

# Availability of cooking fuel in India: Extent, determinants and inter-intra variation analysis

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## Abstract:

Currently, in a country with 25 cr. households, 31% urbanisation (Census 2011) and a per capita income of Rs 39,143 (CSO 2013) approximately 1104 TWh of energy is used for domestic cooking. The rural households mostly used firewood and chips as primary source of energy for cooking. At all India level, firewood and chips were used by more than three-quarters (76.3%) of rural households, followed by LPG, which was used by 11.5% households and In the urban areas, however, most of the households used LPG as primary source of energy for cooking. LPG was used by more than 64% of the urban households at all-India level, followed by firewood and chips, used by 18% households. The objective is based on state-wise coverage of different sources cooking fuel in India and to find out the determinants and inter- intra variation of improved cooking fuel in India. The present study is based on data collected on household's different basic amenities including sanitation, drinking water, Sources of cooking fuel and source of lighting in urban and rural households in India.

Two-stages sampling was used for data collection, first stage sampling covered the selection of census villages in the rural areas and urban frame survey block in the urban sector and second stage covered selected households using random sampling. Total 65,932 households and 333,104 persons were covered by interviewed all over 29 states and 7 union territories of India.

Firewood and chips (47%) and LPG (44%) were the main source of cooking fuel in India. Inter analysis shows Odisha (71%) shows higher use of Firewood and chips as a fuel and Telengana (69%) use of LPG as source of cooking fuel where territory Delhi (98%) report maximum use of LPG in households. Urban (74%), self employed in non agriculture (66%), Non- Hindu (48%), Non-SC (47%), three members (49%) and riches (90%) shows improve cooking fuel prevalence in India. Intra variation analysis shows that Meghalaya (86%), Tripura (75%), Maharashtra (71%) districts less than their state average of have improve cooking fuel. Based on regression result, urban, Non SC, Three member family, Lower socio- economic strata and other house type shows more OR value and significant association with improve cooking fuel India. In conclusion, minorities with lower economics status households need more attention than other category household particular rural as compared to urban in India.

**Keywords:** Cooking fuel and its type, improve cooking fuel, inter-intra variation of cooking fuel, urban and rural differential

## Introduction

India derives the bulk of its cooking energy needs from solid fuels, such as firewood, crop residue and cow dung cake. In contrast, economically developed countries, such as the USA, UK, Italy, Denmark and others use cleaner cooking fuels. India also displays a striking rural-urban dichotomy in its choice of cooking fuels. An overwhelming majority - about 80 percent of rural homes in India - continue to use biomass - firewood, crop residue or cow dung - as their primary cooking fuel. In developing countries, access to improve access to affordable and reliable energy form reduced poverty and promot economic development (Leach, 1992; UNDP, 2005; Modi et al., 2005; WHO, 2006a; UNDP and WHO, 2009; UNIDO, 2009; AGECC, 2010; World Bank, 2011a; Ekouevi and Tuntivate, 2012).[1-9] About 1.26 billion people do not have access to electricity and 2.64 billion people rely on traditional biomass (fuel wood, charcoal, dung and agricultural residues) for cooking mainly in rural areas in developing countries (IEA, 2013a). Household cooking consumes more energy than any other end-use services in low-income developing countries [10]). The International Energy Agency (IEA, 2016) estimated that of the global total of 3.5 million premature deaths from household air pollution (HAP) annually, India accounts for one million[10]. The 68th round of the NSSO (2011–12) reveals that over two-thirds of households in rural India still rely on firewood and chips for their cooking energy needs. Use of firewood and chips for cooking in rural India has declined very slowly over the years, falling from 78.2 per cent of all rural households in 1993–94 to 67.3 per cent in 2011–12, despite the increase in LPG use from less than 2 per cent of rural households 1993-94 to 15 per cent in 2011–12.[11] In 2014–15, the Council on Energy, Environment and Water (CEEW), in collaboration with Columbia University, conducted the largest energy-access survey of its kind in six Indian states having the largest population deprived of access to modern forms of energy—Uttar Pradesh, Bihar, Jharkhand, Odisha, Madhya Pradesh, and West Bengal. As per Census 2011, use of firewood for cooking purposes by households is highest at 49.0 percent followed by LPG/PNG occupying a percentage share of 28.5 percent in the country. As per 2011 national figures, the highest percentage share for rural households is occupied by firewood at 62.5 percent followed by crop residue at 12.3 percent and LPG/PNG with 11.4 percent.[12] The use of cooking practice with solid fuels, such as traditional biomass and coal, can have severe implications for human health, forest/land degradation and climate change. Existing studies, such as Bruce et al. (2000) and WHO (2006a), find that air pollutants, emitted from solid fuels often burned indoors on inefficient cookstoves, is one of biggest challenges to human health in developing countries. Lim et al. (2012), for example, estimated that in 2010, about 3.5 million premature deaths were caused by household air pollution (HAP) resulting primarily from cooking with solid fuels.NITI Aayog's estimations suggest that under the 'Determined Effort' scenario of India Energy Security Scenarios 2047 (IESS), 26 per cent of rural households are expected to use electricity for their primary cooking needs by 2047 if all government rural electrification and cooking energy programmes are implemented as planned and scheduled (NITI Aayog, n.d.). Much of the success of such cooking solutions will depend on the achievement of the government's intention of electrifying all households with 24x7 supply by 2022 (PTI, 2015). However, rural electrification schemes such as the Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) in their current form merely look at electrification, but not the reliability of the electricity supply, which is just as important for the effective use of electricity as a primary source of cooking energy.The government's current flagship programme, the Pradhan Mantri Ujjwala Yojana (PMUY), with a budget of INR 8,000 crore, subsidises the connection cost to provide LPG to BPL households against the name of the female head of household, with BPL identified as in the Socio-Economic Caste Census

(SECC) 2011 ([13]. PMUY households get a cylinder and a regulator; they need to pay for the gas stove and for the first refill (upfront or through later instalments). The payment instalments are recovered from the subsidy received on the refills. The households pay the market price for cylinders until the costs of the gas stove and of the first refill are recovered. Against the first-year target of providing 15 million connections, PMUY has already provided 22 million connections. [13-14]

## **Data and Methodology**

### **Objective:**

1. To access the availability of cooking source of fuel in India.
2. To find the association of area, type of house, Religion, Social Group and socio-economic status, family size and improve cooking fuel in India.
3. To study the state-wise intra districts variation of improve cooking fuel in India

### **Study design**

The study design based on the secondary data set of a nationwide survey collected by the National Sample Survey Organisation (NSSO), India.

### **Data source**

The data source was the representative nationwide survey collected by the National Sample Survey Organization (NSSO) in its 71st round (2014) on 'Health' and 'Education'. The data was collected in all states of India from January 2014 to June 2014. As mentioned in objective, focus is on cooking fuel in India. Unit levels data is extracted for households characteristics included of area, type of house, Religion, Social Group and socio-economic status, family size, monthly consumption expenditure etc.

### **Methodology**

Two-state stratified sampling design was used for the study. First stage sampling applied for the selection of census village in the rural areas and urban frame survey block in the urban sector. In second stage sampling applied for selection of households using random sampling. Survey covered total of 4577 villages and 3720 urban blocks were surveyed from which 36,480 and 29,452 households were sampled in rural and urban areas respectively. Survey covered 65,932 households and 333,104 persons were interviewed all over 36 states of India.

### **Data analysis**

Data was analysed using SPSS version 21.0 for analysis (SPSS Inc. SPSS Statistics for Windows, Version 21.0. Chicago). Wealth quintiles are calculated for all households using monthly per capita consumption expenditures. Based upon this, the households divide into five groups, ranging from the bottom 20% of the sample with lowest consumption expenditure, to the top 20% households of the sample with highest consumption expenditure. Data is extracted based on basic households amenities type of latrines, drainage system, types of cooking fuel, sources of drinking water and characteristics like religion, caste, family size, and nature of house type, urban and rural areas. Intra district variation is measured by taking ratio of total no. of districts in each state who average is less than state average to the total no. of distinct in each states. Recode =1, if districts average is less than states average. Recode=0, if states if districts average is more than states average.

## Result

Firewood and chips (47%), LPG (44%),Dung Cake(5%), Kerosene (2%), coke(1%) and other(1%) were the main source of cooking in India. Inter districts analysis, Coke was found more in Jharkhand (19%) and west Bengal (8%),Bihar(2%) and Chhattisgarh (2%), Firewood and chips found more 65% in Odisha (71%), Chhattisgarh (68%), Meghalaya (68%),Tripura(67%) and Lakshadweep (66%), 60-65% found in Himachal Pradesh (62%), Rajasthan (62%), Madhya Pradesh (61%), Kerala (62%), Assam (60%), 50-60% in Jharkhand (55%) ,Bihar (54%), Arunachal Pradesh (52%) and Arunachal Pradesh (52%), 40-50% in A & N Island 48%), West Bengal (47%), Dadar and Nagar Haveli (47%), Nagaland (47%), Karnataka (47%), Jammu and Kashmir (46%),Gujarat (45%),Uttar Pradesh (43%), Manipur (43%),30-40% found in Maharashtra (39%), Andhra Pradesh (37%), Uttaranchal (36%), Haryana (36%), Sikkim (33%), Mizoram (33%), Tamil Naidu (31%), where as under 30% found in Telengana (29%), Punjab (27%), Daman and Diu (23%), Goa (22%), Pondicherry (20%), Chandigarh (1%) and Delhi (0%) respectively.

LPG found more than 70% in Delhi (98%), Chandigarh (81%), Puducherry (79%) and Goa (77%), 60-70% found in Telengana (69%), Mizoram (66%), Daman and Diu (66%),Tamil Naidu (65%), Sikkim (64%), Uttaranchal (62%), Andhra Pradesh (61%), Punjab (61%), 40-60% found in Maharashtra (57%), Manipur (56%), Nagaland (53%), Haryana (50%), Karnataka (49%), Jammu and Kashmir (49%),Gujarat (48%), Arunachal Pradesh (44%), Dadar and Nagar Haveli (45%), A & N Island (41%), 30-40 % found in Kerala (37%), Assam (37%), Rajasthan (36%), Himachal Pradesh (35%), Madhya Pradesh (35%),Uttar Pradesh (34%),West Bengal (33%), Tripura(32%) whereas under 30 % found in Chhattisgarh (27%), Jharkhand (23%), Bihar (22%), Meghalaya (21%), Odisha (20%) and Lakshadweep (17%) respectively. (Table1)

Dung found in Uttar Pradesh (21%), Bihar (20%), Haryana (13%), Punjab (10%) where as other states like Madhya Pradesh, West Bengal, Chhattisgarh, Jharkhand, Chandigarh, Uttaranchal, Jammu and Kashmir, Gujarat and Rajasthan report between 1-3 %. Char coal found in Dadar and Nagar Haveli (2%), Meghalaya (2%), Manipur (1%) and Himachal Pradesh (1%) respectively. Kerosene found between 1 and 10%, Daman and Diu (10%), A & N Island (10%), Lakshadweep (10%), Chandigarh (8%), Dadar and Nagar Haveli (5%), Meghalaya (4%), West Bengal (4%),where between 1-3% found in Gujarat, Tamil Naidu, Maharashtra, Karnataka, Himachal Pradesh, Punjab, Odisha, Madhya Pradesh, Jammu and Kashmir, Rajasthan, Goa, Pondicherry, Telengana, Sikkim, Arunachal Pradesh, Assam and Tripura respectively. Kerosene found in Lakshadweep (9%), Meghalaya (5%),Jammu and Kashmir (2%),Sikkim (1%) and other fuel found in West Bengal (6%), Bihar (2%), Odisha (1%) and Uttar Pradesh(1%) respective. Few states like, Sikkim, Chandigarh, Gujarat, Tamil Naidu and Karnataka where each states report 1% non availability of cooking fuel in their houses. (Table 1)

**Table1: State-wise availability of cooking fuel in India**

	coke, coal	Firewood and chips	LPG	Gobar gas	dung cake	charcoal	Kerosene	electricity	Others	no cooking arrangement
Jammu and Kashmir	0	46	49	0	1	0	1	2	0	0
Himachal Pradesh	0	62	35	0	0	1	1	0	0	0
Punjab	0	27	61	1	10	0	1	0	0	0
Chandigarh	1	10	81	0	1	0	7	0	0	1
Uttaranchal	0	36	62	0	1	0	0	0	0	0

Haryana	0	36	50	1	13	0	0	0	0	0
Delhi	0	2	98	0	0	0	0	0	0	0
Rajasthan	0	62	36	0	1	0	1	0	0	0
Uttar Pradesh	1	43	34	0	21	0	0	0	1	0
Bihar	2	54	22	0	20	0	0	0	2	0
Sikkim	0	33	64	0	0	0	1	1	0	1
Arunachal Pradesh	0	52	47	0	0	0	1	0	0	0
Nagaland	0	47	53	0	0	0	0	0	0	0
Manipur	0	43	56	0	0	1	0	0	0	0
Mizoram	0	33	66	0	0	0	0	0	0	0
Tripura	0	67	32	0	0	0	1	0	0	0
Meghalaya	0	68	21	0	0	2	4	5	0	0
Assam	1	60	37	0	0	0	1	0	0	0
West Bengal	8	47	33	0	2	0	4	0	6	0
Jharkhand	19	55	23	0	2	0	0	0	0	0
Odisha	1	71	20	0	4	0	1	0	1	0
Chhattisgarh	2	68	27	0	2	0	0	0	0	0
Madhya Pradesh	0	61	35	0	3	0	1	0	0	0
Gujarat	0	45	48	0	1	0	3	0	0	1
Daman and Diu	0	23	66	0	0	0	10	0	0	0
Dadar and Nagar Haveli	1	47	45	0	0	2	5	0	0	0
Maharashtra	1	39	57	0	0	0	3	0	0	0
Andhra Pradesh	0	37	61	0	0	0	0	0	0	0
Karnataka	0	47	49	0	0	0	3	0	0	1
Goa	0	22	77	1	0	0	1	0	0	0
Lakshadweep	0	66	17	0	0	0	8	9	0	0
Kerala	0	61	37	0	0	0	0	0	0	0
Tamil Naidu	0	31	65	0	0	0	3	0	0	1
Puducherry	0	20	79	0	0	0	1	0	0	0
A & N Island	0	48	41	0	0	0	10	0	0	0
Telengana	0	29	69	0	0	0	1	0	0	0
India	1	47	44	0	5	0	2	0	1	0

### Improve cooking fuel and Area

Fuel found in rural area as Delhi (98%) and Chandigarh (88%) shows more than 90% use of improve cooking fuel, between 50-80% found in Goa (64%), Puducherry (63%), Daman and Diu (52%) and Tamil Naidu (50%), between 30-50% found in Telengana (49%), Sikkim (48%), Mizoram (41%), Andhra Pradesh (38%), Punjab (37%), Nagaland (37%), Manipur (37%), Uttaranchal (37%), Maharashtra (37%), between 20-30% found in Jammu and Kashmir (26%), A & N Island (25%), Kerala (24%), Assam (23%), Himachal Pradesh (21%) and Haryana (21%) and Karnataka (21%), between 10-20% found in Gujarat (19%), Arunachal Pradesh (18%), Uttar Pradesh (12%), Rajasthan (11%), Dadar and Nagar Haveli (11%) and less than 10% found in Tripura (8%), West Bengal (8%), Lakshadweep (8%), Bihar (7%), Madhya Pradesh (7%), Meghalaya (6%), Odisha (5%), Jharkhand (4%) and Chhattisgarh (3%) respectively. In Urban area, improve fuel found more than 90% in Delhi (98%), Sikkim (94%), Mizoram (92%), Arunachal Pradesh (92%), Uttaranchal (90%) and Goa (90%), less than 60% found in West Bengal (59%), Chhattisgarh (57%), Odisha (56%), Bihar (52%), Kerala (49%), Jharkhand (49%) and Lakshadweep (44%) where remaining states shows improvement cooking fuel between 60-90% respectively.(Table2)

### **Improve cooking fuel and type of House**

self employed in agriculture houses shows more cooking fuel in Delhi (98%), Puducherry (90%), Daman and Diu (89%), Chandigarh (89%) and less than 25 % found in Arunachal Pradesh (24%), A & N Island (22%), Meghalaya (21%), Chhattisgarh (21%), Jharkhand (20%),

Lakshadweep (17%) and Odisha (15%) whereas remaining districts shows improve fuel in between 90-25%. self employed in non agriculture houses shows Delhi (99%), Arunachal Pradesh (92%), Puducherry (90%) and Telangana (87%) shows more improve cooking fuel and less than 50% fuel found in Meghalaya (49%), West Bengal (49%), Lakshadweep (44%), Odisha (43%), Jharkhand (42%) and Bihar (35%) and remaining districts shows between 50-85%. Regular wage/salary earning shows Delhi (89%), Sikkim (79%), Chandigarh (77%), Mizoram (76%), Goa (73%) report more improve cooking fuel and Odisha (20%), Lakshadweep (18%), Dadar and Nagar Haveli (13%) and Meghalaya (13%) report less improve cooking fuel whereas remaining districts shows between 20-73% respectively. casual labour in non agriculture shows more improve cooking fuel in Delhi (100%), Chandigarh (100%), Mizoram (100%) and very less found in Assam, Rajasthan, Madhya Pradesh, West Bengal, Bihar, casual labour in non in non agriculture report more improve cooking fuel as Delhi (75%), Chandigarh (67%), Puducherry (64%) and Goa (60%) where minimum improve cooking oil found in Gujarat, Meghalaya, Madhya Pradesh, West Bengal, Bihar, Tripura, Jharkhand, other type of house shows more improve cooking fuel in Chandigarh (100%), Dadar and Nagar Haveli (100%), Delhi (98%) and Mizoram (92%) and minimum improve cooking fuel in Bihar (33%), Odisha (32%), Lakshadweep (22%) and A & N Island (15%) respectively. (Table 2)

### **Improve cooking fuel and Religion**

Hindu household shows more improve cooking fuel in Mizoram (100%), Delhi (98%), Puducherry (78%), Nagaland (78%) and Chandigarh (77%) respectively whereas minimum improve cooking fuel found in Jharkhand (26%), Chhattisgarh (25%), Bihar (22%) and Odisha (21%). In Non Hindu; more improve cooking fuel found more Delhi (98%), Jammu and Kashmir (78%), Madhya Pradesh (79%), Karnataka (76%), Maharashtra (76%) whereas minimum cooking fuel found in Meghalaya (15%), Tripura (8%), Odisha (8%) and Lakshadweep (6%) respectively.

### **Improve cooking fuel and social group**

In SC households; improve cooking fuel found more in Chandigarh (100%), Delhi (96%), Uttaranchal (71%), Daman and Diu (67%) and minimum improve cooking found in Chhattisgarh (6%), Jharkhand (6%), and Odisha (5%). In Non SC household; improve cooking fuel found more in Delhi (98%), Goa (84%), Dadar and Nagar Haveli (83%), Chandigarh (81%) and Mizoram (79%) and minimum improve cooking found in Uttar Pradesh (34%), West Bengal (34%), Jharkhand (29%), Odisha (25%) and Bihar (22%) respectively. (Table 2)

### **Improve cooking fuel and Family size**

Improve cooking fuel in one family size found more in Delhi (89%), Goa (83%), Nagaland (83%) and Punjab (82%) and minimum cooking fuel found in Bihar (25%), Chhattisgarh (24%), Meghalaya (22%) respectively. Improve cooking fuel in two family size found more in Delhi (100%), Dadar and Nagar Haveli (100%), Chandigarh (90%) and Puducherry (87%) and minimum improve cooking fuel found in Chhattisgarh (27%), Jharkhand (25%), Bihar (21%) and Odisha (16%) respectively. Improve cooking fuel in three family size found more in Delhi (98%), Chandigarh (86%), Goa (85%) and Daman and Diu (73%) and Puducherry (71%) and

minimum improve cooking fuel found in Chhattisgarh (28%), Jharkhand (26%), Bihar (19%), (23%) and Odisha respectively. Improve cooking fuel in three or family size found in more in Delhi (98%), Chandigarh (83%), Puducherry (80%) respectively. Goa (73%) and Daman and Diu (72%) and minimum improve cooking fuel found in Chhattisgarh (27%), Meghalaya (26%), Lakshadweep (23%), Jharkhand (22%), Bihar (22%), respectively.(Table2)

#### Improve cooking fuel and socio-economic status

Improve cooking fuel in poorest found more in Delhi (88%), Puducherry (59%), Sikkim (40%), Telengana (43%) and minimum cooking fuel found in West Bengal (9%), Chhattisgarh (8%), Bihar (8%), Jharkhand (7%) and Odisha (5%) respectively. Improve cooking fuel in poor found more in Delhi (85%), Goa (77%), Puducherry (69%), and minimum cooking fuel found in Dadar and Nagar Haveli (12%), A & N Island (12%), Meghalaya (11%) and Jharkhand (11%) respectively. Improve cooking fuel in medium found more in Delhi (96%), Telengana (70%), Uttaranchal (70%) and minimum cooking fuel found in Dadar and Nagar Haveli (21%), Jharkhand (19%), Lakshadweep (17%) and Meghalaya (14%) respectively. Improve cooking fuel in rich found more in Delhi (100%), Puducherry (91%), Chandigarh (89%) and Uttaranchal (81%) and minimum cooking fuel found in Kerala (33%), Lakshadweep (26%) and Meghalaya (25%) respectively. Improve cooking fuel in richest found more in Rajasthan (100%), Uttaranchal (98%), Haryana (94%), Dadar and Nagar Haveli (93%) and Arunachal Pradesh (91%) and minimum cooking fuel found in Kerala(38%) and Jammu and Kashmir (5%).(Table2)

**Table2: Improve cooking fuel among household characteristics In India**

	Area		Types of House						Religion		Social Group		Family size				Social Economic status				
	Rural	Urban	self employed in agriculture	self employed in non agriculture	Regular salary/wages	casual labour in non agriculture	casual labour in non in agriculture	other	Hindu	Non Hindu	SC	Non SC	One member	Two members	Three members	More than 3 members	Poor	Poorest	Medium	Rich	Richest
Jammu and Kashmir	26	84	54	73	47	13	8	77	49	78	32	53	70	50	56	50	37	40	46	57	5
Himachal Pradesh	21	84	26	61	36	0	5	53	34	34	25	36	47	42	55	30	21	27	27	37	78
Punjab	37	86	68	77	54	13	27	79	75	62	13	61	82	71	67	59	40	40	48	61	66
Chandigarh	88	78	89	77	77	100	67	100	77	74	100	81	55	90	86	83	38	38	47	89	81
Uttaranchal	35	91	57	85	57	5	10	68	64	48	71	62	73	75	67	59	35	46	70	81	98
Haryana	21	79	55	67	38	3	9	68	52	42	52	50	65	55	57	48	26	28	42	48	94
Delhi	98	98	98	99	89	100	75	98	98	98	96	98	89	100	98	98	88	85	96	100	73
Rajasthan	11	71	36	54	32	1	4	42	34	67	11	39	37	36	35	36	15	24	29	38	100
Uttar Pradesh	12	69	31	55	33	3	5	52	33	68	19	34	50	36	39	33	14	23	31	47	64
Bihar	7	52	25	35	22	1	2	33	22	28	15	22	25	21	19	22	8	16	22	42	68
Sikkim	48	94	41	86	79		23	88	62	59	57	70	75	73	67	62	54	53	66	74	58
Arunachal Pradesh	18	92	24	92	46	0	25	57	61	59	44	53	70	56	64	42	28	57	46	58	91
Nagaland	37	78	40	66	57	0	0	76	78	27	52	75	83	79	59	51	18	39	50	66	75
Manipur	37	78	46	67	67	0	31	83	72	39	25	70	0	59	52	56	28	49	66	71	71
Mizoram	41	92	51	83	76	100	50	92	100	19	66	79	75	68	62	67	28	36	64	73	78
Tripura	8	67	29	50	35	0	2	63	35	8	12	38	32	37	40	29	12	20	22	43	88
Meghalaya	6	66	21	49	13	0	4	80	69	15	22	52	22	29	31	26	14	11	14	25	78
Assam	23	80	32	52	47	2	10	70	43	54	31	39	58	35	38	37	16	33	39	54	73
West Bengal	8	59	37	49	23	1	3	57	40	35	10	34	29	37	38	31	9	16	32	50	76
Jharkhand	4	49	20	42	16	0	1	39	26	33	6	29	37	25	26	22	7	11	19	32	83
Odisha	5	56	15	43	20	0	0	32	21	8	5	25	31	16	23	20	5	14	26	61	65

Chhattisgarh	3	57	21	59	21	3	0	51	25	74	6	36	24	27	28	27	8	18	31	51	84
Madhya Pradesh	7	69	32	71	31	1	3	60	33	78	13	40	34	29	31	36	12	23	36	51	78
Gujarat	19	78	51	71	36	4	4	62	46	74	11	56	41	50	60	47	24	27	39	46	72
Daman and Diu	52	81	89	67	61	0	0	67	66	43	67	66	50	50	73	72	40	33	64	77	73
Dadar and Nagar Haveli	11	80	63	78	13	0	5	100	45	25	13	83	50	100	59	41	25	12	21	68	93
Maharashtra	30	84	53	83	58	9	14	72	56	75	25	60	44	53	65	57	21	45	50	62	90
Andhra Pradesh	38	86	68	80	61	22	36	79	60	48	22	64	47	65	67	61	36	49	56	71	83
Karnataka	21	77	44	76	47	10	20	71	47	76	22	51	41	51	60	47	24	36	45	62	89
Goa	64	90	66	86	73	0	60	86	75	41	33	84	83	83	85	73	40	77	59	75	76
Lakshadweep	8	44	17	44	18	0	0	22	67	6	25	50	33	67	50	23	17	28	17	26	87
Kerala	24	49	41	51	27	6	10	53	37	20	16	38	35	48	42	35	16	22	26	33	38
Tamil Naidu	50	81	72	81	64	31	45	68	64	59	25	66	44	62	70	67	43	53	66	75	53
Puducherry	63	84	90	90	66	20	64	76	78	44		79	67	87	71	80	59	69	54	91	88
A & N Island	25	67	22	77	45	0	8	15	49	22	31	43	27	36	50	40	0	12	24	48	92
Telengana	49	89	65	87	69	20	37	83	69	34	25	71	54	70	69	69	45	56	70	76	69
India	20	74	41	66	43	8	11	60	44	48	26	47	46	47	49	43	18	30	41	55	90

Improved cooking fuel in rural(20%) and Urban(72%), type of houses shows self employed in agriculture (41%), self employed in non agriculture (66%),Regular salary/ wage earning (43%) and Casual labour in agriculture (8%), Casual labour in non agriculture(11%) and other(60%) respectively. Hindu(44%) and Non Hindu(48%) shows improve cooking fuel in India. Social group shows SC(26%) and Non SC(47%), Family member shows static pattern of improve cooking fuel in one member (46%), two member (47%), Three member (49%) and More than 3 members(43%) where as socio economic shows significant pattern of improve cooking fuel in Poorest(18%), Poorest (30%), Medium(41%), Rich (55%) and Richest (90%) respectively (Fig.1)

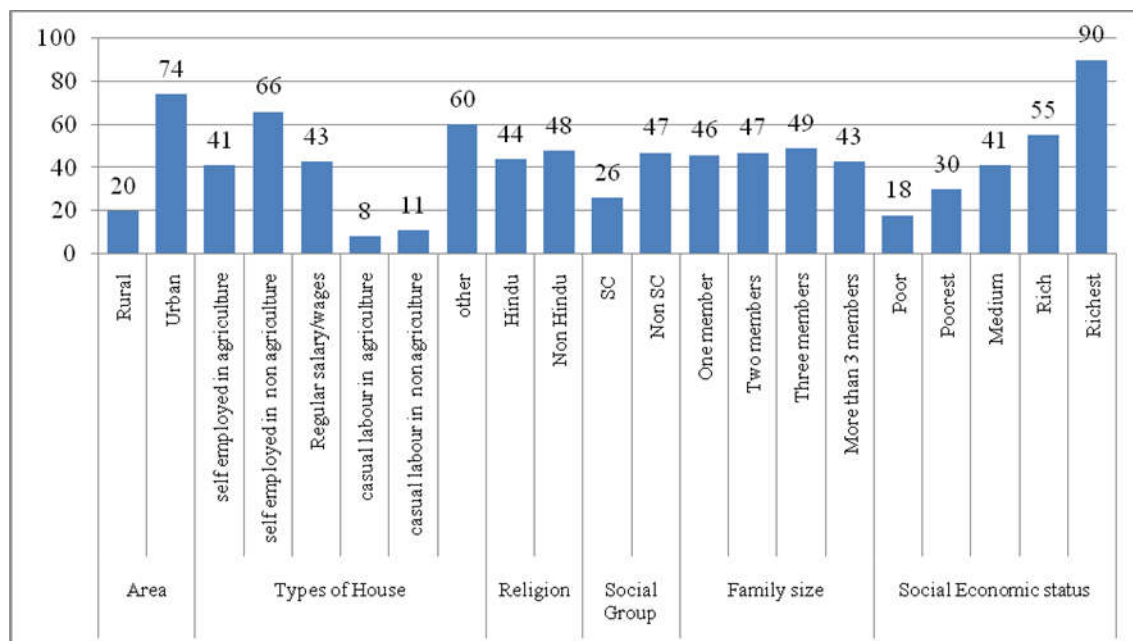


Figure1: Improve cooking fuel among households characteristics in India

Number of districts who shows improve cooking fuel is more than their state average of cooking fuel found more in Uttar Pradesh (30), Bihar (21), Madhya Pradesh (17), Tamil Nadu (16), Rajasthan (15), Haryana (11), Assam (11), Arunachal Pradesh (10), Gujarat (10), Maharashtra (9), Karnataka (9), Jammu and Kashmir (9), Jharkhand (9), Orissa (9), Punjab (8), Chhattisgarh (8), Uttaranchal (7), Kerala (7), Delhi (6), West Bengal (6), Andhra Pradesh (6), Himachal Pradesh (5), Mizoram (4), Manipur (3), Telengana (3), Sikkim (2), Pondicherry (2), Chandigarh (1), Tripura (1), Meghalaya (1), Daman & Diu (1), Goa (1), A&N (1), Dadra & Nagar Haveli (1) respectively. (Table 3)

Number of districts who shows improve cooking fuel is less than their state average of cooking fuel found in Uttar Pradesh (41), Madhya Pradesh (33), Maharashtra (24), Orissa (21), Karnataka (20), Rajasthan (18), Bihar (17), Tamil Nadu (16), Assam (16), Gujarat (16), Jharkhand (15), Jammu and Kashmir (13), West Bengal (13), Punjab (12), Haryana (10), Chhattisgarh (10), Kerala (7), Andhra Pradesh (8), Himachal Pradesh (7), Telengana (7), Arunachal Pradesh (6), Uttaranchal (6), Manipur (6), Meghalaya (6), Nagaland (5), Mizoram (4), Tripura (3), Delhi (2), Pondicherry (2), A&N (2).

Intra district analysis shows more 60 % districts have average less than their state average found in Meghalaya (86%), Tripura (75%), Maharashtra (71%), Orissa (70%), Telengana (70%), West Bengal (68%), Karnataka (67%), Manipur (67%), A&N (67%), Madhya Pradesh (66%), Jharkhand (63%), Gujarat (62%). Between 50-60% found in Punjab (60%), Assam (59%), Jammu and Kashmir (59%), Uttar Pradesh (58%), Himachal Pradesh (58%), Andhra Pradesh (57%), Chhattisgarh (56%), Rajasthan (55%), Tamil Nadu (50%), Kerala (50%), Mizoram (50%), Sikkim (50%), Pondicherry (50%), Daman & Diu (50%) and Goa (50%). Less than 50 % found in Haryana (48%), Uttaranchal (46%), Bihar (45%), Nagaland (45%), Arunachal Pradesh (38%) and Delhi (25%) respectively. Table (3)

**Table 3: State-wise intra variation of improved cooking fuel in India**

	No. of districts having coverage greater or less than state average coverage of improve cooking fuel			
	No. of districts have coverage greater than state coverage	No. of districts have coverage less than state coverage	Total districts survey	Proportion of districts have less coverage than state coverage
Jammu and Kashmir	9	13	22	59
Himachal Pradesh	5	7	12	58
Punjab	8	12	20	60
Chandigarh	1	0	1	0
Uttaranchal	7	6	13	46
Haryana	11	10	21	48
Delhi	6	2	8	25
Rajasthan	15	18	33	55
Uttar Pradesh	30	41	71	58
Bihar	21	17	38	45
Sikkim	2	2	4	50
Arunachal Pradesh	10	6	16	38
Nagaland	6	5	11	45
Manipur	3	6	9	67
Mizoram	4	4	8	50
Tripura	1	3	4	75
Meghalaya	1	6	7	86
Assam	11	16	27	59

West Bengal	6	13	19	68
Jharkhand	9	15	24	63
Orissa	9	21	30	70
Chhattisgarh	8	10	18	56
Madhya Pradesh	17	33	50	66
Gujarat	10	16	26	62
Daman & Diu	1	1	2	50
Dadra & Nagar Haveli	0	1	1	100
Maharashtra	10	24	34	71
Andhra Pradesh	6	8	14	57
Karnataka	10	20	30	67
Goa	1	1	2	50
Lakshadweep	0	1	1	100
Kerala	7	7	14	50
Tamil Nadu	16	16	32	50
Pondicherry	2	2	4	50
A&N	1	2	3	67
Telangana	3	7	10	70
India	267	372	639	58

Result based on regression shows, significant odd ratios found for urban (OR=6.82,  $p<0.01$ ), Hindu (OR=1.12,  $p<0.01$ ), Non SC (OR=1.53,  $p<0.01$ ), keeping other categories of each characteristics as Reference category. Richest showed more odd (14.9,  $p<0.01$ ), rich (Odd=7.14,  $p<0.01$ ), medium (Odd=4.46,  $p<0.01$ ), Poor (Odd=2.61,  $p<0.01$ ) keeping poorest quintile as reference category. Two member families has more odd ratio (OR=2.80,  $p<0.01$ ) followed by one member (OR=2.55,  $p<0.01$ ) and three members (OR=2.14,  $p<0.01$ ). Based on type of house, others house have more odd ratio (OR=1.44,  $p<0.01$ ), casual labour in agriculture/ non agriculture (OR=0.43,  $p<0.01$ ), regular wage/salary earning (OR=0.87,  $p<0.01$ ), taking self-employed in agriculture/ Non agriculture as a references (Table 4)

**Table 4: Association between improve cooking fuel and households characteristics in India**

		Adjusted Odd ratio 95% CI( LL,UL)
Area	Rural (RF)	-
	Urban	6.82** (6.54,7.10)
Religion	Hindu	1.12** (1.07,1.18)
	Non Hindu(RF)	-
Social Group	SC(RF)	-
	Non SC	1.53** (1.43,1.63)
Socio-economic status	Poorest(RF)	-
	Poor	2.61** (2.42,2.80)
	Medium	4.46** (4.14,4.80)
	Rich	7.14** (6.63,7.69)
	Richest	14.90** (13.8,16.1)
Family size	One member	2.55** (2.25,2.89)
	Two members	2.80** (2.57,3.05)
	Three members	2.14** (2.01,2.27)
	More than three members(RF)	-
House Type	self-employed in agriculture/ Non agriculture(RF)	-
	regular wage/salary earning	0.87** (0.82,0.91)
	casual labour in agriculture/ non agriculture	0.43** (0.39,0.46)
	others	1.44** (1.33,1.57)

## Discussion

Study reveals that improved cooking fuel found in rural(20%) and Urban(72%) where as 66% of rural households and 94% of urban households used electricity as primary source of energy for lighting. 33% of rural households and 5% of urban households used kerosene [15] Based on NFHS-4, Firewood and chips used more in rural houses and LPG uses in urban houses. [16]. Study made by Saroj revealed that Firewood and chips found more in rural (75%), Non-Hindu (69%), SC (74%), more than three members (67%) and poorest (76%) and LPG more in Urban (84%), other religion(60%) and Non-SC(36%), Three members (55%), richest (66%) respectively.[17] . Study reveals that Non –SC households having more use of improve cooking. According NSSO study, In rural India, firewood and chips was used by 89% of ST households and 81% of SC households but only 66% of households of the ‘Others’ category .In urban India, the incidence of use of firewood and chips was 31% for SC households, 27% for ST, 23% for OBC and 8% for Others. [15] Study reveals that self employed in agriculture (41%), self employed in non agriculture (66%),Regular salary/ wage earning (43%) and Casual labour in agriculture (8%), Casual labour in non agriculture(11%) and other(60%). According to NSSO, report among the different household types in rural India, the incidence of use of firewood and chips was highest (88%) for agricultural labour households. LPG was used for cooking by 19% of households self-employed in non-agriculture, and by only 3% of agricultural labour households. In urban India, use of LPG for cooking was most common among regular wage/salary earners (77% households) followed by the self-employed (68%), and least prevalent among casual labour households (29%). Use of firewood and chips was commonest among casual labour households (49%), being rare among regular wage/salary earning households (7%) and among ‘others’ (9%).[15] Intra district analysis shows Meghalaya (86%), Tripura (75%), Maharashtra (71%), Orissav (70%), Telengana (70%) show less average as compared to states average and Haryana (48%), Uttaranchal (46%), Bihar (45%), Nagaland (45%), Arunachal Pradesh (38%) and Delhi (25%) respectively shows more average as compared to state average .Coke was found more in Jharkhand (19%) and west Bengal (8%),Bihar(2%) and Chhattisgarh (2%), Firewood and chips found more 65% in Odisha (71%), Chhattisgarh (68%), Meghalaya (68%).Study reveals that Dung found in Uttar Pradesh (21%), Bihar (20%), Haryana (13%), Punjab (10%), According NSSO, Dung cake was the major fuel for cooking for 29% of rural households in Punjab, 20% in Uttar Pradesh, 18% in Haryana and 15% in Bihar.[15] LPG found more than 70% in Delhi (98%), Chandigarh (81%), Puducherry (79%) and Goa (77%), according to study .NSSO, Use of LPG was least in Chhattisgarh (2% households), Jharkhand (2.5%), Bihar (3.5%), and Odisha (3.7%)[15]. Study reveals Dung found in Uttar Pradesh (21%), Bihar (20%), Haryana (13%), Punjab (10%) . According to NSSO, in rural area, the percentages of households depend upon firewood and chips for cooking exceed 70% in all states except Punjab and Haryana.Char coal found in Dadar and Nagar Haveli (2%), Meghalaya (2%), Manipur (1%) and Himachal Pradesh (1%) respectively.[15] Study reveals Daman and Diu (10%), A & N Island (10%), Lakshadweep (10%), Chandigarh (8%), and a use of kerosene as source of energy for cooking was more prevalent in urban areas, especially in Gujarat (14%), Punjab (13%) and Karnataka.[15] Kerosene found in Lakshadweep (9%), Meghalaya (5%),Jammu and Kashmir (2%),Sikkim (1%) and NSSO reveals that in Gujarat (14%), Punjab (13%) and Karnataka were main states[15]

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**Competing interests**

The authors declare that they have no competing interests.

**Consent for publication**

Not applicable.

**Conclusion**

Major variations are found in the availability cooking fuel in rural and urban areas. Disparities in access to basic amenities were observed to have increased between the poor and non-poor households, between ST and SC households and between SC and other households. Study reveals that in rural area Firewood and chips is the main source of cooking and in urban LPG is the back bone of cooking. Due to non availability of LPG cylinder was the main reason of use of wood. In urban mostly houses linked to road, have easily availability of Gas, where in rural scenario is different. High cost of cylinder may also be cause of non availability of use of improve fuel of cooking in India. Thus the LPG prices are dependent upon the global market prices and are not in control while MPCE does not have much dependence on the global market. So the use of LPG will keep on fluctuating unless government puts a ceiling price of a cylinder and caps the rest of the price by subsidies etc

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