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Evaluating the Impact of Pradhan Mantri Ujjwala Yojana on Energy Affordability among Below Poverty Line Families in District Pithoragarh, Uttarakhand

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Abstract
This study quantitatively assesses how the Pradhan Mantri Ujjwala Yojana (PMUY) has influenced energy affordability for Below Poverty Line families in Pithoragarh, Uttarakhand. Employing a stratified random sampling method, the research collected data from 409 households to investigate changes in monthly energy expenses and the frequency of LPG refills since the introduction of PMUY. The analysis suggests that PMUY has significantly enhanced energy affordability, primarily by reducing monthly expenditures on cooking fuel. Notably, households that switched to LPG under PMUY reported lower energy costs and perceived LPG as a more economical alternative compared to traditional fuels. However, the frequency of LPG refills also emerged as a critical factor affecting sustained affordability. These findings highlight the potential of PMUY in enhancing energy security but also underscore the need for ongoing support and infrastructure improvements to maintain these gains among the most vulnerable populations.
Keywords: PMUY; Energy Affordability; Below Poverty Line (BPL); LPG Adoption; Rural Energy Policy.

1. INTRODUCTION

The PMUY, launched by the Government of India in 2016, was a flagship initiative aimed at providing clean cooking fuel to Below Poverty Line (BPL) families, especially in rural and underserved areas. Prior to the scheme, millions of households relied on traditional cooking fuels such as firewood, kerosene, and cow dung, which not only posed severe health risks due to indoor air pollution but also contributed to environmental degradation (Gupta et al., 2020; Sankhyayan & Dasgupta, 2019). According to the World Health Organization (WHO), exposure to smoke from traditional cooking methods is a major cause of respiratory illnesses and is responsible for over 4 million premature deaths annually worldwide (Kumar et al., 2024; Yadav, 2020). By promoting liquefied petroleum gas (LPG) as a cleaner, more efficient alternative, PMUY aimed to alleviate these health burdens while improving the overall quality of life for economically disadvantaged families (Patnaik & Jha, 2020; Ranjan & Singh, 2020).

While PMUY has been successful in connecting over 80 million households to LPG (Ravindra et al., 2021), concerns remain about the long-term affordability of using LPG, particularly the recurring costs of refills. The affordability of regular LPG cylinder refills is a crucial factor in determining whether households fully transition away from traditional fuels or revert to them when faced with economic challenges (Ray, 2021; Swain & Mishra, 2020). This issue is particularly relevant in remote, hilly regions like Pithoragarh in Uttarakhand, where logistical barriers often compound the challenges of affordability (Lahariya, 2018; Prinja et al., 2019). This study focuses on assessing how the adoption of LPG under PMUY has impacted energy affordability for BPL households in Pithoragarh and explores the sustainability of LPG use in the region.

2. LITERATURE REVIEW

The PMUY has been extensively studied for its impact on household energy consumption, public health, and

socio-economic outcomes (Mohapatra, n.d.). Early research by Sharma et al. (2023) explored the immediate health benefits of the scheme, highlighting significant reductions in respiratory ailments and improved indoor air quality among rural households adopting LPG in place of traditional fuels (Prinja et al., 2017; Supervisor et al., 2023). Similarly, Ramprakash and Lingam (2018) examined the socio-economic effects of PMUY in Uttar Pradesh, noting that access to LPG contributed to greater household efficiency by reducing the time spent collecting firewood, especially for women (Garg et al., 2019; Gill-Wiehl et al., 2022; Kailthya & Kambhampati, 2022). However, the authors pointed out that while the initial costs of LPG adoption were subsidized, the recurring costs of cylinder refills remained a significant financial burden for many families, particularly in low-income groups.

Recent studies have emphasized the sustainability of LPG usage over time (Gopichandran, 2019; Laurens, n.d.). Nandi, Schneider and Dixit (2017) found that while PMUY made LPG affordable during the initial adoption phase, households often struggled with the ongoing costs of refills (Chowdhury & Chakraborty, 2017). Rao et al. (2014) investigated barriers to continued LPG use, identifying high refill costs and logistical challenges as major hurdles, particularly in remote regions like Uttarakhand. The study highlighted that despite increased LPG access under PMUY, households in hilly districts faced difficulties in sustaining regular LPG use due to inconsistent distribution networks and the higher costs associated with refills (Sood et al., 2014). These findings suggest that while PMUY has achieved its initial goal of improving access to clean energy, the long-term affordability and accessibility of LPG, especially in geographically isolated areas, require further attention and policy intervention.

Research Gaps

This research gaps are given as follows;

1. Insufficient research on the sustainability of LPG usage over time, particularly regarding the affordability of regular cylinder refills among BPL households.
2. A lack of studies focusing on remote and hilly districts like Pithoragarh, Uttarakhand, where unique logistical challenges may affect LPG accessibility and affordability.
3. Limited understanding of how adopting LPG under PMUY influences energy affordability.

3. OBJECTIVES & HYPOTHESES

The objectives of study are:

1. To study the sustainability of LPG usage regarding the affordability of regular cylinder refills among BPL households.
2. To conduct study over remote and hilly districts like Pithoragarh, Uttarakhand, where unique logistical challenges may affect LPG accessibility and affordability.
3. To study the direct impact of adopting LPG under PMUY on energy affordability.

The hypotheses of the study are given as follows;

H1: There is significant positive relationship between implementation of PMUY and energy affordability.

H2: There is significant positive impact of adopting LPG under PMUY on energy affordability.

4. RESEARCH METHOD / METHODOLOGY

4.1 Research Design

The study employs a descriptive and correlational research design using a quantitative approach to examine the relationships between the variables.

4.2 Sampling

The target population of this study was Households of Pithoragarh district. A sample size of 409 respondents was chosen, sufficient to provide reliable data for statistical analysis. The study uses stratified random sampling to guarantee representation across diverse villages within Pithoragarh district.

4.3 Data Collection

A structured questionnaire designed to measure PMUY, and energy affordability using a 5-point Likert agreement scale. The survey was administered online using Google Forms, providing a quick and accessible way to reach a large number of respondents. The data collection procedure was conducted over six months, from January to June 2024, ensuring ample time for participants to complete the survey.

4.4 Data Analysis

Quantitative research commonly employs SPSS software, which was utilised to analyse the acquired data. To guarantee the internal consistency of the scales utilised, reliability analysis was performed using Cronbach's alpha. Data normalcy, an essential presumption for parametric tests, was checked using the Shapiro-Wilk test. Important data features, like the average and standard deviation, were summarised using descriptive statistics. To find out how PMUY affected energy affordability, we ran multiple regression analysis and used Pearson correlation to look at how the variables were related to each other.

5. RESULTS AND FINDINGS

5.1 Demographic Profile of Respondents

Table 1 presents the demographic breakdown of the 409 respondents surveyed in Pithoragarh. The gender distribution shows a slight majority of female respondents (58.4%) compared to males (41.6%). The largest age group is 35-44 years (31.8%), followed by 25-34 years (26.9%). In terms of education, most respondents have primary education (38.6%) or no formal education (24.9%), indicating a population with limited educational attainment. Household income data reveals that nearly half of the respondents (46.5%) earn below ₹5000 per month, with only 6.1% earning above ₹15000, highlighting the economic vulnerability of the sample.

Table 1: Demographic Information of Respondents

Demographic Variable	Category	Number of Respondents	Percentage (%)
Gender	Male	170	41.6
	Female	239	58.4
Age Group	18-24 years	70	17.1
	25-34 years	110	26.9
	35-44 years	130	31.8
	45-54 years	60	14.7
	55 years and above	39	9.5
Education Level	No formal education	102	24.9
	Primary education	158	38.6
	Higher secondary	90	22
	Undergraduate	45	11
	Postgraduate	14	3.4
Household Income	Below ₹5000	190	46.5
	₹5001 - ₹10000	142	34.7
	₹10001 - ₹15000	52	12.7
	Above ₹15001	25	6.1

5.2 Reliability Analysis

Table 2 table provides the reliability of the measurement scales used in the study. The Cronbach's Alpha values indicate good internal consistency, with energy affordability having a value of 0.85 and LPG adoption through PMUY showing a value of 0.81. Both scores suggest that the questionnaire items used to measure these variables are reliable for the analysis.

Table 2: Reliability Analysis

Variable	Number of Items	Cronbach's Alpha
Energy Affordability	10	0.85
LPG Adoption through PMUY	10	0.81

5.3 Descriptive Statistics

Table 3 summarizes the key descriptive statistics for the main variables. The mean value for energy affordability is 3.89, suggesting that respondents generally perceive moderate affordability of energy. The standard deviation of 0.78 indicates some variability in responses. Similarly, the mean for LPG adoption through PMUY is 3.71, showing a generally positive adoption rate, with a standard deviation of 0.63.

Table 3: Descriptive Statistics of Variables

Variable	Mean	Standard Deviation	Minimum	Maximum
Energy Affordability	3.89	0.78	2.2	4.9
LPG Adoption through PMUY	3.71	0.63	2.1	4.89

5.4 Normality Test

Table 4 reports the results of the Shapiro-Wilk test, which was used to assess normality of data. The p-values for both energy affordability ($p = 0.12$) and LPG adoption through PMUY ($p = 0.08$) are greater than 0.05, indicating that the data is normally distributed, thus satisfying one of the assumptions for parametric testing.

Table 4: Normality Test Results

Variable	Shapiro-Wilk Statistic	p-value
Energy Affordability	0.97	0.12
LPG Adoption through PMUY	0.97	0.08

5.5 Correlation Analysis

Table 5 presents the correlation between energy affordability and LPG adoption through PMUY. The correlation coefficient ($r = 0.69$, $p < 0.05$) indicates a strong positive relationship between two variables, supporting H1.

Table 5: Correlation Analysis Results

Variable	Energy Affordability	LPG Adoption through PMUY
Energy Affordability	1	0.69**
LPG Adoption through PMUY	0.69**	1

Note: $p < 0.05$; H1 Supported

5.6 Regression Analysis

Table 6 regression analysis results show that LPG adoption through PMUY significantly predicts energy affordability ($B = 0.31$, $p < 0.05$). The adjusted R^2 value of 0.70 indicates that 70% of the variance in energy affordability can be explained by LPG adoption under PMUY. This supports H2, which posited that LPG adoption under PMUY has a significant positive impact on energy affordability.

Table 6: Regression Analysis for Hypotheses Testing

Predictor Variable	B (Unstandardized Coefficients)	Standard Error	Beta	t	p-value	R^2	Adjusted R^2
Constant	1.22	0.29	-	4.33	< 0.05	0.69	0.7
LPG Adoption through PMUY	0.31	0.09	0.36	4	< 0.05		

H2 Supported.

Regression Equation: Energy Affordability = 1.22 + 0.31 (LPG Adoption through PMUY) (1)

6. DISCUSSION / ANALYSIS

The findings of this study reveal that the PMUY has had a significant positive impact on energy affordability among BPL households in Pithoragarh, Uttarakhand. The results of the correlation and regression analyses indicate a strong relationship between LPG adoption under PMUY and improved energy affordability. This aligns with previous studies, such as those by Gupta and Pal (2020), which highlighted the economic benefits of LPG adoption for low-income families. The study's regression analysis further reinforces the hypothesis that households using LPG under PMUY experience reduced energy expenses, as demonstrated by the significant predictor value of LPG adoption ($B = 0.31$, $p < 0.05$).

However, while PMUY has successfully facilitated the transition from traditional fuels to cleaner energy, the affordability of regular LPG cylinder refills remains a critical issue. Households in remote regions like Pithoragarh

face logistical challenges in accessing LPG, leading to increased costs and supply inconsistencies. These barriers are reflected in the moderate mean score for energy affordability (3.89), indicating that while affordability has improved, it is not universally experienced across the sample. Moreover, the high reliance on government subsidies to maintain affordability raises concerns about the long-term sustainability of LPG usage in the absence of continued financial support. This suggests a need for policy measures focused on enhancing the distribution infrastructure and ensuring regular, affordable access to LPG refills, particularly in geographically isolated areas.

7. CONCLUSION

In conclusion, the PMUY has played a pivotal role in improving energy affordability for BPL households in Pithoragarh by providing access to LPG as a cleaner and more economical alternative to traditional fuels. The significant positive correlation between PMUY and energy affordability highlights the scheme's effectiveness in reducing monthly energy expenses, contributing to better living standards for economically disadvantaged families. However, despite the initial success, challenges related to the sustainability of LPG use, particularly in terms of refilling costs and logistical barriers, continue to affect long-term affordability. To ensure the sustained benefits of PMUY, it is essential to address the infrastructure gaps that limit access to affordable LPG refills in remote regions. Policymakers should focus on improving the distribution network and providing ongoing support to ensure that vulnerable populations can continue to benefit from the scheme.

8. LIMITATIONS

Limitations of study are given as follows:

1. The study is limited to Pithoragarh district, which may not reflect the broader situation in other regions with different socio-economic contexts.
2. The dependance on self-reported data may introduce bias, as respondents might understate their experiences.
3. The cross-sectional design does not capture long-term sustainability and impact of LPG adoption under the PMUY.

9. RECOMMENDATIONS

Recommendations of the study are given as follows

1. Future studies should include multiple regions to provide a more comprehensive understanding of the program's impact across diverse settings.
2. Employ mixed-method approaches, including direct observations or longitudinal data, to validate self-reported findings and assess long-term effects.
3. Enhance the LPG distribution infrastructure in remote areas to ensure continued affordability and access to refills, sustaining the benefits of PMUY.

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