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ARTICLE

Food and health

# Are 'fruits and vegetables' intake really what they seem in India?

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## Abstract

**Background/objectives** Fruits and vegetables are integral parts of a healthy diet. This study evaluated the quantity and diversity of the fruit and vegetable intake in India, with a focus on its distribution across sectors and wealth quintiles.

**Subjects/methods** A secondary data analysis on the nation-wide NSSO Household Consumer Expenditure Survey 2011–2012 was performed to estimate the amount (g/capita/day) and diversity of household intake of fruits and vegetables in the rural and the urban sectors of India. Using the expenditure data, households in both the sectors were further divided into wealth quintiles and differences in the diversity of intake was evaluated across these quintiles separately for each sector.

**Results** The per capita household vegetable and fruit intake was found to be 145 and 15 g, respectively, for rural India, and 155 and 29 g for urban India. A significant portion of this intake came from energy-dense food items; potatoes and bananas for vegetable and fruit intake respectively. Further, while wealth marginally improved the diversity in vegetable intake, no such trend was observed in fruit intake.

**Conclusions** Given the high proportion of energy-dense fruits and vegetables in the Indian total intake, the focus should be on improving the diversity of vegetables, as well as on increasing the intake and diversity of fruits.

## Introduction

The diversity and amount of fruit and vegetable (F&V) intake in the daily diet is an integral part of normal health and prevention of chronic disease. For the prevention of chronic disease, the FAO/WHO recommends a daily individual intake of at least 400 g/day [1] (or greater than or equal to 5 servings of 80 g each), in which the category of tubers (potatoes and cassava) should be excluded. The WHO recommendation came from epidemiological studies, in which the analysies of F&V intake were compared against the risk of chronic disease. In one such influential study, the intake of vegetables was assessed in the following groups: cruciferous vegetables, dark and yellow vegetables (including yams and sweet potatoes), green leafy vegetables, and other vegetables (corn, mixed vegetables, celery, eggplant, mushrooms, and beets) [2]. In contrast to this, the Indian per capita daily intake of F&V (including roots and tubers) is much lower. For example, in an earlier analysis of an Indian nation-wide survey [3], the consumption of F&V was only 120–140 g/capita/day, with an additional 100 g coming from roots and tubers. In another report, F&V intake was found to be about 150 g/day [4].

It is well known that some food items, such as potato, banana, tomato and onion, are very common in Indian diets. More specifically, energy-dense vegetables and fruits, such as potato and banana, dominate the F&V intake in India. Two important ideas emerge from this: (1) the diversity of the F&V intake may reduce dramatically when a few food items dominate the intake, (2) if energy-dense items are culturally and behaviourally dominant, then simple health messages urging an increased F&V intake are likely to promote a greater intake of such foods. This may have its own impact on the burgeoning problem of overweight in India.

While there are anecdotal accounts of fruit and vegetable intakes in India, there is no recent comprehensive secondary analysis of survey data to evaluate the quantity and composition of the F&V intake in rural and urban sectors of India. This study aimed to fill that gap, while also assessing this in comparison to the production of F&V in India.

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## Methods

A nation-wide and detailed household expenditure and consumption data set, available in the latest Consumer Expenditure Surveys of the 68th National Sample Survey Office (NSSO) was used [5] which was carried out during July 2011 to June 2012. The survey covered the whole of the Indian Union except interior villages of Nagaland situated beyond five kilometres of the bus route, villages in Andaman and Nicobar Islands which remain inaccessible throughout the year and the districts of Leh (Ladakh), Kargil and Poonch of Jammu & Kashmir. Each district from the state and union territory was taken as the primary strata which is divided into rural and urban sector. If the number of households in a district was large, it was further divided into two or more sub-strata of nearly equal households by grouping together contiguous groups of villages having similar socio-economic characteristics. Villages within each sub-stratum for both the sectors were taken as the first-stage units. For rural India, the number of villages surveyed was 7469 and for urban India the number of urban blocks surveyed was 5268. From each sample village and urban block, two samples of 8 households available for survey were selected as second-stage units.

Household data on the purchase and consumption quantities of different raw fruits and vegetables over a recall period of last 30 days were used for this analysis. A small proportion of the fruit and vegetable intake that was not captured in the raw food purchased, came from purchased "cooked meals". While the composition of these meals was not reported, the mean number of such cooked meals was <0.07 (per capita/day) in both the sectors. Therefore this contribution was ignored. The original sample size consisted of 59,695 and 41,967 rural and urban households respectively. The data were modified by removing households with extreme values of per capita calorie intake. Additionally, households which did not consume any "cereals" and "vegetables" at home, and probably consumed them as a part of "cooked meal prepared outside the house" were excluded. Further, the intakes calculated were adjusted to account for (1) meals prepared at home but consumed by non-members and (2) meals received for free from other households by household members [5]. The final sample size consisted of 59,151 and 40,275 rural and urban households respectively. To evaluate the intake of F&V with increasing wealth in each sector, the monthly household expenditure data was used to divide the sample in both urban and rural sectors into wealth quintiles. For availability, data for production, import and export of F&V in India were obtained for 2011-12 from the Indian Horticulture Database [6], published by the Ministry of Agriculture, and converted to per capita figures using census data.

**Table 1** Descriptive characteristics of households in the survey

| | Rural | Urban |
|---|---|---|
| Number of households | 59,151 | 40,275 |
| Household size | 4.7 ± 2.2 | 4.3 ± 2.1 |
| % of female headed households* | 11.9 | 11.0 |
| % of illiterate household heads* | 39.5 | 16.2 |
| Age of the household head | 46.2 ± 13.2 | 45.5 ± 13.5 |
| Per capita monthly household expenditure (INR) | 1383 ± 1075 | 2766 ± 2616 |
| Proportion of household expenditure on food (%) | 51 ± 11 | 42 ± 12 |
| Per capita monthly expenditure on F&V (INR/month) | 90 ± 57 | 140 ± 96 |
| Proportion of household total expenditure on F&V (%) | 7 ± 3 | 6 ± 3 |
| Proportion of household food expenditure on F&V (%) | 14 ± 6 | 14 ± 5 |

Data are mean ± SD values except those marked with *

Since the intake data were not normally distributed, these are presented as medians with their interquartile ranges. Comparisons were made using the Kruskal–Wallis *H*-test. Statistical significance was considered at $p < 0.05$. All statistical analyses was performed in Stata 12 (StataCorp. 2011. Stata Statistical Software: Release 12. College Station, TX).

## Results

The household descriptive data are presented in Table 1. The F&V intake, as well as proportions of different F&V within this intake, are provided in Table 2. The vegetable and fruit consumption was about 145 and 15 g/capita/day respectively for rural households, while 155 and 29 g/capita/day for urban households. Potato intake (including plantain and sweet potato) dominated the total vegetable intake; its share was 33 and 26% of the total vegetable intake for rural and urban India respectively. The median per capita per day vegetable intake of households fell from 145 to 99 g in rural and 155 to 117 g in urban sector once potatoes were excluded: a fall of more than 35 g in both sectors. Though not considered energy-dense, the share of onions and tomatoes was also high compared to other vegetables. The share of other vegetables in total intake, once potatoes, onions and tomatoes were excluded, was less than 50% in both the sectors. Table 2 also provides the detailed share of different vegetables in total vegetable intake. The diversity in fruit intake is also poor (Table 2). About 21 and 10% respectively, of rural and urban households, did not report any consumption of any fruits whatsoever. Overall, the share of banana in the fruit intake was

**Table 2** Total and disaggregated Intake of fruits and vegetables in India

| | Rural | Urban |
|---|---|---|
| Number of households | 59,151 | 40,275 |
| Household Vegetable Intake (g/capita/day) | 145 (101, 203) | 155 (109, 216) |
| As above—minus potato (g/capita/day) | 99 (69, 139) | 117 (82, 162) |
| *Share of different vegetables in total vegetable intake (%)* | | |
| Potato (including plantain and sweet potato) | 33 | 26 |
| Onion | 14 | 15 |
| Tomato | 9 | 12 |
| Green leafy vegetables | 7 | 7 |
| Cauliflower and cabbage | 7 | 8 |
| Pumpkin and gourd | 6 | 6 |
| Aubergine (Brinjal) | 6 | 5 |
| Ladies finger | 3 | 4 |
| Other vegetables* | 15 | 17 |
| Total Household Fruit Intake (g/capita/day) | 15 (4, 32) | 29 (14, 54) |
| As above—minus banana (g/capita/day) | 7 (0, 20) | 17 (6, 34) |
| *Share of different fruits in total fruit intake (%)* | | |
| Banana | 34 | 35 |
| Mango | 15 | 11 |
| Coconut | 10 | 9 |
| Apple | 5 | 11 |
| Orange, sweet lime (Mosambi) | 5 | 8 |
| Guava | 8 | 5 |
| Watermelon | 6 | 5 |
| Papaya | 4 | 5 |
| Grapes | 3 | 4 |
| Other fruits** | 9 | 8 |

Data are median and interquartile range

*Radish, carrot, green chilli, peas, beans, lemon, garlic, ginger, other vegetables

**Jackfruit, pineapple, water chestnut, muskmelon, pear, berries, litchi, other fresh fruit

34 and 35% in rural and urban India, respectively. Other energy-dense fruits such as coconut contributed another 9–10% of fruit intakes. The intake of fruits excluding banana and coconut was 5 and 13 g in rural and urban sector respectively. The detailed share of different fruits in total fruit intake is presented in Table 2.

Table 3 presents the intake of F&Vs across wealth quintiles for each sector. As expected, the vegetable as well as fruit intake had an increasing trend moving from the poorest to the richest quintile of the population for both the sectors. The median per capita/day vegetable and fruit intake increased by 43 and 35 g for rural sector and 78 and 54 g for urban sector (Table 3). Of note was that the potato intake fell by a small amount as wealth increased. No such replacement effect occurred with fruits; the intake of both banana and other fruits increased equally with richer populations, but was generally low in quantity. Overall, wealth improved the diversity of vegetable intake marginally; the diversity of fruit intake did not improve with wealth.

The production figures of F&V in India are also skewed by roots and tubers, and bananas. While the export and import of F&V occurred, it was a small percentage of the production. The net availability (production plus imports–exports) of vegetables, about 350 g/capita/day, and fruits, about 174 g/capita/day, appeared to be more than sufficient to meet the recommended F&V intake [1]. These are crude net availability figures based on the production, export, import and population; since change in stocks and wastage figures for fruits and vegetables in India could not be obtained.

Disaggregating the total vegetables into different food items showed that the proportions of consumption of different vegetables followed the pattern of their production, although much less in aggregate was eaten every day, for example, per capita availability of potatoes was about 94 g/day [6], which was well over the daily consumption (Table 2), and similarly, the production and per capita availability of other vegetables (cabbage, tomato, cauliflower, brinjal, beans, peas and others) was about 256 g/day.

The quantity of the 400 g/day (or 5 servings) of F&V comes, for example, from the data collected in influential studies such as the Women's Health Study in the USA [2]. This has also been confirmed in a recent meta-analysis of 16 studies with 833,234 participants, where the continuum of decreasing risk of all-cause mortality was observed when the consumption was below 5 servings of F&V /day, but no further benefit was observed from a greater intake [15]. Some studies from other developed countries have gone on to suggesting that the minimum requirement is even more than this [16]. Against this is the backdrop of the emergence of the food industry, in which fruits and vegetable juices also account for many of the servings that are eaten. This can become extreme, in which the amount of tomato sauce on a pizza can also be considered as a single serving of vegetables [17]. It is important to begin to consider this recommendation with the following in mind: that in India, convenient or 'processed servings' of F&V are not available for most people; diversity in F&V is simply not there. While there are indications from our analyses that there is an increasing diversity in vegetable intake with increasing wealth, this is a small increase. It is worth understanding why such a small increase occurs with increasing wealth, if the capacity to access more F&V is present in the higher wealth quintiles. Setting a target for F&V intake is not

**Table 3** Distribution of fruit and vegetable intake across wealth quintiles

| | Rural India ($n = 59,151$) | | | | | | Urban India ($n = 40,275$) | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wealth Quintiles | 1 | 2 | 3 | 4 | 5 | All classes | 1 | 2 | 3 | 4 | 5 | All classes |
| All vegetable Intake (g) | 128 (88, 176) | 143 (98, 204) | 147 (102, 207) | 155 (111, 218) | 171 (122, 239) | 145* (101, 203) | 116 (82, 165) | 131 (95, 183) | 151 (112, 202) | 176 (128, 244) | 194 (140, 262) | 155* (109, 216) |
| Potato Intake (g) | 44 (21, 79) | 40 (15, 83) | 28 (13, 67) | 26 (12, 63) | 25 (12, 53) | 33* (14, 71) | 32 (13, 67) | 25 (11, 56) | 25 (13, 52) | 30 (14, 60) | 30 (15, 55) | 27* (13, 57) |
| Other veg intake excluding potato (g) | 75 (53, 106) | 94 (68, 128) | 106 (76, 143) | 119 (86, 162) | 136 (97, 186) | 99* (69, 139) | 76 (55, 105) | 98 (73, 128) | 117 (89, 155) | 140 (104, 185) | 155 (113, 210) | 117* (82, 162) |
| Proportion of Potato intake in total vegetable intake | 0.36 (0.21, 0.51) | 0.29 (0.14, 0.46) | 0.21 (0.11, 0.38) | 0.18 (0.10, 0.32) | 0.16 (0.89, 0.26) | 0.25* (0.13, 0.43) | 0.29 (0.15, 0.45) | 0.20 (0.11, 0.36) | 0.18 (0.10, 0.30) | 0.17 (0.10, 0.27) | 0.16 (0.09, 0.25) | 0.19* (0.10, 0.32) |
| All fruit intake (g) | 6 (0, 13) | 13 (3, 23) | 19 (8, 33) | 27 (14, 44) | 42 (23, 69) | 15* (4, 32) | 10 (2, 19) | 20 (11, 32) | 29 (16, 45) | 40 (24, 62) | 64 38, 100) | 29* (14, 54) |
| % household reporting zero fruit intake | 36 | 22 | 15 | 11 | 6 | 21 | 23 | 11 | 7 | 8 | 3 | 10* |
| Banana Intake (g) | 0 (0, 6) | 0 (0, 10) | 7 (0, 13) | 10 (0, 19) | 14 (0, 24) | 3* (0, 13) | 0 (0, 8) | 8 (0, 13) | 10 (0, 19) | 14 (0, 25) | 20 (9, 33) | 10* (0, 20) |
| Other fruit intake excluding banana (g) | 1 (0, 8) | 6 (0, 14) | 9 (2, 21) | 15 (5, 29) | 25 (11, 47) | 7* (0, 20) | 5 (0, 11) | 11 (4, 20) | 16 (7, 29) | 22 (10, 40) | 41 (22, 69) | 17* (6, 34) |
| Proportion of Banana intake in all fruit intake | 0.08 (0, 0.71) | 0.36 (0, 0.71) | 0.38 (0, 0.68) | 0.38 (0, 0.62) | 0.35 (0.11, 0.55) | 0.35* (0, 0.67) | 0.38 (0, 0.71) | 0.40 (0, 0.65) | 0.38 (0.16, 0.59) | 0.38 (0.17, 0.55) | 0.32 (0.16, 0.47) | 0.38* (0.11, 0.57) |
| Total F&V intake excluding potatoes (g)[#] | 85 (60, 117) | 111 (82, 149) | 130 (98, 172) | 153 (114, 200) | 188 (138, 248) | 120 (84, 169) | 90 (66, 120) | 121 (93, 155) | 151 (116, 194) | 185 (141, 244) | 228 (171, 303) | 152 (107, 214) |
| Per capita monthly expenditure on F&V (INR) | 52 (38, 69) | 70 (53, 93) | 85 (63, 112) | 105 (77, 139) | 143 (103, 196) | 77 (53, 111) | 59 (43, 80) | 88 (66, 114) | 115 (87, 151) | 153 (114, 196) | 210 (152, 295) | 117* (78, 175) |
| Proportion (in %) of total monthly expenditure on F&V | 7 (6, 10) | 7 (5, 9) | 6 (5, 8) | 6 (4, 8) | 5 (4, 7) | 7* (5, 9) | 7 (5, 9) | 6 (5, 8) | 6 (4, 8) | 5 (4, 7) | 4 (3, 5) | 6* (4, 7) |

Data are median and interquartile range

*$P < 0.01$; Kruskal–Wallis $H$-test

[#]For comparison with recommended guidelines

possible in India specifically, since it is not possible to evaluate relationships with chronic disease or other outcomes, given the low range of quantity and diversity of F&V intake. The authors are unaware of any rigorous cohort based Indian data on the prevention of CVD or chronic disease with increasing F&V, and the collection of such data must be a priority.

If the total weight of raw food eaten in a day is considered, this is about 760 and 680 g/day for adult men and NPNL women, of which cereals are more than half the quantity [8]. In general, this would apply to developing country populations where cereals are the mainstay of intake and effective in combating hunger, or where generations have grown up with this pattern of food intake. Indeed, F&V, in terms of raw weight, constitute only a quarter of this intake (even less when food is cooked), and it requires serious consideration of how 400 g of F&V can be set as a target in such a food intake pattern. Body size also matters; in the Women's Health study [18], the average BMI was a little over 25 kg/m$^2$. Based on NNMB data for rural populations, the proportion of Indian men with BMI <25 was 90% (35% had BMI <18.5); for women, this proportion was 87% (35% had BMI <18.5). the similar pattern is observed in less affluent countries, where the BMI remains low [19], and where, for example, 6% of the Indian population has a BMI <16, or have severe chronic energy deficiency [20].

The production rate of vegetables and fruits in India over the last 20 years has shown gains, increasing, for example, from about 58 to over 163 million tons/year for vegetables, and from about 28–89 million tons/year for fruits [6, 21]. It is worth noting that only half of this production is consumed by the population. This is because of the large interstate variations in F&V production and distribution, and wastage rates are high at 30–40% of production [12]. These losses occur mainly during transportation and storage of F&V. In addition, a proportion of the production is procured by industries for value addition and retail purposes. The pattern of consumption appears to follow the same pattern of production, with potatoes forming about 26% of the total vegetable production. A similar picture exists for fruits, where the production of banana and mango (seasonal) dominate the production, but since mango is exported, the main available fruit is banana. Therefore, even if F&V intake were to increase, they are simply not available in any diversity, and given their wastage and unequal distribution, are likely to benefit the higher wealth quintiles of the population.

In conclusion, given the low diversity and proportion of monthly expenditure on F&V, many strategies need to be leveraged to improve the diversity and amount of F&V consumption in India. Production, including home based production, distribution and access are critical components of the strategy. Messages to increase the intake of F&V need to focus on increasing the intake (and diversity) in general.

## Data availability

1. The household consumption and expenditure data used for this study can be purchased from Ministry of Statistics and Programme Implementation, Government of India based in New Delhi. The procedure to order the data is available on http://mail.mospi.gov.in/index.php/policies-procedure
2. The data on production, import and export is published by Ministry of Agriculture and Farmers Welfare, Government of India and is freely downloadable from http://eands.dacnet.nic.in/PDF/Agricultural_Statistics_At_Glance-2015.pdf
3. The census data is published by Ministry of Home Affairs, Government of India and is freely downloadable from http://www.censusindia.gov.in/2011census/C-series/C-13.html

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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