010-12) asked respondents to recall intake over the previous year, and we have therefore used the years of intake in these surveys as 2004-6 and 2009-11, respectively, and matched these data for comparison to the IHDS-1 conducted in 2004-2005, and the NSS 66 conducted in 2009-10.

Comparisons using the Indian Migration Study were additionally stratified by income groups, as the employed IMS respondents and their siblings may have represented a higher socioeconomic sample than the average Indian population. For this, we generated a common standard of living index (SLI) between the IHDS and IMS, based on the SLI methodology developed in the Indian National Family Health Survey (NFHS)[35]. The components of this index include ownership of various assets and utilities, and we compared intake between the surveys for SLI tertiles. APCAPS data were compared to NSS rural households in Ranga Reddy district. Although matching for the same specific APCAPS villages was not possible in the NSS, the mean SLI between the APCAPS sample and the district-level NSS sample was very similar.

Relative differences in total daily intake, and for individual food groups (both in grams/day), were calculated for each dietary intake method comparison. We were not able to assess the statistical significance of the comparisons, as FAO and NNMB data do not allow for standard error calculations, and the main underlying uncertainty for all the methods is likely to be a function of measurement error rather than sample size. Spearman coefficients assessed the similarity of ranked food group intake across comparisons.

Ethics committee approval for IMS was obtained from the All India Institute of Medical Sciences Ethics Committee, and for APCAPS from the National Institutes of Nutrition, Hyderabad, and Public

Health Foundation of India, New Delhi. Ethics committee approval for this analysis was obtained from the London School of Hygiene and Tropical Medicine. Consent was sought from the factory managers for the Indian Migrant Study and from the community leaders in the villages for the APCAPS study.

Results

Individual intake of food groups was calculated for twelve Indian national and sub-national data sources, conducted between 2004-2012, representing four dietary intake estimation methods (Table 1).

National-level trends over time

Both the NSS and NNMB surveys showed a decline nationally in total intake of food, in grams/day, between 2004/5-2011/12, though the IHDS and the FAO FBSs showed an overall increase over the same years (Figure 1). Changes in food group consumption between 2004-2012 were mostly consistent across the NSS, IHDS, and FAO data; nationally, sources showed an increase in intake of pulses, dairy, fats, eggs (no change in IHDS data), meat and fish, and sugar, and a decrease in cereals (no change in the FAO data). Intake of fruits and vegetables showed a decrease in NSS, and an increase in IHDS and FAO data. The IHDS, NSS, and IMS recorded higher overall intake in grams/person/day in urban than rural areas, for all available survey rounds (Supplementary figures 3 and 4).

In 2012, the most recent year of data availability, intake (in kg) in India was highest for cereals (about 30-45%, depending on the data source), while consumption of dairy and vegetables was also high (about 20-25%). Eggs and meat constituted the lowest intakes (2% or less), and consumption of pulses, oil, and sugar were also low (about 3-5%) (Figure 1).

222

223 *Overall differences across survey types*

224 Relative differences in combined intake of all food groups across the individual data comparisons
225 varied markedly, and ranged from 1% between the IHDS-1 and the corresponding NNMB 24HR
226 survey, to 50% between the NSS round 68 and FAO FBSs. The IHDS and NSS expenditure surveys
227 were similar to each other, showing a relative difference in total intake of just 1%, averaged across
228 the two rounds of the surveys. Compared to HCESs, FFQs and FBSs showed higher absolute intake
229 (on average, by 13% and 35%, respectively), and the 24HR surveys lower intake (average of -9%)
230 (Table 2).

231

232 Type 1 and 2 formats were compared for round 68 of the NSS data (2011-2012). The type 2 survey
233 showed substantially higher intake for those foods surveyed with the 7-day recall (vegetable oils,
234 eggs, meat & fish, vegetables, and fruit & nuts; with increases of 9%, 66%, 43%, 48%, and 63%,
235 respectively). Intake for the remaining foods that retained the 30-day recall in type 2 (cereals,
236 pulses, and sugar) showed minor relative differences of about 1% compared to the same 30-day
237 recall of these foods in the type 1 survey (Supplementary figure 5).

238

239 *Food group differences across survey types*

240 Of all food groups, intake of cereals showed the smallest relative differences in grams/person/day
241 across the survey comparisons, ranging from -1 to 9%, with an average difference of 5%. Fruit and
242 nuts, eggs, meat and fish, and sugar had high average relative differences across the comparisons
243 (120%, 119%, 56%, and 50% average differences, respectively). Fruit and nuts in particular had the
244 highest variability in differences between comparisons, ranging from a -36% difference between
245 the NSS and IHDS HCESs, to a 264% difference between the expenditure surveys and FBSs (Table 3).

246

Spearman correlation analysis of food group ranks (intake of a food group as the proportion of total intake in kg) showed very high correlation across surveys (Spearman's rho 0.8-1.0 across surveys, p=0.01 to p<0.0001).

Discussion

We present a comparison of several sources of Indian dietary data, representing a variety of intake estimation methods. This is, to our knowledge, the first such analysis. We found differences in estimates of overall and food group intake across these comparisons when matching sources for year, sex, and region, which may be partly due to methodological differences across the surveys.

Compared to the national consumer expenditure surveys, relative differences in total estimated intake in grams/person/day varied from 1% to 50% across the other data sources. The two national expenditure surveys were most similar to each other, while the FFQs and FBS showed higher intake, and the 24HR surveys lower intake, in relation to these. Cereal consumption had high agreement across survey types, while fruit and nuts, eggs, meat and fish, and sugar had the least.

Recent work has suggested that the Indian expenditure and 24HR surveys may to some degree underestimate food consumed out of home[19], and this could partly explain the lower consumption recorded in these sources relative to FFQ and FBS data. The NSS records the value and number of snacks and meals, respectively, eaten out of the home from a single respondent (and IHDS records only the value of meals). This is generally the female adult of the household who recalls other household members' intake[19], and may therefore not be aware of some foods eaten out of the home[20,36,37]. The NNMB 24HR surveys share a similar limitation, and to our knowledge, do not provide details on how the nutritional composition of recalled food is determined, or how food outside the home is accounted for. However, the NSS is the longest-running source of nationally

representative data, and is frequently used to analyse consumption trends in India. Two factors may help improve estimates of dietary intake from these expenditure data. First is the use of the "type 2" data, in which the use of a shorter recall period may help improve accuracy[27,38], particularly for nutrient-rich food groups. We calculated a 13% higher total intake in grams per person per day across all foods, and NSS-own estimates show about 6-9% higher caloric intake in rounds 66 and 68, when compared to the typical "type 1" 30 day recall [18,27]. Secondly, our calculations showed about 7-8% of NSS households' food expenditure was spent on snacks and food prepared outside the home (data not shown), and methods are needed to estimate intake from these sources. The two most recent NSS rounds have improved the specificity of food types eaten out of home[18,27], and while the survey provides the average estimated caloric, fat and protein composition of these items, the data format still does not allow for direct intake estimates of food groups or key nutritional indicators such as sugar, salt, or micronutrients.

The decline in overall intake between 2004/5 and 2011/12 in the NSS and NNMB data was not seen in the FAO FBSs or the IHDS expenditure surveys. The FAO captures all food available at the national level, and may better assess all available food regardless of where it was purchased or eaten, though as the IHDS shares similar methodology to the NSS expenditure survey, it is not clear why they diverged on the direction of overall intake.

FAO FBS data have been shown to generally overestimate per capita intakes[2,25,39], as they may not fully account for wastage along the value chain from production up to consumption[25]. However, the FBSs are a common source for assessing trends over time in food availability[2]. Comparisons of FBSs to other data sources have found that despite the general overestimation, FBSs can underestimate intake of certain food groups[23,25]. In our study, the FBSs overestimated all food groups relative to NSS and IHDS expenditure surveys.

297

298 FFQs have been shown to have variable performance compared to other reference methods, in
299 terms of direction and magnitude, though generally provide accurate ranking of food group
300 intake[24]. FFQ characteristics such as the number of recall items and recall period affect their
301 accuracy[24]. The IMS FFQ was calibrated against a series of three 24HR surveys[26], which are often
302 used as a reference standard. Our use of these adjustments lessened the differences between the
303 IMS and expenditure survey considerably, as the original IMS data showed almost 50% higher total
304 intake than the HCES. A similar validation was not undertaken for APCAPS, and this may explain
305 why the difference in intake between APCAPS and the HCES is higher than that between the IMS
306 and the HCES.

307

308 As each dietary data method was designed for select purposes, it is expected that the dietary
309 intakes in our comparisons would differ. Consumption of nutrient-rich food groups, as well as of
310 sugar, showed high degrees of variability between the various data sources. This observation
311 agrees with other recommendations that the dietary assessment methods we have reviewed may
312 not be appropriate for precise assessment of individual-level caloric or micronutrient intake[40-42].
313 Instead, these data sources could be applicable for broader nutritional assessments, such as
314 relative comparisons between groups or identification of groups at nutritional risk, measures of
315 dietary diversity, time trends, categorization of dietary patterns, and selection of foods for
316 biofortification[40,42,43]. For example, the FFQ used in the IMS and APCAPS data was designed to
317 examine relative differences in food consumption, nutrition, and health across population groups,
318 and has been reported to be valid for such purposes[26]. Our findings of high correlation in ranked
319 food group intake across all compared data sources also support these recommendations. Analyses
320 of dietary impacts on health require the use of data sources that contain information on potential
321 socioeconomic confounders, such as the IMS, APCAPS, and IHDS (though IHDS only include

anthropometric data, while IMS and APCAPS measured a range of health outcomes). However, even within the recommended uses of these data, additional limitations may exist for populations with unique dietary needs or intake patterns, such as children (for whom 24HRs or FFQs would require knowledgeable respondent proxies, and difficult assumptions about individual allocation from household-level surveys) and minority populations (where FFQs may not be reflective of unique cultural foods). Users of these data sources should therefore examine their suitability for purposes other than what the data were originally designed for. The most precise methods for micronutrient and caloric intake remain doubly-labelled water, and in some cases, 7-day weighed food records, though their use is limited by their cost and time requirements. As such, there may be a trade-off between feasibility of national coverage and accuracy of individual-level intake. These above points apply to any uses of the data, including for research or programmatic needs.

This comparison of Indian dietary data has some limitations. Firstly, it is not possible to validate the individual data sources as no gold standard reference exists for our use, and therefore our comparisons between sources are only in relative terms. We have matched data for major characteristics such as year, region, sex, and socioeconomic levels, though other sampling factors may have contributed to the differences in intake we have calculated, particularly for the non-nationally representative data sources. The availability of data meant we could not compare all survey types against each other for a given time period, and for this reason, we used the expenditure surveys, for which several rounds are available, as the common reference comparison to other data sources. The year of the data source may have differentially affected our comparisons, for example, as increasing consumption out of home may have exacerbated differences between HCES and FBS for the more recent time period. All data sources, except the FBS, are also likely to suffer to some degree from recall bias. The conversion of HCES intake data from the household to individual level may have introduced some bias, as differences in intra-

family food allocation likely exist[44] outside of age- and sex- derived caloric requirements. However, despite these limitations, this is the first comparative analysis to bring these varied data sources together, and this work should serve as a useful platform to inform the many future uses of these data.

This analysis compares estimated food intake across several Indian data sources to contextualize broad relative differences across dietary intake estimation methods. Each methodological choice may have its own advantages and disadvantages for particular research uses, and further work is required to suggest specific improvements for current Indian dietary data sources. Of general usefulness would be the development of more comprehensive nutritional composition databases, and improved methods in the on-going national surveys for measuring consumption out of home. Also crucial is generation of high-quality data that can be used to validate or calibrate the various current and future sources of dietary intake.

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Conflict of interest

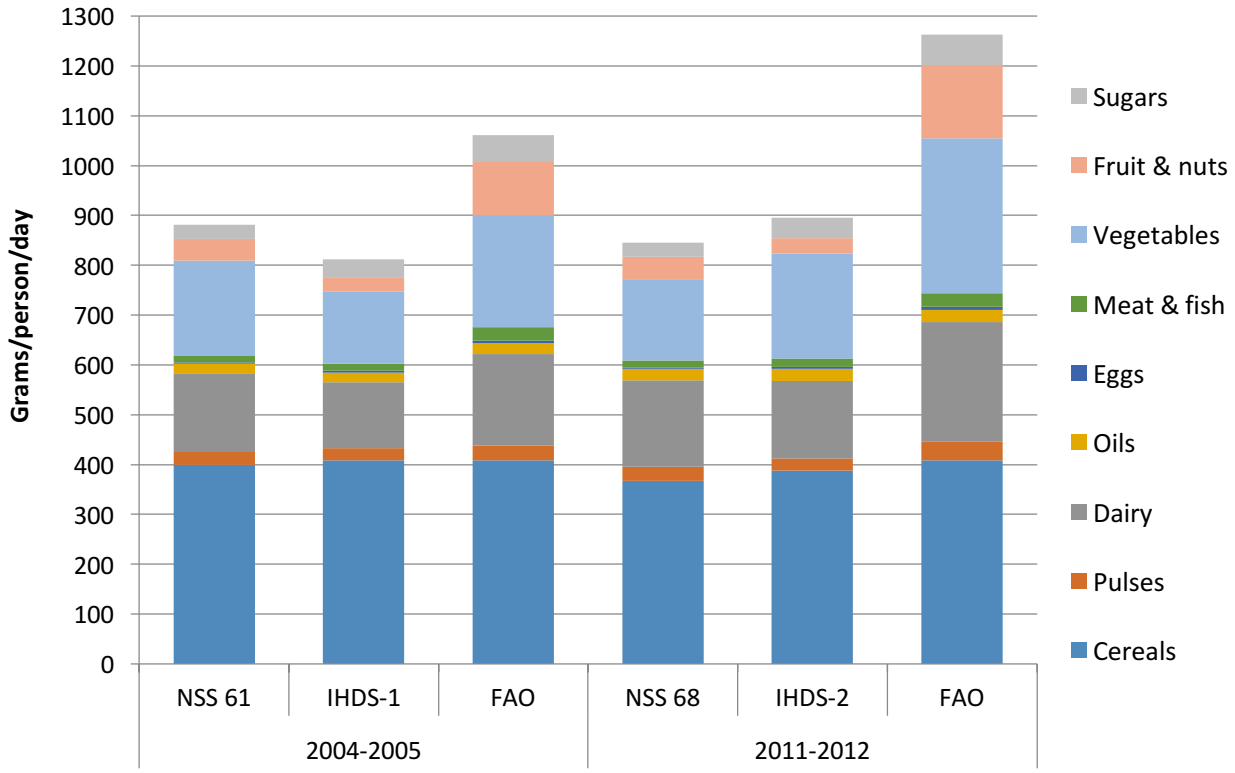
The authors declare that there are no conflicts of interest.

Authorship

LA and MT designed the study, and LA carried out the analysis, and drafted the paper. SK was involved in data collection of the APCAPS, and shared the IMS and APCAPS data. LA has primary responsibility for the final content. All authors were involved in data interpretation, critical revisions of the paper, and approved the final version.

Figures

Figure 1: Consumption of food groups at the national level, recorded in household expenditure surveys (NSSO, IHDS) and food balance sheets (FAO), in 2004-5 and 2011-12.



Tables

Table 1: Description of datasets

	Data type	Year of survey	Region	Rural/ urban	Recall period	Sample size
NSS 61	HCES	2004-2005	National	Both	30 days	353,561
NSS 66	HCES	2009-2010	National	Both	30 days	284,718
NSS 68	HCES	2011-2012	National	Both	30 days	285,954
NSS 68 type 2	HCES	2011-2012	National	Both	7 days*	285,695
IHDS-1	HCES	2004-2005	National	Both	30 days	124,355
IHDS-2	HCES	2011-2012	National	Both	30 days	121,622
IMS	FFQ	2005-2007	Hyderabad, Lucknow, Nagpur, Bangalore districts	Both	1 year	4,531
APCAPS-3	FFQ	2010-2012	Rangareddy district, Andhra Pradesh	Rural	1 year	6,273
NNMB	24HR	2004-2005	National**	Rural	24 hours	N/A
NNMB	24HR	2011-2012	National**	Rural	24 hours	N/A
FAO	FBS	2005-2006	National	Both	N/A	N/A
FAO	FBS	2011-2012	National	Both	N/A	N/A

NSS, National Sample Survey; HCES, Household consumption expenditure survey; IHDS, India Human Developent Study; IMS, Indian Migration Study; FFQ, food frequency questionnaire; APCAPS, Andhra Pradesh Child and Parent Study; NNMB, National Nutrition Monitoring Bureau; 24HR, 24-hour recall; FAO, Food and Agriculture Organisation; FBS, food balance sheets.

*7-day recall for meats, eggs, oils, fruits, vegetables; 30-day recall for cereals, pulses, sugar.

**Data collected in 10 Indian states, sample not designed to be nationally-representative.

Table 2: Relative differences in absolute intake of all food groups (g/person/day) between survey types

Reference survey	Intake g/d	Comparison survey	Intake g/d	% Difference
HCES vs. HCES (avg.)				**-1%**
NSS 61	881	IHDS-1	813	-8%
NSS 68	845	IHDS-2	895	6%
FFQ vs. HCES (avg.)				**13%**
IHDS-1	996	IMS	1052	6%
NSS 66	735	APCAPS	891	21%
FBS vs. HCES (avg.)				**35%**
NSS 61	881	FAO	1061	20%
NSS 68	845	FAO	1263	50%
IHDS-1	813	FAO	1061	31%
IHDS-2	895	FAO	1263	41%
24HR vs. HCES (avg.)				**-9%**
IHDS-1	735	NNMB	745	1%
IHDS-2	862	NNMB	712	-17%
NSS 61	807	NNMB	745	-8%
NSS 68	814	NNMB	712	-13%

HCES, Household consumption expenditure survey; NSSO, National Sample Survey Organistion; IHDS, India Human Developent Study; FFQ, food frequency questionnaire; IMS, Indian Migration Study; APCAPS, Andhra Pradesh Child and Parent Study; FBS, food balance sheets; FAO, Food and Agriculture Organisation; 24HR, 24-hour recall; NNMB, National Nutrition Monitoring Bureau.

Table 3: Relative differences in intake (g/person/day) of food groups between survey types

	HCES vs. HCES	FFQ vs. HCES	FBS vs. HCES	24HR vs. HCES	Average*
Cereals	4%	-1%	5%	9%	5%
Pulses	-10%	41%	31%	25%	27%
Dairy	-13%	49%	37%	-34%	33%
Fats	1%	15%	11%	-28%	14%
Eggs	60%	212%	87%	N/A	119%
Meat & fi	11%	114%	83%	-17%	56%
Vegetable	3%	-24%	52%	-26%	26%
Fruit & nu	-36%	182%	264%	-1%	120%
Sugar	44%	-24%	78%	-55%	50%

HCES, Household consumption expenditure survey; FFQ, food frequency questionnaire; FBS, food balance sheets; 24HR, 24-hour recall.

*Absolute magnitude, taking all relative differences as positive.

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