Has Financial Autonomy of Indian Women Any Potential to Accelerate Transitions to Clean Fuel?

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Abstract: *Women are principally responsible for collection and use of fuel in many low-income countries, and women's empowerment has been identified as key to accelerating progress towards the sustainable development goals (SDGs). WHO, under its indoor air quality guidelines, defines solid fuels (coal plus biomass such as charcoal, wood, dung, and crop residues) and kerosene as 'polluting', and other fuels, such as electricity, LPG, biogas and natural gas as 'clean'. As income rises, households move away from traditional fuels like wood, crop wastes and dung to adopt intermediate fuels like charcoal, coal and kerosene, and then to modern, less polluting fuels, including gas and electricity. My objective is to examine whether there is any association between women's empowerment and household fuel use at national-level across India, and also to quantify the associations between different dimensions of women's empowerment and household fuel use at national-level across India. I have applied binary logistic regression. The data is analyzed using Stata13. In this paper, I have shown that households in which women have greater empowerment in the arena of decision making and control over expenditure decisions appear to be more likely to invest in the usage of clean cooking fuels. These results point to the importance of incorporating gender into our considerations as we think about ways of encouraging households to move away from the use of solid fuels to that of clean fuels.*

Keywords: women, fuel, clean, polluting, environment, empowerment

1. Introduction

Fuel use by households is driven by a complex interaction of various social, cultural and environmental factors, and women are often responsible in acquisition and use of fuel in many societies. Women are principally responsible for collection and use of fuel in many low-income countries, and women's empowerment has been identified as key to accelerating progress towards the sustainable development goals (SDGs). Women's empowerment is a complex, multidimensional concept, with no standard definition. Notwithstanding this, definitions of women's empowerment generally refer to women's individual and/or collective capacity to have power to control their own lives (both within and outside the home), ability to influence the direction of social changes (nationally and internationally), and access to opportunities and resources.

The World Health Organization (WHO), under its indoor air quality guidelines, defines solid fuels (coal plus biomass such as charcoal, wood, dung, and crop residues) and kerosene as 'polluting', and other fuels, such as electricity, LPG, biogas and natural gas as 'clean'. These fuels are all associated with some emissions, but this binary classification is a useful way to distinguish relatively high and low emission fuels. I analyse National Family Health Survey-4(NFHS-4) data published in 2015-2016

2. Literature Review

The proportion of the world's population with access to clean cooking fuels (i.e. being able to use clean fuels as primary source of energy for cooking) was estimated to be 57% in 2014, while 43% were without such access (i.e. relying on polluting fuels). Apart from primary cooking fuels, it is well documented that some households use a combination of clean and polluting fuels in parallel (i.e.

'fuel-stacking'). Despite modest reductions in many countries since 2010, in 2017, approximately 3.6 billion people (47% of the global population) still relied on solid fuels alone (i.e. excluding kerosene), with deep disparities between rich and poor, and between urban and rural dwellers.

Earlier research from developing countries established the concept of the 'energy ladder'. As income rises, households move away from traditional fuels like wood, crop wastes and dung to adopt intermediate fuels like charcoal, coal and kerosene, and then to modern, less polluting fuels, including gas and electricity. However, it has been demonstrated that higher income does not necessarily move households 'up the ladder'. Other factors may contribute to fuels used in the household.

A large amount of empirical research has been undertaken in low-and middle-income countries on solid fuels and health over the past several decades, such as the crucial and sustained work of Professor Kirk R Smith (1947–2020). There is also a substantial body of research that focused on socio-economic and other determinants of fuel use and/or switching to cleaner fuels.

3. Objectives

The aims of our study are:

(a) To examine whether there is any association between women's empowerment and household fuel use at national-level across India;

(b) To quantify the associations between different dimensions of women's empowerment and household fuel use at national-level across India;

Data and Methodology:

I want to assess the associations between women's autonomy and cooking fuel use in India. I analyse National Family Health Survey-4(NFHS-4) data published in 2015-2016 (n = 259627 among which 228501 are male household heads and 31126 are female household heads). I have chosen only women data. I have included the domain of empowerment, i.e. decision-making. Binary Logistic regression models assessed the associations between women's empowerment domains and the type of fuel used in the household ('clean': electricity, liquefied petroleum gas (LPG), biogas or natural gas; 'polluting': solid fuels or kerosene).

The data is analyzed using Stata13 and our analytical approach includes both bivariate and multivariate analysis.

Description of variables

Outcome variable

The NFHS 4 data record only the primary fuel type used for cooking in each household, and do not capture multi-fuel stacking or non-cooking fuel sources. The primary cooking fuel was the outcome variable in my analyses,

and all references in the text to household fuel use refers to that variable. I then create a binary outcome, based on WHO definitions in their indoor air quality guidelines comprising clean fuels (including electricity, LPG, natural gas and biogas) and polluting fuels (kerosene, coal, charcoal, wood, dung, crop residue, grass, shrubs and straw). The binary outcome was our primary focus in the analyses. Here Y_i is the dependant variable taking value 0 for women use the polluting fuel and 1 for women use clean fuel. As, dependant variable has two outcome (polluting fuel=0, clean fuel=1) binary logit is applied to estimate whether women use the polluting fuel or clean fuel.

Exposure Variables:

Our main exposure variables are the variables, which are based on household level NFHS data collected among women aged 15–49 years, and covered the financial empowerment of Indian women.

The table in the following shows the different exposure variables, and the values taken.

Events that the respondent (female household head) experienced in the 12 months prior to interview.

Variable code	Variables	Values taken
s927	Women has money that alone can decide how to use	No=0, Yes=1
s929	Women has bank or savings account that she uses	No=0, Yes=1
s933	Women knows programme in this area that give loans to women to start or expand a business	No=0, Yes=1
s934	Women ever taken a loan, cash or in kind, from these programmes, to start or expand a business	No=0, Yes=1

Where x_i's are independent variables, all are dummy, and β_i s are regression coefficients. Here x_i's the independent variables taking value 0 for women are not empowered and 1 for women is empowered.

The Model:

Now we can write,

Women fuel use = f (Women has money that alone can decide how to use, Women has bank savings account that she uses, Women knows programme in this area that give loans to women to start or expand a business, Women ever taken a loan, cash or in kind, from these programmes, to start or expand a business)

$$P(Y=1|x_1,x_2,x_3) = F(\beta_0+\beta_1 x_1+\beta_2 x_2+\ldots\ldots+\beta_4 x_4)$$
$$= 1/ \left(1+e^{-(\beta_0+\beta_1 x_1+\ldots\ldots+\beta_4 x_4)}\right)$$

Where x_i's are independent variable and β_i s are regression coefficients. Y is the dependant variable taking value 0 for bad fuel and 1 for good fuel.

Presentation, analysis & Findings:

Table 1: Distribution of women according to their use of Toilet Facility

Type of cooking fuel		Freq.	Percent	Cum.
Electricity	229	0.74	0.74
lpg, natural gas	8,059	25.89	26.63
Biogas	115	0.37	27.00
Kerosene	247	0.79	27.79
coal, lignite	252	0.81	28.60
Charcoal	223	0.72	29.32
wood	13,784	44.28	73.60
straw/shrubs/grass	1,237	3.97	77.58
agricultural crop	1,409	4.53	82.10
animal dung	3,371	10.83	92.93
no food cooked in house	2	0.01	92.94
Other	8	0.03	92.96
not a de jure resident	2,190	7.04	100.00
Total	**31,126**	**100.00**	

Source: Authors computation from NFHS data

Among the 31,126 female population, highest use of fuel is wood (44.28%) and 2nd highest use of fuel is LPG and Natural Gas (25.89%). This is shown in Table 1.

Now we want to see whether different indicators of women's financial autonomy or empowerment are significant determinants of women's fuel use or not. So binary logistic regression of fuel use by women headed household is applied on x_1 (Women has money that alone can decide how to use), x_2 Women has bank or savings account that she uses), x_3 (Women knows programme in this area that give loans to women to start or expand a business), and x_4 (Women ever taken a loan, cash or in kind, from these programmes, to start or expand a business). From table 2, I see that x_1, x_2, x_4 variables are significant.

Table 2: Regression results of women empowerment on women's fuel use:

Logistic regression

Number of obs = 1940
LR chi2(3) = 11.09
Prob > chi2 = 0.011
Log likelihood =-96.614063 Pseudo R2 = 0.543

v161	Odds Ratio	Std. Err.	z	P>|z|	Std. [95% Conf. Interval]
s927					
yes.	1.594274	1.21388	2.41	0.016**	0358474, .7090355
s929					
yes	1.664566	3.846462	2.71	0.048**	2137315 2.066368
s933					
Yes	1 (omitted)				
s934					
yes	1.4823	1.120177	0.52	0.002**	.3370397 6.519149
_cons |	526.5927	414.8672	7.95	0.000	112.4268 2466.49

Source: Authors compilation from NFHS data

The overall model is statistically significant (chi-square = 11.09, p =.01). Chi-square is actually a special case of logistic regression. In a chi-square analysis, both variables must be categorical. The **z** test statistic for the predictor x1 is 2.41 with an associated p-value of <0.0001. If we again set our alpha level to 0.05, we would reject the null hypothesis and conclude that the regression coefficient for **s927** has been found to be statistically different from zero in estimating **cooking fuel use by women headed house hold** given that **s929, s933. S934** in the model. Similarly, we would reject the null hypothesis of x_2 and conclude that the regression coefficient for **s929** has been found to be statistically different from zero in estimating **cooking fuel use by women headed house hold** given that **s927, s933. S934** in the model. Similarly, we would reject the null hypothesis of x_4 and conclude that the regression

coefficient for **s934** has been found to be statistically different from zero in estimating **cooking fuel use by women headed house hold** given that **s927, S929, s933** in the model.

The odds ratio of the variable s927, Women has money that alone can decide how to use with respect to women can't decide how to use is 1.594274 (greater than one). This implies that the amount of change expected in the odds ratio when there is a one unit change in the predictor variable with all of the other variables in the model held constant. i.e. for a one unit increase in women who can decide how to use money likely to use clean fuel , the odd of clean fuel with respect to polluting fuel used by women who can decide how to use her money are 1.59 times greater, given the other variables held constant in the model. Similarly, the odd ratio of the variable s929, Women has bank or savings account that she uses with respect to Women has bank or savings account that she doesn't use is 1.664566 (greater than one). It implies that for a one unit increase in women who use her bank account likely to use clean fuel, or in other word, the odd of clean fuel with respect to polluting fuel used by women who use her own bank account is 1.66 times greater, given the other variables held constant in the model. s933, Women knows programme in this area that give loans to women to start or expand a business, is omitted because of collinearity. The odds ratio of the variable s934, Women ever taken a loan, cash or in kind, from these programmes, to start or expand a business with respect to Women do not takea loan, cash or in kind, from these programmes, to start or expand a business is 1.4823 (greater than one). i.e for a one unit increase in Women ever taken a loan, cash or in kind, from these programmes, to start or expand a business likely to use clean fuel. Or in other word, the odd of clean fuel with respect to polluting fuel used by women who take a loan, cash or in kind, from these programmes, to start or expand a business is 1.48 times greater, given the other variables held constant in the model.

4. Conclusion

In this paper, I have shown that households in which women have greater empowerment in the arena of decision making and control over expenditure decisions appear to be more likely to invest in the usage of clean cooking fuels. These results point to the importance of incorporating gender into our considerations as we think about ways of encouraging households to move away from the use of solid fuels to that of clean fuels. Women alone can decide how to use her income/money can influence household adoption of clean fuel via both income and substitution effect. A woman has bank account and she herself uses it, also has an effect on accessing the clean fuel. The result also indicate that when women are engaged in taking a loan, cash or in kind, from the programmes of giving loan to women in the local area, to start or expand a business, households seem to be more inclined to invest scarce resources in clean fuels due to substitution effect, which will free up their time from collecting fuel wood or other biofuel and cooking for long hours, and reduce the negative health impacts for women who are the primary cooks. As women bear greater share of the burden of household chores, such as collecting fuel wood or cooking and cleaning, they are more likely to shift towards clean fuel adoption.

The SDGs have an explicit focus on energy, specifically, goal seven aims to ensure access to affordable, sustainable and modern energy for all by the year 2030.Household energy, as a goal, is not only an end in itself, but it is also a means through which to accelerate the progress of other SDGs Another pivotal SDG, which is aimed at accelerating sustainable development, is the promotion of women's empowerment and gender equality. Our results suggest that components of these two SDGs (i.e. women's financial autonomy and clean household energy) have a number of interesting associations in India . Greater empowerment of women in decision-making in her day to day life was associated with higher odds of using clean fuel as primary energy source for cooking in the household.

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