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Paediatrics Section

Public Report on Health: Development of a Nutritive Value Calculator for Indian Foods and Analysis of Food Logs and Nutrient Intake in 6 States

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ABSTRACT

The Public Report on Health (PRoH) was initiated in 2005 to understand public health issues for people from diverse backgrounds living in different region specific contexts. States were selected purposively to capture a diversity of situations from better-performing states and not-so-well performing states. Based on these considerations, six states – the better-performing states of Tamil Nadu (TN), Maharashtra (MH) and Himachal Pradesh (HP) and the not-so-well performing states of Madhya Pradesh (MP), Uttar Pradesh (UP) and Orissa (OR) – were selected. This is a report of a study using food diaries to assess food intakes in sample households from six states of India.

Method: Food diaries were maintained and all the raw food items that went into making the food in the household was measured using a measuring cup that converted volumes into dry weights for each item. The proportion consumed by individual adults was recorded. A nutrient calculator that computed the total nutrient in the food items consumed, using the 'Nutritive Value of Indian Foods by Gopalan et al., was developed to analyze the data and this is now been made available as freeware (http://bit.ly/ncalculator). The total nutrients consumed by the adults, men and women was calculated.

Results: Identifying details having been removed, the raw data is available, open access on the internet http://bit.ly/foodlogxls. The energy consumption in our study was 2379 kcal per capita per day. According to the Summary Report World Agriculture the per capita food consumption in 1997-99 was 2803 which is higher than that in the best state in India. The consumption for developing countries a decade ago was 2681 and in Sub-Saharan Africa it was 2195. Our data is compatible in 2005 with the South Asia consumption of 2403 Kcal per capita per day in 1997-99. For comparison, in industrialized countries it was 3380. In Tamil Nadu it was a mere 1817 kcal.

Discussion: The nutrient consumption in this study suggests that food security in the villages studied is far from achieved. It is hoped that the new Food Security Ordinance will make a dent in the situation. The calculator for computing nutrients of foods consumed which we developed based on the ICMR defined nutrient values for Indian foods has been made available as freeware on the internet. This is with the hope that more such studies can be carried out at the household level.

Keywords: Food security, Dietary requirements

INTRODUCTION

Food security exists only when all people, at all times have physical, social and economic access to sufficient, safe and nutritious food to meet their daily dietary needs and food preferences for an active and healthy life (FAO 1996) [1]. The national average food consumption from food balance sheets, shows that in developing countries, the availability of calories rose from 2054 per capita per day in 1964-66 to 2681 in1997-99 [2]. According to FAOSTAT, in 1967, in developing countries, of the 2059 total calorie intake, 1898 (92%) calories came from vegetable and 161 (8%) calories came from animal sources but in 1997-99 of the total 2681 calories consumed, 2344 (87%) came of vegetable origin and 337(13%) from animal sources indicating an apparent shift towards more expensive foods.

The annual food balance sheet of the FAO (FAOSTAT 2012) provides national data on food availability including production, imports, exports and utilization by commodity [3]. However, the average per capita supply of energy, protein, and fat derived from this do not correspond to actual per capita availability of these nutrients at the regional and local levels. These need to be studied at the household level to understand the socioeconomic factors determining access at the individual level.

Assessment of consumption

Of the several methods employed to assess dietary intakes, food frequency questionnaires, food records, and 24 hour diet recall are the three most common ones [4]. Food Frequency Questionnaire (FFQ) is a limited checklist of foods and beverages with a frequency response to report how often each item was consumed over specified periods of time [5].

Calculations for nutrient intake can then be estimated via computerized software programs. In non-quantitative FFQs, portion size information is not collected and in general are less sensitive to measures of absolute intake for specific nutrients.

On the other hand, in food record or food diaries document a detailed description of the types and amounts of food, beverage and/or supplements are documented over a prescribed period, usually 3 to 7 days. Participants may be asked to weigh and measure food items and, if used correctly, they are not dependent upon the participant's memory. However, the act of recording dietary intake may alter eating behavior which is considerably a disadvantage in measuring "usual intake". Food diary has limited use in many populations because the method puts substantial burden upon the participant, is expensive to code and analyze due to the cost of skilled personnel, computer hardware and software, and requires

literate and motivated individuals. It is known that, as the number of reporting days increase, there is significant decrease in the subjects recording intake.

The 24 hour dietary recall is the most widely used diet assessment method. Twenty four hours dietary recall first assesses the raw amounts used for cooking for the entire household, converts them into cooked quantities of food, share of each person in these amounts (along with remaining amount /wastage etc) and also information on additional food items consumed by each person in the house hold. Though it puts the least amount of burden on the participant they are expensive. There is need for trained and skilled interviewers because the estimation of portion sizes may be very difficult. It can be made easier through the use of food models and photographs. A table providing comparison of advantages and disadvantages of the different methods is provided as [Table/Fig-1].

This is a report of a study using food diaries to assess food intakes in sample households from six states of India [6,7].

The Public Report on Health (PRoH)

A national level study, the PRoH, was initiated in 2005 by a team with members from different disciplinary backgrounds. The study was designed to understand public health issues for people from diverse backgrounds living in different region specific contexts. States were selected purposively to capture a diversity of situations from better-performing states and not-so-well performing states. Based on these considerations, six states – the better-performing states of Tamil Nadu (TN), Maharashtra (MH) and Himachal Pradesh (HP) (better developed-BD) and the not-so-well performing states of Madhya Pradesh (MP), Uttar Pradesh (UP) and Orissa (OR) (less developed-LD) – were selected [Table/Fig-2] shows the location, access, and population of the study villages. The study design and key findings have been reported previously. Briefly, the sample comprised of six villages in Phase I and of sixty villages in Phase II from these six states. One aspect of the data collected in Phase I relates to food logs to examine [8] food security in these populations.

Food Logs - Methods

The study was carried out in six villages selected purposively from less developed districts of the six states Virudunagar district (TN), Jalna district (MH), Chamba district (HP), Shadhol district (MP), Allahabad district (UP), and Rayagada district (OR). [Table/Fig-2] gives the location and access of the six villages to indicate the level of connectivity and development. Following a village meeting to explain the purpose of the food logs, from each of the villages, approximately 20 households were selected in a purposive way that would ensure the inclusion of broad socio economic (land holding/sources of livelihood and caste/tribe and religion) categories and occupational groups on the basis of information available through the initial baseline survey of the villages. In each of the selected households, after obtaining informed consent, daily food logs were maintained at the household level for a period of a week every month. To overcome inaccuracies in the usual methods of documenting food intake, food diaries were maintained and all the raw food items that went into making the food in the household was measured using a measuring cup that converted volumes into dry weights for each item. Raw food was measured in Seiko measuring cup which converts volume of different dry foods into weights. The measuring jug was itself tested for accuracy of calibration for the different items on a Salter electronic scale Model 1004 (Salter Ltd Tonbridge UK) and found to have an accuracy of +/- 5%. Food consumed daily by the household along with the amount consumed (in cooked quantity) was also recorded by one of the literate persons from the household under the supervision of the local team member. In the absence of literate persons within a household, the local team member with the help of literate persons in the village recorded intakes. No incentives, monetary or otherwise, were provided. The data was entered in a format 'Daily Household Log' which listed broad food groupings; cereals, pulse, oil/ghee, milk/milk products, vegetables (green leafy), vegetable (others), meat/egg/fish, fruit and sugar/jaggery. The name of cereal, pulse, vegetable etc were to be recorded by the recording person. The proportion consumed by individual adults was recorded.

The data was then logged on an Excel spreadsheet and the intake in the adults calculated in grams. A nutrient calculator that calculated the total nutrient in the food items consumed, using the 'Nutritive Value of Indian Foods by Gopalan et al., [9], was developed to analyze the data and this is now been made available as freeware (http://bit.ly/ncalculator). This communication reports the total nutrients consumed by individual adults in the study households calculated using this software programme. Food log records were available from 410 individuals 210 of them men and 197 women, (and there were 13 where sex was not recorded) from the six villages; 85 were from the HP village, 52 were from MH village, 89 from MP village, 78 from OR village, 70 from TN village and 36 from UP village. Data from UP was included in the overall assessments but in view of its small sample size it was not included in the state-wise comparisons. Data from males was compared with females. Data from Himachal Pradesh which is comparatively a better performing state was used as the benchmark and intake in other states was compared to HP. Mean intake of each nutrient was calculated as also the standard deviation. The Confidence Interval (CI) calculator was used to determine the 95% CI of all the values and for looking at significance of differences between groups [Confidence Interval Analysis (CIA) Software Version 2.2.0 (http://www.som.soton.ac.uk/cia)] [10].

RESULTS

[Table/Fig-3] gives the intake of each nutrient (Means, SD and CI). Overall the energy consumption was 2379 Kcal (95%CI 2286-2472) with a carbohydrates intake of 472 g (CI 454-491), protein intake of 65 g (CI 62-68) and fat intake of 25.5 g (CI 24-27).

The consumption was best in HP where on an average 2894 Kcal were consumed, of which 528 g was carbohydrates, 89 g protein and 42.19 g fat. This was followed by the OR village (2289 calories; 492 g carbohydrate, 55 g of protein and 11.7 g fat). Though the calorie intake of MH and MP villages were similar (2158 and 2122 respectively), their intake of protein (79 g and 50 g respectively) and fat (14.6 g and 19.7g respectively) was different indicating the differences in the composition of diet. The surprising finding was the TN village which had the least calorie intake at 1817 but had the highest intake of fat at 32 g.

[Table/Fig-4] compares the intake in other states against HP consumption. Energy consumption in TN village was 1032 Kcal less than HP, 727 Kcal less in MP, 691 Kcal less in MH and 560 Kcal less in Orissa. Carbohydrate intake was 185 g less in TN, 99 g in Maharashtra, 91 g less in MP and 35.7 g less in Orissa. Compared to HP village, protein intake in TN was 48 g less, MP was 40 g less OR was 34 g less and MH was 10g less. Fat intake in HP village was 42 g, and in comparison to it, fat intake was 30 g less in OR, 28 g less in MH, 22 g less in MP and 10 g less in TN. Iron intake was 26 mg in HP, 12 mg less in OR, 15 mg less in TN, and 16 mg less in MP; iron intake in MH was 4.3 mg higher than that in the HP village. The intake of iron by women in TN was only 7 mg, in MP it was 8 mg, less than half of the daily requirement. The Recommended Dietary Recommendations (RDA) for iron is dependent on the absorption of available iron and the presence of phytates inhibit the absorption of iron.

[Table/Fig-5] shows consumption disaggregated by gender with the RDA of the ICMR [11].

Men consumed 2559 Kcal compared to 2195 Kcal by women. Men consumed 508 g of carbohydrates 72 g protein and 27 g fat

Method	Description	Strengths	Limitations
Household consumption and expenditure survey (HCES)	Detailed information on household expenditure for a month is collected and percapita expenditure on food is calculated from this	For large ecological studies	Based on recall Price of food items may fluctuate over the survey period complicate computing Errors in reporting (recall and deliberate)
Food frequency questionnaires (FFQ)	Participant asked the frequency of consumption (daily, weekly, monthly) of the different foods listed in the questionnaire	Easy to administer Can cover a large sample in a short time Can be admini stered by non-specialised person	Errors in estimating potion size Over-reporting or underreporting of more expensive foods (which are thought to be healthy)
24 Hour recall	The respondent (individual or for a family) is asked to remember food items intake (type and quantity) in the previous day	More accurate than the FFQ method Not very difficult to administer	Retrospective method and relies on memory. Cannot be validated. One day may not be representative. Can be considered intrusive.
Three day weighment	All the food weighed before preparing	High quality data	Needs a trained worker Time consuming Only a small sample can be covered Can be considered intrusive High respondent motivation to participate.
Food record/diary (the current study)	All the foods and their potion size recorded and quantity measured using standardised cups/spoons	Relatively more accurate to get total food prepared, consumed and intra-family consumption.	Researcher and respondent fatigue if done for a prolonged period Relies on memory and on respondent's statement

[Table/Fig-1]: Strengths and limitations of different methods of dietary intake assessment

State	District	Distance from Hqs (Kms)	Distance from Main Road	Transport		Condition of Roads	Households	Population
				Public	Private			
TN	Virudunagar	9(taluk)	Passes through	yes	yes	Good tar, all weather	358	1287
MH	Jalna	20 (taluk)	10 kms	no*	yes	Kaccha road	223	1081
HP	Chamba	10(dt)	Passes through	no	yes	Blocked during monsoon	182	896
MP	Shahdol	40(block)	7 kms	no	yes	No road; dirt track	253	1119
UP	Allahabad	3(block)	3 kms	no	no	Dirt track	245	1298
OR	Rayagada	18 & 16 (block)	2 kms	no	no	Blocked during monsoons	260	1085

[Table/Fig-2]: Location, access, and population of the study villages

	ALL	HP	Maharashtra	MP	Orissa	TN	UP
Energy (Kcal)	2379.2 [957.9]	2894.4 [769.5]	2158.5 [1028.9]	2121.9 [908.7]	2289.1 [338.4]	1817.1 [591.6]	3511.7 [1412.0]
	(2286.2 - 2471.9)	(2683.3 - 3015.2)	(1871.9 - 2444.8)	(1930.3 - 2313.2)	(2212.8 - 2365.3)	(1676 - 1957.9)	(3033.9 - 3989.4)
Carbohydrates (g)	472.2 [190.3]	527.8 [147.7]	428.4 [196.6]	436.7 [199.7]	492.1 [72.8]	342.0 [116.6]	701.7 [270.3]
	(453.6 - 490.5)	(495.8 - 559.5)	(373.6 - 483.1)	(394.6 - 478.7)	(475.6 - 508.5)	(314.2 - 369.7)	(610.1 - 793)
Protein (g)	65.2 [33.0]	89.0 [27.8]	78.8 [38.1]	49.5 [23.7]	54.9 [9.5]	40.7 [18.4]	98.1 [40.8]
	(61.8 - 68.2)	(82.9 - 94.8)	(68.0 - 89.1)	(44.5 - 54.4)	(52.6 - 56.9)	(36.2 - 44.9)	(84.1 - 111.8)
Fat (g)	25.5 [19.4]	42.1 [16.1]	14.6 [12.2]	19.7 [17.5]	11.7 [4.9]	32.2 [15.6]	33.5 [26.8]
	(23.6 - 27.3)	(38.6 - 45.5)	(11.1 - 17.8)	(15.9 - 23.2)	(10.6 - 12.7)	(28.5 - 35.8)	(24.4 - 42.5)
Crude Fibre (g)	8.3 [5.3]	12.2 [4.1]	9.8 [4.7]	4.2 [2.7]	9.1 [2.0]	4.3 [4.9]	12.9 [7.0]
	(7.6 - 8.7)	(11.3 - 13.0)	(8.4 - 10.9)	(3.5 - 4.6)	(8.6 - 9.5)	(3.1 - 5.4)	(10.5 - 15.2)
Minerals (g)	11.2 [6.8]	15.5 [4.5]	15.5 [7.7]	6.8 [3.9]	9.8 [1.7]	5.8 [3.7]	18.7 [9.3]
	(10.4 - 11.7)	(14.4 - 16.3)	(13.3 - 17.6)	(6 - 7.6)	(9.2 - 10.1)	(4.9 - 6.6)	(15.5 - 21.8)
Calcium (mg)	386.3 [274.1]	412.1 [187.5]	389.7 [155.3]	210.7 [211.5]	680.4 [137.4]	209.4 [198.4]	561.4 [389.1]
	(359.7-412.9)	(371.7-452.5)	(346.5-432.9)	(166.1-255.3)	(649.4-711.4)	(162.1-256.7)	(429.7-693.1)
Iron	18.2 [13.7]	26.0 [9.4]	30.3 [19.0]	9.5 [7.3]	13.9 [4.4]	10.6 [11.5]	28.0 [14.4]
	(18.2 - 13.7)	(23.8 - 27.9)	(25 - 35.5)	(7.8 - 10.9)	(12.9 - 14.8)	(7.8 - 13.3)	(23.2 - 32.7)
Thiamine (mg)	1.3 [1.2]	2.2 [0.7]	2.3 [1.3]	0.5 [0.7]	0.9 [0.4]	0.3 [0.4]	2.3 [1.4]
	(1.0 - 1.3)	(1.9 - 2.5)	(1.9 - 2.6)	(0.2 - 0.5)	(0.3 - 0.4)	(0.2 - 0.4)	(1.8 - 2.7)
Carotene (mcg)	1481.2 [2786.2]	2502.3 [2326.7]	445.5 [412.9]	571.9 [982.1]	681.8 [612.2]	2166.0 [4568.0]	3214.4 [4625.8]
	(1210.9 - 1751.2)	(2000.4 - 3004.1)	(330 - 560)	(364.9 - 778.6)	(543.6 - 819.7)	(1076.6 - 3255.3)	(1649.2 - 4779.5)
Riboflavin (mg)	0.4 [0.5]	0.7 [0.4]	0.9 [0.7]	0.2 [0.3]	0.1 [0.1]	0.2 [0.3]	1.0 [0.6]
	(0.3 - 0.4)	(0.6 - 0.7)	(0.6 - 0.9)	(0.0 - 0.1)	(0.0 - 0.1)	(0.1 - 0.3)	(0.7 - 1.1)
Folic Acid (free) (mcg)	87.0 [50.3]	110.0 [36.4]	86.7 [46.2]	46.0 [28.6]	102.4 [23.0]	58.0 [50.4]	118.6 [65.2]
	(82.1 - 91.8)	(102.0 - 117.3)	(73.8 - 99.5)	(39.9 - 52)	(115.1 - 125.4)	(46 - 69.6)	(96.5 - 140.6)

[Table/Fig-3]: Nutrient intake by State [SD] (CI)

Numbers	Maharashtra Compared to HP Difference [95% CI]	MP Compared to HP Difference [95% CI]	Orissa Compared to HP Difference [95% CI]	TN Compared to HP Difference [95% CI]
Energy (Kcal)	-690.9 [-996.1 to -385.6]	-727.5 [-980.0 to -474.9]	-560.3 [-747.0 to-373.5]	-1032.3 [-1253.8 to-810.7]
Carbohydrates (g)	-99.4 [-157.8 to -40.9]	-91.1 [-143.8 to -38.3]	-35.7 [-72.2 to 0.8]	-185.8 [-228.7 to -142.8]
Protein (g)	-10.3 [-21.4 to 0.8]	-39.5 [-47.5 to-31.7]	-34.1 [-40.6 to -27.5]	-48.3 [-55.3 to -40.6]
Fat (g)	-27.5 [32.6 to -22.3]	-22.4 [-27.4 to -17.3]	-30.4 [-34.1 to -26.6]	-9.9 [-14.9 to -4.8]
Crude Fibre (g)	-2.4 [-3.9 to -0.8]	-8.0 [-9.1 to -6.9]	-3.1 [-4.1 to -2.1]	-7.9 [-9.3 to -6.4]
Minerals (g)	-0.3 [-2.3 to 1.7]	-8.7 [-9.4 to -7.4]	-5.7 [-6.7 to -4.6]	-9.7 [-11.0 to-8.3]
Calcium (mg)	-22.4 [-83.7 to 38.9]	-201.4 [-261.3 to -141.5]-	268.3 [217.1 to 319.5]	-202.7 [-264.1 to -141.3]
Iron	4.3 [-0.5 to 9.1]	-16.5 [-19.0 to -13.9]	-12.1 [-14.4 to -9.7]	-15.4 [-18.7 to -12.1]
Total B6 (mg)	0.1 [0.0 to 0.2]	0.0 [-0.1 to 0.1]	-0.2[-0.2 to -0.1]	-0.1 [-0.1 to -0.0]
Calcium (mg)	-647.7 [-967.7 to -327.6]	-684.3 [-947.2 to -421.3]	-2131.1 [-2322.4 to -1939.7]	-989.1 [-1225.6 to -752.5]
Iron	4.3 [-0.5 to 9.1]	-16.5 [-19.0 to -13.9]	-12.1 [-14.4 to -9.7]	-15.4 [-18.7 to -12.1]
Vitamin C (mg)	-46.8 [-57.3 to-36.2]	-4.4 [17.8 to 9.1]	-13.4 [-24.1 to -2.6]	-16.9 [-29.0 to -4.8]
Thiamine (mg)	0.1 [-0.2 to 0.4]	-1.7 [-1.9 to -1.5]	-1.3 [-1.4 to -1.1]	-1.9 [-2.1 to -1.7]
Carotene (mcg)	-2056.8 [-2701.9 to -1411.6]	-1930.4 [-2460.6 to -1400.1]	-1820.5 [-2357.1 to -1283.8]	-336.3 [-1458.4 to 785.8]
Riboflavin (mg)	0.2 [0.0 to 0.4]	-0.5[-0.6 to -0.3]	0.6 [0.5 to 0.6]	-0.5 [-0.6 to 0.3]
Folic Acid (free) (mcg)	-23.3 [-37.3 to -9.2]	-64.0 [-73.7 to -54.2]	10.4 [0.8 to 19.9]	-52.0 [-65.8 to -38.2]

[Table/Fig-4]: Nutrient intake of individual states compared to HP

	All		HP		Maharashtra		MP		Orissa		TN		UP	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
Energy (Kcal) RDA M 2730 F 2255	2559.2 [1043.8] (2416.8 - 2701.5)	2195.8 [827.6] (2082.0 - 2309.3)	3056.8 [792.4] (2812.8 - 3300.5)	2662.4 [701.9] (2451.5 - 2873.2)	2443.7 [1097.7] (2009.3 - 2877.8)	1850.5 [868.3] (1492 - 2208.7)	2320.3 [1021.4] (2005.8 - 2634.5)	1911.9 [753.1] (1693.2 - 2130.5)	2375.3 [335.2] (2266.5 - 2483.8)	2203.0 [323.2] (2098.1 - 2303.0)	1942.8 [700.8] (1709.1 - 2176.4)	1676.1 [404.2] (1532.6 - 1819.3)	3658.1 [1624.5] (2898 - 4418.1)	3328.7 [1115.8] (2734.1 - 3923.2)
Carbohydrates (g) RDA M F	508.0 [208.7] (479.4 - 536.3)	435.4 [161.1] (413.2 - 457.5)	568.7 [156.9] (520.3 - 616)	490.7 [125.0] (453 - 528.1)	483.1 [208.7] (400.5 - 565.6)	369.4 [167.2] (300 - 438.2)	473.2 [222.9] (404.5 - 541.6)	398.2 [169.7] (348.9 - 447.4)	510.1 [71.3] (486.9 - 533.2)	474.1 [70.7] (451.2 - 496.9)	369.2 [138.5] (323 - 415.3)	311.5 [76.8] (284.1 - 338.6)	738.3 [318.1] (589.4 - 887.1)	655.9 [195.8] (551.4 - 760.1)
Protein (g) RDA M 60 F 55	71.5 [35.6] (66.6 - 76.3)	58.9 [29.4] (54.8 - 62.9)	96.9 [30.0] (87.6 - 106.1)	82.5 [24.4] (75 - 89.7)	90.7 [39.4] (75 - 106.1)	65.7 [32.6] (52.1 - 79)	54.0 [27.1] (45.6 - 62.3)	44.4 [19.6] (38.7 - 50)	57.4 [10.2] (53.9 - 60.6)	52.4 [8.1] (49.7 - 55)	47.8 [20.9] (407.3 - 54.6)	32.8 [10.5] (28.9 - 36.4)	100.1 [45.4] (78.7 - 121.2	95.6 [35.6] (76.5 - 114.4)
Fat (g) RDA M 30 F 25	26.9 [20.2] (24.1 - 29.6)	24.1 [18.7] (21.5 - 26.6)	43.7 [15.4] (38.9 - 48.4)	40.4 [18.4] (34.8 - 45.7)	16.6 [14.1] (10.9 - 22)	12.4 [9.7] (8.4 - 16.3)	23.2 [21.6] (16.4 - 29.7)	16.0 [11.8] (12.4 - 19.3)	12.4 [4.8] (10.7 - 13.8)	11.1 [4.9] (9.3 - 12.6)	31.4 [16.8] (25.6 - 36.9)	33.2 [14.2] (28.1 - 38.1)	33.1 [27.0] (20.3 - 45.6)	34.1 [27.3] (19.4 - 48.5)
Crude Fibre (g) RDA M 55 F 45	9.3 [5.7] (8.4 - 9.9)	7.3 [4.9] (6.6 - 7.9)	13.7 [4.2] (12.3 - 14.8)	11.1 [4.0] (9.9 - 12.2)	11.1 [4.7] (9.2 - 12.9)	8.3 [4.2] (6.5 - 10)	4.4 [3.0] (3.3 - 5.2)	3.8 [2.4] (3.1 - 4.4)	9.7 [2.3] (8.9 - 10.4)	8.5 [1.4] (7.9 - 8.8)	5.8 [5.6] (3.9 - 7.6)	2.6 [3.1] (1.5 - 3.6)	13.2 [7.3] (9.7 - 16.6)	12.5 [6.7] (8.9 - 16)
Minerals (g)	12.4 [7.2] (11.4 - 13.3)	10.0 [6.2] (9.0 - 10.7)	16.9 [4.5] (15.4 - 18.1)	14.4 [4.5] (12.1 - 15.6)	17.8 [7.9] (14.5 - 20.8)	13.0 [6.7] (10.2 - 15.7)	7.5 [4.5] (6 - 8.7)	6.1 [3.1] (5.2 - 7)	10.4 [1.8] (9.7 - 10.8)	9.3 [1.4] (8.8 - 9.7)	7.5 [4.0] (6.1 - 8.9)	3.9 [1.9] (3.2 - 4.5)	19.2 [10.1] (14.3 - 23.8)	18.2 [8.6] (13.6 - 22.7)
Calcium (mg) RDA M 600 F 600	420.0 [273.0] (382.8- 457.2)	353.9 [278.7] (315.6- 392.2)	410.3 [143.1] (366.3- 454.3)	435.7 [262.5] (356.8- 514.6)	371.2 [162.0] (307.1- 435.3)	262.0 [128.6] (208.9- 315.1)	231.2 [243.2] (156.3- 306.1)	186.7 [175.3] (132.7- 240.6	713.0 [148.4] (669.9- 756.1)	647.7 [118.5] (609.3- 686.1)	298.1 [231.8] (220.8- 375.4)	110.0 [71.7] 84.6- 135.4)	566.6 [382.1] (387.8- 745.4)	554.9 [410.2] (336.3- 773.5)
Iron (mg) RDA M 17 F 21	20.5 [15.0] (18.3 - 22.4)	16.4 [14.3] (14.3 - 18.2)	28.4 [9.0] (25.5 - 31.0)	25.9 [18.8] (20.2 - 31.5)	34.6 [21.3] (26.1 - 43)	25.6 [15.2] (19.3 - 31.8)	10.5 [8.1] (7.8 - 12.4)	8.3 [6.3] (6.4 - 10.1)	15.3 [5.4] (13.4 - 16.9)	12.6 [2.7] (11.6 - 13.63)	13.5 [13.6] (8.9 - 18)	7.4 [7.7] (4.5 - 10)	29.1 [15.6] (21.7 - 36.2)	26.8 [13.1] (19.7 - 33.6)
Vitamin C (mg)	55.2 [67.1] (45.9 - 64.2)	44.5 [70.7] (34.6 - 54.1)	58.7 [33.9] (48.2 - 69.1)	56.2 [42.0] (43.4 - 68.7)	9.9 [25.5] (- 0.2 - 19.8)	9.3 [26.5] (- 1.7 - 20.1)	50.3 [45.6] (36.2 - 64.3)	52.6 [60.3] (34.9 - 70)	45.2 [35.6] (33.5 - 56.6)	40.7 [38.8] (28.1 - 53.2)	59.6 [42.9] (45.2 - 73.9)	17.0 [31.6] (5.8 - 28.1)	130.5 [161.4] (54.9 - 206)	107.8 [189.7] (66 - 208.7)
Thiamine (mg) RDA M 1.4 F 1.1	1.4 [1.3] (1.2 - 1.5)	1.1 [1.0] (0.9 - 1.2)	2.4 [0.8] (2.0 - 2.5)	2.0 [0.6] (1.7 - 2)	2.7 [1.5] (2.1 - 3.2)	2.0 [1.1] (1.4 - 2.3)	0.6 [0.8] (0.2 - 0.7)	0.4 [0.5] (0.2 - 0.5)	1.0 [0.4] (0.8 - 0.9)	0.9 [0.4] (0.8 - 1)	0.4 [0.5] (0.2 - 0.6)	0.2 [0.3] (0.1 - 0.3)	2.4 [1.6] (1.5 - 3)	2.3 [1.3] (1.6 - 2.9)

Carotene (mcg)	1936.5 [3393.3] (1473.6 - 2399.1)	1082.1 [2241.9] (774.1 - 1390.0)	2794.9 [2736.9] (1952.7 - 3637.0)	2481.3 [3131.9] (1540.3 - 3422.2)	507.6 [464.0] (323.9 - 691)	378.4 [346.5] (235.3 - 521.2)	566.3 [867.8] (299.2 - 833.3)	578.4 [1092.1] (261.3 - 895.4)	723.7 [658.0] (510.3 - 936.9)	639.8 [568.1] (455.6 - 823.9)	3911.6 [5769.5] (1987.8 - 5835.1)	209.0 [289.4] (106.2 - 311.5)	3676.6 [4580.1] (3462.1- 3890.8)	2636.7 [4766.1] (96.6 - 6176.7)
Riboflavin (mg) RDA M 1.6 F 1.3	0.5 [0.6] (0.4 - 0.5)	0.4 [0.5] (0.2 - 0.3)	0.8 [0.4] (0.7 - 0.8)	0.6 [0.3] (0.5 - 0.6)	1.0 [0.7] (0.7 - 1.2)	0.7 [0.6] (0.4 - 0.9)	0.1 [0.3] (0.0 - 0.1)	0.2 [0.3] (0.0 - 0.1)	0.1 [0.1] (0.1 - 0.1]	0.1 [0.1] (0.7 - 0.1)	0.3 [0.4] (0.2 - 0.4)	0.0 [0.1] (0.1 - 0.1)	1.1 [0.6] (0.8 - 1.3)	0.9 [0.6] (0.6 - 1.2)
Folic Acid (free) (mcg) RDA M 200 F 200	96.9 [52.1] (89.7 - 103.8)	76.8 [46.5] (70.4 - 83.1)	119.4 [38.6] (107.4 - 131.1)	101.3 [32.9] (2.7 - 199.8)	98.3 [48.6] (78.9 - 117.4)	74.2 [40.9] (57.3 - 91)	47.7 [25.0] (40 - 55.3)	43.7 [31.5] (34.5 - 52.7)	124.6 [24.9] (116.4 - 132.5)	116.2 [20.4] (49.9 - 182.2)	82.3 [58.2] (62.8 - 101.3)	30.8 [14.9] (25.5 - 36)	125.4 [68.5] (93.3 - 157.4)	110.1 [21.9] (77.1 - 143)

[Table/Fig-5]: Nutrient Intake by Gender against the Recommended Dietary Allowance (ICMR)

		Caste Groups				
		SC	**ST**	**OBC**	**FC**	**Combined**
HP	LD district	86.70	81.60	100.00*	90.70	88.30
MH	LD district	79.50	86.40*	89.20	86.00	85.60
MP	LD district	27.10*	34.40	57.90	64.60	46.00
OR	LD district	47.90	41.00	82.00*	0.00	43.10
TN	LD district	24.70	-	27.10	100.00*	26.80

[Table/Fig-6]: Households (%) with food sufficiency through the year across caste- 60-village study

		TN study village (6 village study)		
	BMI	**Up to 18.4**	**18.5-24.9**	**25-29.9**
Combined	Male	60.1	38.9	0.8
	Female	78.2	21.1	0.7
	Total	69.5	29.6	0.7
Scheduled Caste	Male	68.0	31.4	0.7
	Female	83.1	16.9	0.0
	Total	76.1	23.6	0.3
Backward Classes	Male	51.8	46.6	1.0
	Female	73.2	25.8	1.0
	Total	62.9	35.8	1.0
% normal male		19.8		
% normal female		14.3		

[Table/Fig-7]: BMI adults in TN villages in which food log was carried out

compared to 435 g, 59 g, and 24 g respectively by women.

There was a clear gender differential in all the study villages which was least pronounced in the OR village, for instance calorie intake was 2375 in males and 2203 in females and most pronounced in the MH village (2443 in males and 1850 in females). In TN village, while both men and women had very low intakes, the difference between them was relatively modest. However, interestingly, the women in TN consumed marginally higher amount of fat than men (33 g and 31 g respectively). Another interesting finding was while there was a gender differential in the intake of iron in all the five villages, it was the sharpest in the TN village (13.5 g men and 7.4g women). Among the sub-groups, the men from the MH village had the highest dietary intake of iron (34.6 g). The highest intake of carotene was in the males from TN (3911.6 mcg) and the sharpest gender differential was also in the TN village with the women consuming 209 mcg of carotene.

The data logged into the nutrient calculator (identifying details removed) is available here http://bit.ly/foodlogxls.

DISCUSSION

Dietary intakes have been studied previously using a variety of methods. Nasreddine and colleagues describe consumption of each food, while [5] Chopra and colleagues describe diet using the FFQ method in Bombay slum dwellings [12]. Dary and colleagues have compared results from the Household Consumption and Expenditure survey (HCES nationwide survey) against results from the Food Frequencies Questionnaire FFQ [13]. Berti has suggested that intra household of distribution of food in most countries is relative equilibrium within 20% margin [14]. It was given this background that the PRoH set out to study food intake in different states of India.

The findings in the food log study of Phase I are consistent with the findings in the Phase II of the PRoH study which covered 40 households per village from 5 villages in 12 districts of the six states, in all 2,400 households in 60 villages, the households being selected using circular systematic sampling method with a random start. In this part of the study, the respondents were asked a question whether they had sufficient food throughout the year. The HP villages and MH villages reported the highest self-sufficiency (88% and 86% respectively), the MP and OR villages reported less than half of households with food sufficiency through the year and TN villages reported the least with only 27% reporting self-sufficiency. While there was little difference across caste groups in TN villages and OR villages, in MP, MH, and HP there was a differential with less proportion of the lower castes reporting self-sufficiency [Table/Fig-6].

However, in making such generalizations, it is important that the recommended intakes depend on sex, weight and type of activity engaged in by the individual. The recommended energy requirements for men (60 Kg) doing heavy work is 2730 kcal and that for women (55 Kg) doing moderate work is 2230 kcal (Indian Council of Medical Research 2010:50). However, most of the men and women in this study, though weighing less than these standard weights, were engaged in heavy work and the ICMR recommends 3490 kcal for men and 2850 kcal for women. While the deficit is present for both men and women, the deficit appears to be higher for men than women.

The TN data is surprising, given the almost universal access to PDS in TN, but appears to be consistent with the findings of nutritional levels assessed anthropometrically. Body Mass Index (BMI) of the adults in the village showed almost two thirds of the population with a BMI of < 18.5, the cutoff point of under-nutrition [Table/Fig-7].There was a gender differential with higher proportion of women (78%) being undernourished than men (60%). The findings also showed a caste differential with proportionately higher under-nutrition state in both men and women from the Scheduled Caste (SC) population. However, this finding is based on a small sample and caution needs to be exercised in extrapolating this data to the whole of TN. It is likely that the finding reflects the pre-ponderance of adults involved in daily wage labour in the a sample which is from a district chosen on the criterion of being 'less developed'.

While the intake across caste in the study does not appear to be vastly different between the caste groups, the higher proportion of

hunger and under-nutrition across caste levels could be explained by the excess energy expenditure among the lower castes whose livelihood depends upon energy expending labour as daily wage earners with, for instance, half or more than half of the 15- 59 age group employed as daily wage labour in OR (61.5%), MP (56.6%) and TN (44.9%) villages.

The findings of our study is consistent with secondary data provided by NNMB [15] the only national level survey that provides 24 hour recall dietary data. In 2004, the NNMB data showed that the median intake of energy was 1787 Kcals, protein 47g (with the lowest level in TN at 41g), median intake of iron was 12.3 mg much below the RDA of 28g [16]. In 2004-05, proportion of population consuming less than 1890 Kcals was the highest in TN (23.4%), followed by MH (19.7%), MP (16.0%), and OR (15.4%) and the lowest proportion was in HP(2.8%) [17].

Our study shows that it is possible to evaluate intake in poor rural homes using the measuring cup method. The food log data in our study suggests that intake in some states is suboptimal. Poor nutrition results in health consequences and affects earning capacity and further erodes the ability of individuals living in poverty to improve their situation.

In this study we have attributed intakes to individuals according to the fraction of the day's family consumption they took. Another method would have been to divide the family consumption by adult equivalent estimates of the number of people partaking of food from the kitchen [18]. However this technique would not be suitable for estimating the actual differences in intake of men and women in the household.

The energy consumption in our study was 2379 kcal per capita per day [19]. According to the Summary Report World Agriculture the per capita food consumption in 1997-99 was 2803 which is higher than that in the best state in India, that for developing countries a decade ago was 2681 and that in Sub-Saharan Africa is 2195. Our data is compatible in 2005 with the South Asia consumption of 2403 Kcal per capita per day in 1997-99. For comparison, in industrialized countries it is 3380. In Tamil Nadu it was a mere 1817 kcal.

The fat consumption in this study has also been very low. In 1997-9 the World per capita fat consumption was 73 g and it was 45 g in Sub Saharan Africa and 45 g in south Asia. In India it was a mere 25 g and this was lowest in OR at 12 g and 17 g in MH, 23 g in MP 32 g in TN and 33 g in UP.

This finding is consistent with data on widespread hunger in four of the five states that provided data for this study. This study has presented data on adult males and females and except for OR, the deficit in calorie intake was specifically pronounced for adult females. The relatively higher consumption of fat in TN in the context of very low calorie intake indicates a shift to energy dense food in the midst of calorie deficit which is linked to consuming fried snacks instead of cooked meals.

Our study was carried out through several partner organizations with varying capacities in effectively getting households to log their data and caution must therefore be exercised in interpreting values of consumption we have documented especially when comparing across states. Moreover, given that there were elements of purposiveness in the selection of households for maintaining the food diaries the data must be treated as a qualitative one, indicative of the pattern of food consumption in these sample villages.

The nutrition calculator developed for this project using ICMR food values is now available as free software.

AUTHORS' CONTRIBUTIONS

CS, NJK, AD, KBS, RP, RB, RS, OM, CN, MS and JP were on the overview board of the PRoH and were responsible for planning and execution of the study and approved the final write up, AP developed the nutritive values calculator and helped analyze the data, SK, and JP helped write up the first drafts of the report and CS with inputs from the larger study helped in its finalization.

JP and CS will be guarantors for the paper.

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