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Consumption pattern of selected vegetables at five sites in Delhi NCR region

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ABSTRACT

In the present study, an investigation was carried out to analyze vegetable consumption rates by the comprehensive survey at five selected sites (Alipur, Shahdara, Kanjhawala, Mehrauli, and Najafgarh) in Delhi NCR region.Six vegetables, i.e., potato, carrot, tomato, spinach, mustard, and okra mostly cultivated in the peri-urban areas, data were collected from each site of 25 families. Results indicated that the gross per capita per day vegetable consumption was highest at Shahdara (0.314 kg/capita/day), followed by Najafgarh (0.307 kg/capita/day).It was also observed that the per capita per day consumption of vegetables was highest mostly in the case of potato followed by tomato.Tomato was the second-highest utilized vegetable at most of the selected sites. While mustard was consumed lowest at most of the sites except Mehrauli. It was also observed that in selected vegetables, the consumption of root vegetables was higher as compared to other vegetables.

Key words: Consumption, Delhi, Per capita, Survey, Vegetables, Weight

Nutrition is a fundamental human requirement and a prerequisite to a healthy lifestyle. A balanced diet is essential from the very early stages of life for proper growth, development, and to remain active. The consumption of food, which largely depends on production, delivery, manages the health and nutritional status of the consumers. The recommended dietary allowances (RDA) guidelines are nutrient-centered and technical in nature. Aside from providing nutrients, vegetable provides a host of other elements which have a positive influence on health. Since the population consumes food, it is essential to support nutrition in terms of foods rather than nutrients. The primary sources of heavy metal contamination are industrialization, mining, milling, fossil fuel burning, agrochemicals that discharge a variety metals such as As, Cr, Hg, Cd, Cu, Ni, Co, Zn and Pb into the agricultural soils and water bodies (Kumar *et al.* 2019; Gupta *et al*. 2018).

Vegetables are mostly cultivated in the peri-urban areas to fulfill the booming demand in time. The sufficient supply of irrigation water to these vegetables is a challenging task in the present time around the cities. Therefore, this booming demand compensates by applying the sewage wastewater originated from a nearby polluting source. The wastewater discharged from industries, and commercial activities is laden with heavy metals. Vegetables are essential eating routine used by populations all through the world, being wellsprings of fundamental nutrients, antioxidants agents, and metabolites (Shakya and Khwaounjoo 2013). Vegetables being the carrier of metals, when used up by human beings, get ingested into the human body. Toxic metals can be unusually threatening to the human body, even at low levels, as there is no compelling excretion device (Ghosh *et al.* 2012; Maurya *et al.* 2019). Therefore, these toxic metals are dangerous for human health and cause several problems such as cancer, liver, heart, hepatic damaging, renal system damaging, mental retardation, CNS breakdown, looseness of the bowels, hookworm disease and degeneration of basal ganglia of brain and liver (Misra and Dinesh 1991).

All the vegetables and fruits are rich reservoirs of micronutrients and macronutrients. The main micronutrients present are minerals and vitamins, whereas the macronutrients present are combined carbohydrates and fibers. They hold sufficient quantities of iron, calcium, vitamin C, folic acid, carotenoids, and phytochemicals. Many vegetables give meager calories, whereas others such as potato, sweet potato, tapioca, and yam are rich in starch. Hence, vegetables can be utilized to improve or reduce calories in our daily diet and maintain the health of consumers.

Vegetables are an essential part of the human diet due

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to the richness of beneficial and essential minerals and nutrients (Nankishore 2014).

The Expert Committee (EC) of the Indian Council of Medical Research (ICMR), taking into attention the nutrient requirements, has recommended that each individual per day should consume at least 300 g of vegetables (including green leafy vegetables: 50 g; other vegetables: 200 g; roots and tubers: 50 g). As the necessities of iron and folic acid are essential for pregnant women, they should consume at least 100g of leafy vegetables per day. Total production of vegetables is about 30% less than the demand of 100 million tonnes (Mukherjee *et al*. 2016). The toxic metals have the tendency of accumulating in the vegetables and, ultimately via food chain enter into humans. The amount of vegetables enter into the human body mainly depends on the quantity and types of vegetables consumed per day, type of irrigation source, area of production, and age group of consumers (Kumar *et al.* 2019).

Unfortunately, vegetables can uptake and accumulate toxic metals beyond recommended limits in their entire body, including both edible and inedible parts (Tasrina *et al*. 2015). In the last decade, the level of heavy metals in vegetables (leafy, root, and fruit) has been observed at high levels (Wai *et al.* 2017). Ultimately, the build-up of toxic metals in vegetables and edible parts of crops in contaminated soils is a matter of grave concern due to the harmful and irreversible effects of metals impacting the human's health (Malik 2004).

MARTIALS AND METHODS

Sampling location and demography

Delhi city is resided in Northern India, at 28.7041°N 77.1025°E with 216m elevation. It is surrounded by Uttar Pradesh (Gautam Budh Nagar, Ghaziabad, and Baghpat) and by Haryana (Gurugram, Faridabad, Jhajjar, and Sonipat) on three sides. The NCR Delhi covers an area of 1484 km^2, of which 783 km^2 is a rural area and 700 km^2 urban area. According to the 2011 census, the population of Delhi's city was over 11 million. The river Yamuna was the historical boundary between Punjab and UP, and its flood plains provide fertile alluvial soil suitable for agriculture but are prone to intermittent floods.

Delhi has a dry-winter humid subtropical climate, including a hot semi-arid climate. Temperatures range from 2 to 47°C with average annual rainfall is around 886mm, which most of which falls during the monsoon season (July-August) (ESD 2006).

Sampling sites

In Delhi NCR, 5 sampling sites were selected for conducted present study . All the information about the sites were given in Table 1.

Sampling procedure

The data collection sheets were prepared by using standard parameters required for the assessment of the toxicity of metal. Families were randomly selected. Data were collected using standardized questionnaires by face to face interactions at the time of sampling for each site in the city of Delhi (INDDEX Project 2018). The questionnaire requested self-reported information regarding sociodemographic characteristics, types of consumers, number of family members, number of vegetable consumers, age group, types of vegetables consuming, dietary patterns, and weight. Additionally, some other information also collected like male: female ratio in family and disease regarding information (Krebs-Smith *et al.* 1995). A total of 125 families were surveyed, 25 at each location including 455 members during 2017-18 and 2018-19 (Table 2).

Table 1 Sampling sites with their latitude, longitude, and altitude

Site	District of Delhi	Latitude	Longitude	Altitude
Alipur	North West	28.797460	77.132991	214.4 m
Kanjhawala	North West	28.735456	77.002011	213.9 m
Najafgarh	South West	28.611856	76.981354	219.0 m
Mehrauli	South West	28.521586	77.179149	260.8 m
Shahdara	North East	28.700868	77.289846	207.0 m

Table 2 Number of families, family members and vegetable consumers at selected sites

Site	No. of family surveyed	No. of members	Vegetable consumers
Alipur	25	103	92
Kanjhawala	25	92	82
Najafgarh	25	99	97
Mehrauli	25	90	85
Shahdara	25	71	70
Total	125	455	426

Vegetables selected

For the present study, 6 vegetables of different categories such as leafy, root, and shoot were collected from selected sites (Table 3). The consumption pattern of

Table 3 Selected vegetables and their category

Vegetable	Botanical name	Family	Category	Sampling season
Potato	*Solanum tuberosum* L.	Solanaceae	Root	Winter
Carrot	*Daucus carota* L.	Apiaceae	Root	Winter
Tomato	*Solanum lycopersicum* L.	Solanaceae	Fruit	Winter
Okra	*Abelmoschus esculentus* L.	Malvaceae	Fruit	Summer
Spinach	*Spinacia oleracea* L.	Chenopodiaceae	Leafy	Winter
Mustard	*Brassica juncea* L.	Brassicaceae	Leafy	Winter

these vegetables was surveyed and found per day per capita consumption.

RESULTS AND DISCUSSION

The vegetable consumption data were collected from all the five selected sites in the Delhi region, i.e. Alipur, Shahdara, Mehrauli, Kanjhawala and Najafgarh. From each site 25 families were selected randomly to collect data. In Alipur, data of 103 individuals were collected from 25 families regarding total vegetable consumption per week, total number of consumers, and non-consumers. In Alipur, the total vegetable consumption per week was 41 kg, 22 kg, 38.5 kg, 22.5 kg, 29 kg, and 20 kg of potato, okra, tomato, spinach, carrot, and mustard respectively.The per capita per day consumption of leafy vegetable (mustard) is lowest (39g/day) and of root vegetable (potato) is highest (64g) at this site. At Alipur, the per day per capita consumption rate of vegetables is potato > tomato > carrot > okra = spinach = mustard (Table 4).

From each site, 25 families were selected randomly to collect data. In Shahdara, data of 92 individuals were collected from 25 families regarding total vegetable consumption per week, the total number of consumers and non-consumers. In Shahdara, the total vegetable consumption per week was 33 kg, 31.7 kg, 32.5 kg, 33.3 kg, 35 kg, and 27.8 kg of potato, okra, tomato, spinach, carrot, and mustard respectively. The per capita per day consumption of leafy vegetable (mustard) is lowest (48g/day) and of root vegetable (potato) is highest (57g) at this site. At Shahdara, the per day per capita consumption rate of vegetables is potato > carrot > spinach> okra = tomato > mustard (Table 5).

From each site, 25 families were selected randomly to collect data. In Mehrauli, data of 99 individuals were collected from 25 families regarding total vegetable consumption per week, the total number of consumers and non-consumers. In Mehrauli, the total vegetable consumption per week was 36 kg, 36 kg, 38.5 kg, 28.5 kg, 26.3 kg, and 22 kg of potato, okra, tomato, spinach, carrot, and mustard respectively. The lowest and highest per capita per day consumption was found in the case of root vegetable (carrot) 41g/day and in fruit vegetable (tomato) 57g, respectively at this site. At Mehrauli, the per day per capita consumption rate of vegetables is tomato > potato > okra > mustard > spinach > carrot (Table 6).

From each site, 25 families were selected randomly to collect data. In Kanjhawala, data of 90 individuals were collected from 25 families regarding total vegetable consumption per week, the total number of consumers and non-consumers. In Kanjhawala, the total vegetable consumption per week was 39 kg, 35.5 kg, 31.5 kg, 26 kg, 28.5 kg, and 18 kg of potato, okra, tomato, spinach, carrot, and mustard respectively. The lowest and highest per capita per day consumption was found in the case of leafy vegetable (mustard) 34 g/day and in root vegetable (potato) 66 g, respectively, at this site. At Kanjhawala, the per day per capita consumption rate of vegetables is potato>okra >

Table 4 Vegetable consumption at Alipur

Parameter	Unit	Potato	Okra	Tomato	Spinach	Carrot	Mustard
Total no. of family surveyed	-	25	25	25	25	25	25
Quantity of 6 vegetables consumption	kg/week/25 families	41	22	38.5	22.5	29	20
Total number of consumers	Per 25 families	103	103	103	103	103	103
Number of non-vegetable consumers	Out of 103	11	22	0	20	11	30
Net vegetable consumers	-	92	81	103	83	92	73
Per capita consumption/week	kg	0.446	0.272	0.374	0.271	0.315	0.274
Per capita consumption/day	kg	0.064	0.039	0.053	0.039	0.045	0.039
Mean consumption	kg/week/25 families	1.64	0.88	1.54	0.90	1.16	0.80
SD		0.98	0.60	0.43	0.74	1.01	1.08

Table 5 Vegetable consumption at Shahdara

Parameter	Unit	Potato	Okra	Tomato	Spinach	Carrot	Mustard
Total no. of family surveyed	-	25	25	25	25	25	25
Quantity of 6 vegetables consumption	kg/week/25 families	33	31.75	32.5	33.25	35	27.75
Total number of consumers	Per 25 families	92	92	92	92	92	92
Number of non-vegetable consumers	Out of 103	10	2	0	3	0	9
Net vegetable consumers	-	82	90	92	89	92	83
Per capita/week	kg	0.402	0.353	0.353	0.374	0.380	0.334
Per capita/day	kg	0.057	0.050	0.050	0.053	0.054	0.048
Mean consumption	kg/week/25 families	1.32	1.27	1.30	1.33	1.40	1.11
SD		0.66	0.65	0.54	0.66	0.54	0.79

Table 6 Vegetables consumption at Mehrauli

Parameter	Unit	Potato	Okra	Tomato	Spinach	Carrot	Mustard
Total no. of family surveyed	-	25	25	25	25	25	25
Quantity of 6 vegetables consumption	kg/week/25 families	36	36	38.5	28.5	26.25	22
Total number of consumers	Per 25 families	99	99	99	99	99	99
Number of non-vegetable consumers	Out of 103	2	0	0	2	8	33
Net vegetable consumers	-	97	99	99	97	91	66
Per capita/week	kg	0.371	0.364	0.389	0.294	0.288	0.333
Per capita/day	kg	0.053	0.052	0.056	0.042	0.041	0.048
Mean consumption	kg/week/25 families	1.44	1.44	1.54	1.14	1.05	0.88
SD		0.62	0.99	0.45	0.65	0.65	0.89

Table 7 Vegetable consumption at Kanjhawala

Parameter	Unit	Potato	Okra	Tomato	Spinach	Carrot	Mustard
Total no. of family surveyed	-	25	25	25	25	25	25
Quantity of 6 vegetables consumption	kg/week/25 families	39	35.5	31.5	26	28.5	18
Total number of consumers	Per 25 families	90	90	90	90	90	90
Number of non-vegetable consumers	Out of 103	5	3	0	2	6	15
Net vegetable consumers	-	85	87	90	88	84	75
Per capita/week	kg	0.459	0.408	0.350	0.295	0.339	0.240
Per capita/day	kg	0.066	0.058	0.050	0.042	0.048	0.034
Mean consumption	kg/week/25 families	1.56	1.42	1.26	1.04	1.14	0.72
SD		0.68	0.73	0.48	0.32	0.57	0.52

Table 8 Vegetables consumption at Najafgarh

Parameter	Unit	Potato	Okra	Tomato	Spinach	Carrot	Mustard
Total no. of family surveyed	-	25	25	25	25	25	25
Quantity of 6 vegetables consumption	kg/week/25 families	32.5	23.75	25	20.75	29.5	4.75
Total number of consumers	Per 25 families	71	71	71	71	71	71
Number of non-vegetable consumers	Out of 103	1	5	4	3	2	49
Net vegetable consumers	-	70	66	67	68	69	22
Per capita/week	kg	0.464	0.360	0.373	0.305	0.428	0.216
Per capita/day	kg	0.066	0.051	0.053	0.044	0.061	0.031
Mean consumption	kg/week/25 families	1.30	0.95	1.00	0.83	1.18	0.19
SD		0.61	0.64	0.32	0.50	0.72	0.32

tomato>carrot > spinach > mustard (Table 7).

From each site, 25 families were selected randomly to collect data. In Najafgarh, data of 71 individuals were collected from 25 families regarding total vegetable consumption per week, the total number of consumers and non-consumers. In Najafgarh, the total vegetable consumption per week was 32.5 kg, 23.7 kg, 25 kg, 20.7 kg, 29.5 kg, and 4.75 kg of potato, okra, tomato, spinach, carrot, and mustard respectively. The lowest and highest per capita per day consumption was found in the case of leafy vegetable (mustard) 31 g/day and in root vegetable (potato) 66 g, respectively at this site. At Najafgarh, the per day per capita consumption rate of vegetables is potato >carrot > tomato >okra > spinach > mustard (Table 8).

Per capita per day consumption rate of selected vegetables was observed highest in the case of potato at all the sites except Mehrauli, where the tomato was consumed in higher amount (Fig 1).Tomato was second highest consumed vegetable at most of the sites. Mustard was consumed lowest at most of the sites except Mehrauli. The consumption order of selected vegetables given in Table 9. In selected vegetables, we observed that consumption of root vegetables especially potato was higher as compared to other vegetables. The consumption pattern of vegetables determines the risk assessment in further studies of heavy metals analysis. The type of vegetables consumption pattern also determines the requirement or demand some specific vegetables in particular are.

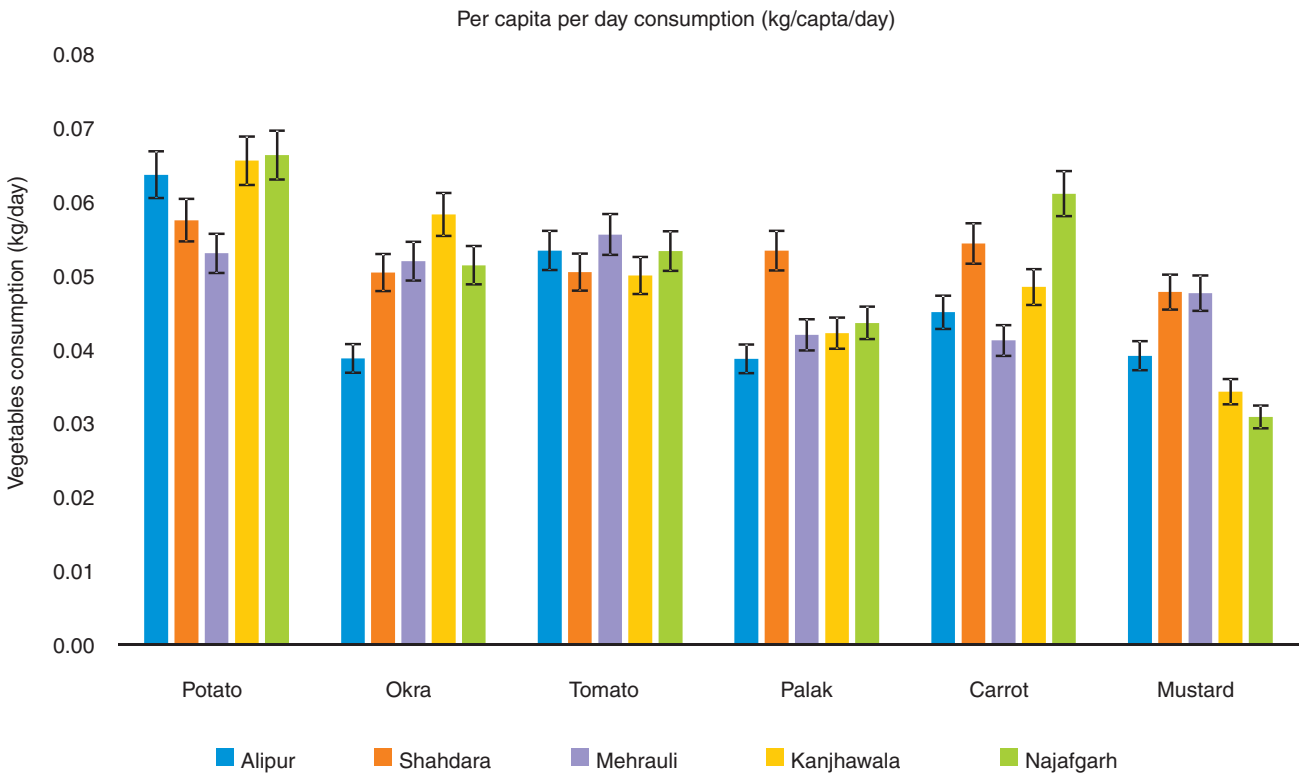

Fig 1 Per capita per day consumption rate of selected vegetables.

Table 9 Consumption order of vegetables at selected sites (kg/capita/day)

Site	*Per capita per day consumption (kg)	Consumption order (kg/capita/day)
Alipur	0.279	Potato > Tomato > Carrot > Okra = Spinach = Mustard
Shahdara	0.314	Potato > Carrot > Spinach > Okra = Tomato > Mustard
Mehrauli	0.291	Tomato > Potato > Okra > Mustard > Spinach > Carrot
Kanjhawala	0.299	Potato > Okra > Tomato > Carrot > Spinach > Mustard
Najafgarh	0.307	Potato > Carrot > Tomato > Okra > Spinach > Mustard

*This is the total amount of 6 selected vegetables consumed per capitaper day.

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