Original Article

Households with Access to Clean Fuels for Cooking and Associated Factors Towards Achieving Sustainable Development Goals in India: Insights from National Family Health Survey-5 (2019-21)

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Abstract

Background: Cooking using open fires or inefficient stoves fuelled by kerosene, biomass (wood, animal dung and crop waste) and coal generates harmful household air pollution. This study tried to estimate the proportion of Households with primary reliance on clean fuels and technology for cooking in India and determine the factors associated with it using the National Family Health Survey (NFHS) 5 data.

Materials and methods: We used data from the 2019–2021, National Family Health Survey (NFHS-5) household level data. Clean cooking fuel was considered as household's who are using electricity, LPG, biogas, natural gas and unclean cooking fuel was considered as any other fuel other than clean fuel. Multivariate logistic regression was performed to estimate the determinants of usage of unclean cooking fuel.

Results: Total 6,36,699 households were included in final analysis. The national level proportion of household's using clean fuel for cooking was 53%. Muslims, Sothern states, households with male Head of the Family (HoF), richest wealth index households, HoF with higher education status were more likely using clean fuels. Whereas Rural households, scheduled tribe households, households with kutcha houses, non-nuclear families and unmarried Hof were more likely using unclean fuels.

Conclusions: More than 50 percentage of households do not have access to clean fuels and technologies for cooking. Focus should be on providing access to North Indian states, rural households, households with female as head of the family (HoF), HoF with poor education, non-nuclear families and Scheduled tribe households to fill the gap to achieve Sustainable Development goals (SDG) target by 2030.

Key words: clean fuels and technologies for cooking, NFHS, sustainable Development goals.

Introduction

Household air pollution is generated when cooking is done using open fires or inefficient stoves that are fuelled by kerosene, biomass (such as wood, animal dung, and crop waste), and coal. Utilizing solid fuels for cooking is a significant contributor to household air pollution (HAP), which is a leading

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cause of mortality worldwide. Additionally, this practice imposes substantial environmental burdens.[1] In 2014, it was estimated that more than 800 million individuals in India did not have access to clean cooking fuel. This suggests that non-poor rural households have also been utilizing solid biomass as a source of energy for cooking.[2] According to reports, the use of solid biomass in inefficient cookstoves leads to approximately 1.3 million premature deaths annually in India.[3] The use of traditional stoves for cooking, especially in poorly ventilated areas, increases the direct exposure of individuals (mainly women and children in the Indian context) to household air pollution (HAP).[4] The implementation of enhanced cooking technology among the poorest third of the global population has been praised as a cost-effective intervention that has the potential to significantly alleviate these challenges.[5] When implemented correctly, which means using clean cooking technologies that counterbalance the use of traditional, polluting stoves and fuels, the adoption of clean cooking technology can contribute to the achievement of at least five of the Sustainable Development Goals (SDGs) outlined in the 2030 Sustainable Development Agenda. The National Programme on Climate Change and Human Health elaborates on the short term and long-term ill effects of air pollution, such as headaches, recurrent ARIs, skin irritation, and Cerebrovascular accidents, diabetes, Hypertension. Household air pollution is produced when cooking is done using open fires or inefficient stoves that are fuelled by kerosene, biomass (such as wood, animal dung, and crop waste), and coal. This study tried to estimate the proportion of Households with primary reliance on clean fuels and technology for cooking in India and determine the factors associated with it using the National Family Health Survey (NFHS) 5 data.

Material and Methods

Study Setting: We used data from the 2019–2020, National Family Health Survey (NFHS-5) household level (IAHR7CFL) data which is a nationally representative household survey that covered each district in all 29 states and 7 union territories of India.

Sampling method: NFHS-5 has adopted uniform sample design, which is representative at the national, state/union territory and district level. It used a two-stage cluster sampling approach. In first stage, primary sampling units (PSUs i.e., villages in rural areas and census enumeration blocks or CEBs in urban areas) were selected using probability proportional to size (PPS) technique. In the second stage, a fixed number of 22 households per cluster (i.e., PSUs) were selected using the technique of systematic random systematic selection from newly created lists of households' living in the selected PSUs. The list of households' is created as a result of the mapping and household listing operation conducted in each selected PSU before the household selection in the second stage. NFHS-5 gathered information from 636,699 households', 724,115 women, and 101,839 men.

Data collection was conducted by using 1,061 field teams. Each team consisted of one field supervisor, three female interviewers, one male interviewer, two health investigators, and a driver.

Dependant variable:

Clean cooking fuel: Clean cooking fuel was considered as household's who are using electricity, LPG, biogas, natural gas and **unclean cooking fuel** was considered as any other fuel other than clean fuel**.** [6]

Independent variables: Number of household members, Type of place of residence(rural/urban), Sex of head of household (Hof), education of Hof (No education, Primary, secondary and higher), religion (Hindu, Muslim, Christian and others), caste (SC, ST, OBC, others), house type (Pucca, Semi pucca, Kutcha), household structure (Nuclear and non-nuclear), Region of country (North, Central, East, North east, West and South), Wealth index (Poorest, poorer, middle, Richer and Richest).

Data analysis: House hold recode file (IAHR7CFL) having household level data was accessed from Demographic and Health surveys (DHS) programme.

The proportions of household with clean cooking fuel along with (95% Confidence interval) has been estimated. The association between socio-demographic factors and Clean cooking fuel were assessed through a bivariate analysis. A multivariate logistic regression model was used to examine the

association between households' socio-demographic factors and clean cooking fuel. Variables with a p-value<0.05on bivariate analysis, and variables with contextual importance were included in the final multivariate logistic regression. A p value <0.05 will be considered statistically significant. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp was used for analysis.

Results

Sample characteristics: During NFHS-5 survey, data from 636699 households was collected during 2019-20. Among them majority of households had less than 5 members in the family (56.1%), rural residents (74.6%), with female Hof (53.7%), age of Hof more than 40 years (54.4%), Hof educated up to secondary school (60.4%) and married (52.7%), poorest wealth index family (33.9%) belong to other backward-caste (56%), pucca type of house (72.3%), nuclear families (53.7%), belong to Muslim religion (57.2%) and population of south region (80%). The Proportion of households using clean cooking fuel was 52.8% (95%CI: 52.7%-53.0%)

Table 1: Socio demographic factors wise distribution of Households (NFHS 5, 2019-20)

Variable		Number	Clean Cooking Fuel		p-value
			Yes	No	
No of household members	< 5	472192	56.1	43.9	<0.001
	≥ 5	162800	44.3	55.7	
Place of residence	Urban	159622	88.7	11.3	<0.001
	Rural	475370	41.1	58.9	
Age of Head of Family	< 40 Years	193163	50	50	<0.001
	≥ 40 years	441829	54.4	45.6	
Wealth index	Poorest	148201	7.7	92.3	<0.001
	Poorer	140618	33.9	66.1	
	Middle	128705	65	35	
	Richer	114826	84	16	
	Richest	102642	95.2	4.8	
Caste	Scheduled Caste	122620	49.8	50.2	<0.001
	Scheduled tribe	123197	34.4	65.6	
	Other backward class	233309	56	44	
	None of them	124012	68.7	31.3	
Sex of Head of Family	Male	525897	52.9	47.1	<0.001
	Female	109079	53.7	46.3	
Religion	Hindu	480734	52.4	47.6	<0.001
	Muslim	72447	57.2	42.8	
	Christian	49605	48	52	
	Others	32106	61.8	38.2	

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Region	North	121490	58.1	41.9	<0.001
	Central	138592	39.4	60.6	
	East	103161	33.1	66.9	
	Northeast	94380	45.2	54.8	
	West	65191	68	32	
	South	112178	80.7	19.3	
Highest level of education attained	No education/ Preschool	188437	37.3	62.7	<0.001
	Primary	117515	45.1	54.9	
	Secondary	268560	60.4	39.6	
	Higher	59925	85	15	
Current marital status	Never married	12457	59.8	40.2	<0.001
	Married	532667	52.7	47.3	
	Living together	89725	54.3	45.7	
Household Type	Kachha	37616	17.7	82.3	<0.001
	Semi-Pucca	245672	31.9	68.1	
	Pucca	342975	72.3	27.7	
Household structure	Nuclear	373494	53.7	46.3	<0.001
	Non nuclear	261498	52.1	47.9	

From Table 1 It was observed that majority of households with family size of < 5 (56.1%), households resided in urban areas (88.7%), households with female Hof (54.4%), Hof aged 40 or older, households belonged to the richest wealth index (95.2%), households belonged to other castes (56%), Muslims (57.2%), households located in the southern region (80.7%), households with Hof educated to higher level of education (85%), households Hof with marital status of never married (59.8%), households residing in pucca (permanent) structure (72.3%), and nuclear families (53.7%) were using clean cooking fuel when compared to their counterparts.

Table 2: Association between sociodemographic factors and Clean cooking fuel (NFHS 2019-21)

Variable		**Clean cooking fuel**	
		U OR (95%CI)	**A OR (95% CI)**
No of household members	< 5	1	1
	≥ 5	0.624(0.617-0.631)	0.652 (0.640-0.664) *
Place of residence	Urban	1	1
	Rural	0.089(0.087-0.090)	0.282 (0.276-0.288) *
Age of Head of Family	< 40 Years	1	1
	≥ 40 years	1.191(1.178-1.204)	0.825(0.811-0.839) *

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Wealth index	Poorest	1	1
	Poorer	6.169(6.034-6.306)	6.315(6.157-6.477) *
	Middle	22.422(21.927-22.978)	24.997(24.292-25.722) *
	Richer	63.118(61.572-64.703)	75.312(72.812-77.898) *
	Richest	240.937(232.763-249.398)	313.527(299.633-328.066) *
Caste	Scheduled Caste	1	1
	Scheduled tribe	1.217(1.198-1.236)	0.717(0.699-0.736) *
	Other backward class	0.841(0.825-0.856)	0.778(0.763-0.794) *
	None of them	1.471(1.437-1.505)	0.997(0.974-1.021) *
Sex of Head of Family	Male	1	1
	Female	1.032(1.019-1.046)	6.315(6.157-6.477) *
Religion	Hindu	1	1
	Muslim	0.530(0.522-0.539)	1.408(1.372-1.446) *
	Christian	1.286(1.269-1.304)	0.726(0.701-0.752) *
	Others	2.216(2.180-2.253)	1.184(1.144-1.225) *
Region	North	1	1
	Central	0.468(0.461-0.475)	1.786(1.744-1.829) *
	East	0.357(0.351-0.364)	2.242(2.183-2.302) *
	Northeast	0.595(0.585-0.685)	3.598(3.490-3.710) *
	West	1.533(1.502-1.564)	4.501(4.371-4.635) *
	South	3.010(2.954-3.067)	8.558(8.330-8.792) *
Highest level of education attained	No education	1	1
	Primary	1.379(1.359-1.400)	0.922(0.902-0.942) *
	Secondary	2.568(2.537-2.600)	1.051(1.031-1.071) *
	Higher	9.553(9.324-9.789)	1.576(1.522-1.631) *
Current marital status	Never married	1	1
	Married	0.749(0.722-0.776)	0.640(0.607-0.676) *
	Living together	0.799(0.770-0.831)	0.813(0.767-0.862) *
Household Type	Pucca	1	1
	Semi-Pucca	2.177(2.118-2.239)	0.842(0.814-0.871) *
	Kaccha	12.129(11.800-12.468)	0.589(0.568-0.611) *
Household structure	Nuclear	1	1
	Non-nuclear	0.935(0.926-0.944)	0.842(0.814-0.871) *

*Significant, UOR – Unadjusted odds ratio, AOR- Adjusted odds ratio.

From Table 2 It was observed that households with family size of ≥ 5 (AOR-0.652% (95% CI: 0.640% - 0.664%), rural residence households (AOR-0.282% (95% CI: 0.276%-0.288), Households with Hof aged ≥40 years (AOR-0.825% (95% CI: 0.811%-0.839), Scheduled tribe households (AOR- 0.717(0.699-0.736), Christian religion households (AOR-0.726(0.701-0.752), Households with Hof educated up to primary education (AOR-0.922(0.902-0.942), households with Married Hof (AOR-0.813%(95% CI: 0.767%-0.862%), Household residing in kaccha houses (AOR- 0.589(0.568-0.611), Household structure with nonnuclear (AOR- 0.842%(95% CI: 0.814%-0.871) were less likely using clean cooking fuels. Whereas households belonged to richest wealth index (AOR-313.527(299.633-328.066), households in the southern region (AOR-8.558(8.330-8.792), Households with Hof educated up to higher education (AOR-1.576(1.522-1.631) were more likely using clean cooking fuels.

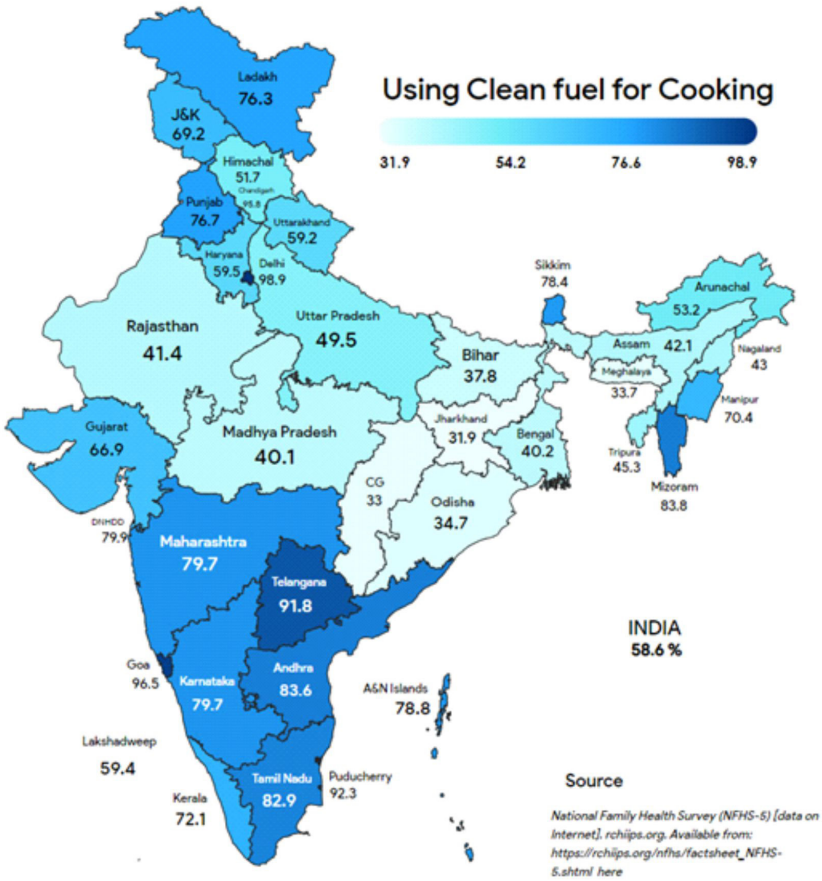

Figure 1: Showing the usage of clean cooking fuel in India as per National Health Family Survey NFHS-5 (2019-2021)

State wise proportion of usage of clean fuel was ranging from 31.9% to 98.9%. Jharkhand was the lowest and Delhi was the highest proportion of using clean cooking fuel.(Figure 1)

Discussion

This study used a wide range of variables to assess the availability and use of clean cooking fuels in Indian households, out of which women's education and wealth including their share in household expenditure seem to have the most significant impact on the use of clean fuel.[7]

The relevance of this study is highlighted as we delve into the worldwide statistics, among which the one that stands out the most is a WHO study published in the Global health observatory in 2022, stating that a staggering 2.3 billion people worldwide still remain without access to clean cooking fuel, with the lowest coverage found in Sub-Saharan Africa.[8]

Approximately 2.5 million premature deaths occur annually as a result of household air pollution, primarily caused by cooking smoke. Recent data shows a progressive decline worldwide in the number of people who do not have access to clean cooking facilities. However, this decline has not been sufficient to keep up with the population growth in numerous countries, particularly in sub-Saharan Africa. The Covid-19 pandemic exacerbated the problems, increasing the number of people without clean cooking by 1% between 2019 and 2021.[9] Approximately 1.5 billion individuals residing in developing Asia, which accounts for 60% of the global population, lack access to clean cooking facilities.[10] Of overwhelming concern is the fact that use of unclean fuel is a contributes significantly to household air pollution which is caused by release of particulate matter, CO, NO, CO2 and other noxious gases. The majorly affected were women[11], young children[12] and causing a huge impact on incidence of LRTI in under-6 children, low birth weight[13] and under-five mortality. In other studies, conducted in India, it was found that women exposed to biomass fuel gas had higher adverse ophthalmic, dermatological, cardiovascular and obstetric outcomes[15]. Studies conducted in African countries reflect wide urban-rural gaps in clean fuel accessibility and consumption and a very slow, disheartening progress towards adoption of clean fuel.[16] Similarly, studies conducted in other parts of the world showcase allied results, and even highlight some underestimated individual health issues. Studies done in rural China show that use of solid cooking fuels and the resultant HAP from it is associated with rapid decline of mental health among the elderly[17] as well as cognitive dysfunction[18] and higher depression symptoms/similar diseases[19-20]. In addition, use of clean fuels has shown to drastically improve the health of women.[21] It is estimated that HAP due to use of solid cooking fuels is a major drive for global warming[22], as well as other environmental and health hazards associated with solid biomass.[23]

Clean fuel utilization is linked to various factors apart from wealth index, such as educational status, caste, gender variables, religion and marital status to name a few, as has been highlighted in our current study. Hence, studies emphasizing on social factors are able to provide a clearer picture to the hidden variables that are sometimes overlooked. For instance, the number of households having access to LPG has been estimated at a 97.5% by the GOI.[24] However, a study conducted by IRES[25] estimates this number at only 85%. This vast gap is explained by the fact that just the number of domestic household connections is insufficient to determine LPG penetration, pinpointing at possible duplication of connections. Other concerns highlighted in the study which hinder the adoption of clean fuel include unaffordability of LPG especially for people living in kutcha/semi kutcha houses[26], and the stacking of solid fuels in rural India by no less than 38% of the houses, which has been attributed to the recurring expense of refills associated with LPG connections, as well as lack of refills and non-receipt of subsidy payment.[27]

One of the initiatives taken by the Indian government to achieve the sustainable development goal 7is the launch of the Pradhan Mantri Ujjawala Yojana[28], under which LPG cylinders are distributed at a subsidized price to the lower caste, BPL, forest dwellers and people on islands.[29]China, the implementation of natural gas infrastructure and African clean cooking energy solutions (ACCES) initiatives has been taken up to meet the SDG 7.[30]

Strengths and limitations:

This study used data from the NFHS-5, ensuring reliable, national data for a full analysis. National data collection eliminates cultural and personal biases and minimizes inaccuracies. The study evaluates wealth, housing type, quality of life, religion, marriage, and education to understand how socio-demographic factors affect cleaner cooking practices. Since grassroots data is not collected directly, it is impossible to ascertain its acquisition techniques. Which family members attended the collection process, and how freely could the interviewees respond? The study neglects the influence of children on the data and their well-being, especially female children. We could have also addressed the difference in healthcare expenditures between households using clean fuel and those using non-clean fuel, as well as their financial implications.

Conclusions

More than 50% of households do not have access to clean fuels and technologies for cooking. Focus should be on providing access to North Indian states,

rural households, households with female as head of the family (HoF), HoF with poor education, non-nuclear families and Scheduled tribe households to fill the gap to achieve Sustainable Development goals (SDG) target by 2030.

Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors

Availability of data and material: The data can be downloaded from the website of the Demographic and Health Survey (DHS) (http://dhsprogram.com/Data/).

Ethical Considerations: This study based on secondary dataset, is available in public domain for research use. Hence, no ethical approval was required from any institutional review board

Conflict of Interest: None Declared

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