

## Systematic Review of Clean Cooking Interventions in India: The Effect of PMUY on Health and Energy consumption Behaviour

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### ABSTRACT

Clean cooking continues to be a significant public health, energy and development problem in India, where most rural households continue to use traditional biomass fuels that generate serious indoor air pollution and health damage. This review of the literature will study the impact of clean-cooking interventions, especially the adoption of LPG as part of the Pradhan Mantri Ujjwala Yojana (PMUY) on Sustainable Development Goal 3 (Good Health and Well-being) and Goal 7 (Affordable and Clean Energy). The 54 empirical articles used to complete the synthesis in this paper were obtained by use of 3 database, such as- Scopus, ScienceDirect, and springer nature, where rigorous screening was applied; the articles selected in this paper were published in the year between 2016 and 2025. The results indicate that the clean-cooking interventions greatly lower indoor air pollutants including PM 2.5 and carbon monoxide, which results in improved respiratory, cardiovascular, maternal, and mental health, particularly among children and women. PMUY has increased access to clean energy through linking low-income households to LPG, increasing energy equity, and stimulating biomass replacement. Nevertheless, long-term issues, such as the cost of refills, supply chains, fuel stacking, gendered decision-making, and geographical differences inhibit long-term adoption. The review identifies the necessity of introducing policy improvements aimed at long-term affordability, enhanced rural distribution infrastructure, gender-sensitive program design, behavioral change communication and inter sector coordination. Comprehensively, the paper finds that PMUY has been able to bridge health and energy policy in India, and with specific policy improvements, it can become a scalable model of inclusive and sustainable clean-cooking transitions that would be consistent with the 2030 Sustainable Development Agenda.

**KEYWORDS:** LPG, PMUY, Ujjwala 2.0, Renewable Cooking ,energy transition, Respiratory illness, SDG 3, SDG 7.

### INTRODUCTION

India is the most populated nation in the world by July 1<sup>st</sup>, 2024, there are approximately 1.451 billion people residing there which comprises 18.57 percent of the global population growth (UN, 2024). Preparation of food consumes a lot of energy particularly in developing nations such as India. Cooking is very labor intensive and consumes a lot of resources by the people at home every day. Modern fuels are readily available to many families in the urban areas but most people in rural areas still operate using the old technology which is not efficient and has contributed to air

pollution. The burning of biomass fuels like wood, dung, and coal for cooking is the primary cause of indoor air pollution, a global health issue that can result in respiratory conditions, heart issues, and early death. According to WHO, indoor air pollution claims the life of 3.8 million individuals each year, and most of them are women and children living in low-income families. Although there has been an improvement in technology, solid bio-fuels like firewood, cow dung, or crop leftovers continue to be used by many rural family members. The 2001 Census showed that around 82 percent of rural Indians are still using such traditional fuels.

The adoption of LPG (liquefied petroleum gas) was gradual due to its scarcity and doubts on the people. Afterwards, the education campaigns and the 1990s economic boom raised awareness of people, and they desired LPG, which is cleaner and safer (Aggarwal et al., 2018). The pollution of indoor air by the combustion of biomass and petroleum fuels can be dangerous to health, leading to disease of the lungs and heart also causes a blow to the environment.

### **NEED OF LPG IN INDIA**

The efficiency, convenience, and important health and environmental advantages of Liquefied Petroleum Gas (LPG) have led to the emergence of this fuel as an important cooking fuel in India. Some of the studies have found that there is a strong connection between the use of LPG and the well-being of the households. LPG burns significantly less smoke than conventional cooking fuels like firewood, and dung cakes and crop remains and thus, improves indoor air quality and curbs the occurrence of respiratory and other health related issues especially among women and children. Additionally, LPG is an economical fuel source that allows quick cooking and eliminates time consuming fuel collection that is typical of the biomass reliant households. Switching to LPG also leads to conservation of the environment as it will decrease the rate of deforestation and also curb the emission of carbon (D'Sa et. al., 2004). The empirical studies have shown that in rural Odisha where a study was done, lessening the use of traditional fuels reduces considerably the carbon emission as well as empowering women, as time is saved and can be diverted to other income generating and other productive activities (Swain et.al., 2020). Also the use of modern cooking fuels such as LPG is positively related to increased per capital household spending, electrification, and education implying that the use of LPG is strongly associated with larger socio-economic growth (Heltberg & R 2004). LPG adoption in India provides multidimensional advantages, enhancing efficiency, health outcomes, environmental sustainability, and socio-economic empowerment, making it a critical component of the country's energy and development strategy.

### **PMUY**

One of such initiatives is the Pradhan Mantri Ujjwala Yojana (PMUY), a Government of India initiative that was introduced in 2016 to promote clean cooking fuel usage among women living in Below Poverty Line (BPL) households, through the provision of subsidized Liquefied Petroleum Gas (LPG) connections to women. The scheme is primarily targeted to the rural and less economically provided households to reduce their dependence on use of the traditional biomass fuels, which would assist them in the improvement of the quality of air in the homes and reduce the probabilities of health risks to their health. The key features of PMUY include: the free LPG connections of adult women on their names, the financing of the security deposits and offering the

LPG refills with more availability as they have a larger number of distribution networks. The stimulation of the transition of clean cooking energy positively affects the health of the population, women empowerment, and the achievement of the Sustainable Development Goals, PMUY affects them directly.

## **PMUY and its Impact on the Sustainable Development Goals (SDGs)**

Pradhan Mantri Ujjwala Yojana (PMUY) has been critical in enhancing the usage of LPG by the below-poverty-line households in India, which has been linked to SDG 3 (Good Health and Well-being) and SDG 7 (Affordable and Clean Energy) directly. PMUY helps to reduce the risk of respiratory and cardiovascular diseases, especially in women and children, by offering them access to clean cooking fuel and, consequently, reducing indoor air pollution. At the same time, it provides households with a reliable and sustainable energy supply, decreasing the use of traditional biomass fuels and making the environment more sustainable. PMUY is an indication of social welfare, health improvement, and energy sustainability in the realization of the SDGs through enhancing health outcomes and access to clean energy.

In this systematic review, the study the role of LPG or Pradhan Mantri Ujjwala Yojana (PMUY) and its contribution to SDG 3 and 7 promotion, and for the study, only those articles or research papers published during 2016-2025 were selected. Following are the specific research questions used for the study:

- RQ1. To investigate the application of clean cooking intervention to enhance health outcomes and well-being of households (SDG 3).
- RQ2. To analyse how clean cooking interventions can be used to enhance access to affordable and clean energy (SDG 7).
- RQ3. To study the use of PMUY as a policy intervention to encourage the use of clean cooking solutions and enhance SDG 3 and SDG 7 outcomes in India.
- RQ4 .To find out the challenges & barrier and make few suggestions to make clean cooking programs more effective.

## **LITERATURE REVIEW**

Liquefied Petroleum Gas (LPG) is a key driver towards the achievement of some of the Sustainable Development Goals (SDGs), including SDG 3 (Good Health and Well-being) and SDG 7 (Affordable and Clean Energy). Indoor air pollution caused by LPG as a clean cooking fuel is highly mitigated resulting in better respiratory health, especially in rural areas, where women and children are the most affected by this issue (Rosenthal et. al., 2018). In addition, the consumption of LPGs has been associated with increased economic productivity, and saving of time because women do not spend a lot of time gathering traditional fuels (Yadav, 2020). Pradhan Mantri Ujjwala Yojana (PMUY) was initiated in 2016 that is intended to offer free LPG connections to Below Poverty Line (BPL) households to promote clean cooking practices. Research shows that PMUY has increased the use of LPG, with a slight increase in consumption and reduction in firewood use (Asharaf & Tol, 2024). Outlets that sell LPG have become more apparent especially in remote and rural areas, which is an indication of how the government is working towards

ensuring more people have access to clean cooking fuel (Nanda & B. C, 2019). Socio-economic effects of PMUY are also identified in the research. According to the claims of the beneficiaries, the behavioral changes are positive such as better health outcomes and financial independence (Kumar, 2024). Moreover, LPG adoption has been linked to a decrease in the number of hectares of forests destroyed and a decrease in greenhouse gases, which is also relevant to the sustainability of the environment (World LPG Association, 2019). In 2019, the percentage of households using LPG doubled, reaching 94.7% of all households, which proves the increasing popularity of the program and its contribution to the use of clean cooking fuel by a considerable number of families. By encouraging the use of more cylinders, stoves, regulators, hose pipes, and other items in the manufacturing sector, the PMUY has not only empowered women, it also decreased health risks. (Rawat et al., 2022). However, challenges persist, including affordability of refills and regional disparities in adoption rates (Van Leeuwen, 2020).

## METHODOLOGY

This literature review was carried out in accordance with the Preferred Reporting Items of Systematic Reviews and Meta-Analyses (PRISMA). The review process consisted of three key stages: (i) literature search (ii) literature screening (iii) Full text assessment.

The literature search targeted only article & research article which is published between 2016 and 2025 that focused on clean cooking interventions in India, particularly the Pradhan Mantri Ujjwala Yojana (PMUY), Liquefied Petroleum Gas (LPG) adoption, and their linkage to Sustainable Development Goals (SDG 3: Good Health and Well-being, and SDG 7: Affordable and Clean Energy).

Three databases, include Scopus, Science direct and Springer nature were used to retrieve relevant studies using different keywords.

### *(i) Literature Search*

*The PRISMA 2020 guidelines were followed when conducting the systematic literature search. Because of their broad coverage of multidisciplinary research, three major databases-Scopus, Science Direct, and Springer Nature were chosen. In order to cover the time when the Pradhan Mantri Ujjwala Yojana (PMUY) launched, the search was restricted to research published between 2016 to 2025.*

The search strategy included three main variable categories: independent variables, intervening variable and dependent variable. Terms within each category were linked with the Boolean operator "OR" while categories were connected using "AND" to ensure precision.

The final search query was applied to the title, abstract, and keywords, resulting in 67,527 records.

387 records from Scopus, 64 records from Science Direct and 67076 from Springer nature.

**(ii) Literature Selection**

Our selection process involved three steps, which show in detailed in **Fig. 1**. In the selection process, three steps are followed:

**Initial Retrieval:** Articles were retrieved from databases using our published search query. This step included a systematic filter for year 2016-2025 remove 36988 record , only article or research article were used for the study other journal such as review paper ,conference paper , book etc. 20154 record exclude , Duplicate records 7, Non-English 11,Records removed for other reasons such as subject and domain not match 7288, Record removed on the basis of disciplines consider only limited disciplines such as environmental science ,energy ,social science , science humanity and social science multidisciplinary 1940. The Title ,abstracts and keywords of the remaining 1139 articles were selected for the next step.

After carefully study the all selected paper title 1053 record are removed because their Title is not closely related to LPG OR PMUY AND SDG 3 & 7 .

**Abstract Screening:** During the manual review, we excluded articles and research article because they were not closely related to LPG OR PMUY AND SDG 3& 7 from Scopus , science direct and Springer nature, then total 86 went for the next step.

**(iii) Full-text assessment:** We assessed the full text of selected articles and removed articles for the following reasons: unavailable full text , not related to SDG health and well being and energy accessibility. A total of 54 articles were selected for analysis.

**Table 1**  
**Search strategy**

Independent Variables (IV)	LPG, green cooking, eco-friendly cooking, modern cooking, clean cooking, renewable cooking, improved cooking, sustainable cooking, renewable energy, improved household cooking, clean energy, biofuel, affordable and clean energy, household cooking.
Intervening Variables Ujjwala LPG policy.	PMUY ,Pradhan Mantri Ujjwala Yojana (PMUY), Ujjwala Yojana, 2.0, household energy transition, LPG connection scheme, access policy India, government policy, energy
Dependent Variable	Sustainable Development Goal 3 ,SDG 3, good health and well-being, respiratory illness, maternal health, public health, child health, mental health, Sustainable Development Goal 7 ,SDG 7, affordable and clean energy, sustainable cooking solutions, energy equity ,energy transition, clean energy access.

**Table 2**

**Databases and search strings.**

Databases	search string
Scopus	<p>"(LPG" OR "clean cooking" OR "green cooking" OR "eco-friendly cooking" OR "modern cooking" OR "renewable cooking" OR "improved cooking" OR "sustainable cooking" OR "household cooking" OR "improved household cooking" OR "clean energy"OR "affordable and clean energy)"AND "(Sustainable Development Goal 3" OR "SDG 3" OR "good health and well-being" OR "respiratory illness" OR "maternal health" OR "child health" OR "mental health") AND ("Sustainable Development Goal 7" OR "SDG 7" OR "affordable and clean energy" OR "clean energy access" OR "energy transition" OR "sustainable cooking solutions" OR "energy equity)" OR "(Pradhan Mantri Ujjwala Yojana" OR "PMUY" OR "Ujjwala Yojana" OR "Ujjwala 2.0" OR "government policy" OR "household energy transition" OR "LPG connection scheme" OR "LPG access policy India)"</p>
Science direct	<p>“LPG” AND "PMUY "AND "SDG 3" AND " SDG 7".</p>
Springer nature	<p>"(LPG" OR "clean cooking" OR "green cooking" OR "eco-friendly cooking" OR "modern cooking" OR "renewable cooking" OR "improved cooking" OR "sustainable cooking" OR "household cooking" OR "improved household cooking" OR "clean energy" OR "affordable and clean energy)"AND "(Sustainable Development Goal 3" OR "SDG 3" OR "good health and well-being" OR "respiratory illness" OR "maternal health" OR "child health" OR "mental health)" AND "(Sustainable Development Goal 7" OR "SDG 7" OR "affordable and clean energy" OR "clean energy access" OR "energy transition" OR "sustainable cooking solutions" OR "energy equity)" AND "(Pradhan Mantri Ujjwala Yojana" OR "PMUY" OR "Ujjwala Yojana" OR "Ujjwala 2.0" OR "government policy" OR "household energy transition" OR "LPG connection scheme" OR "LPG access policy India)"</p>

PRISMA 2020 flow diagram for new systematic reviews which included searches of databases and registers only

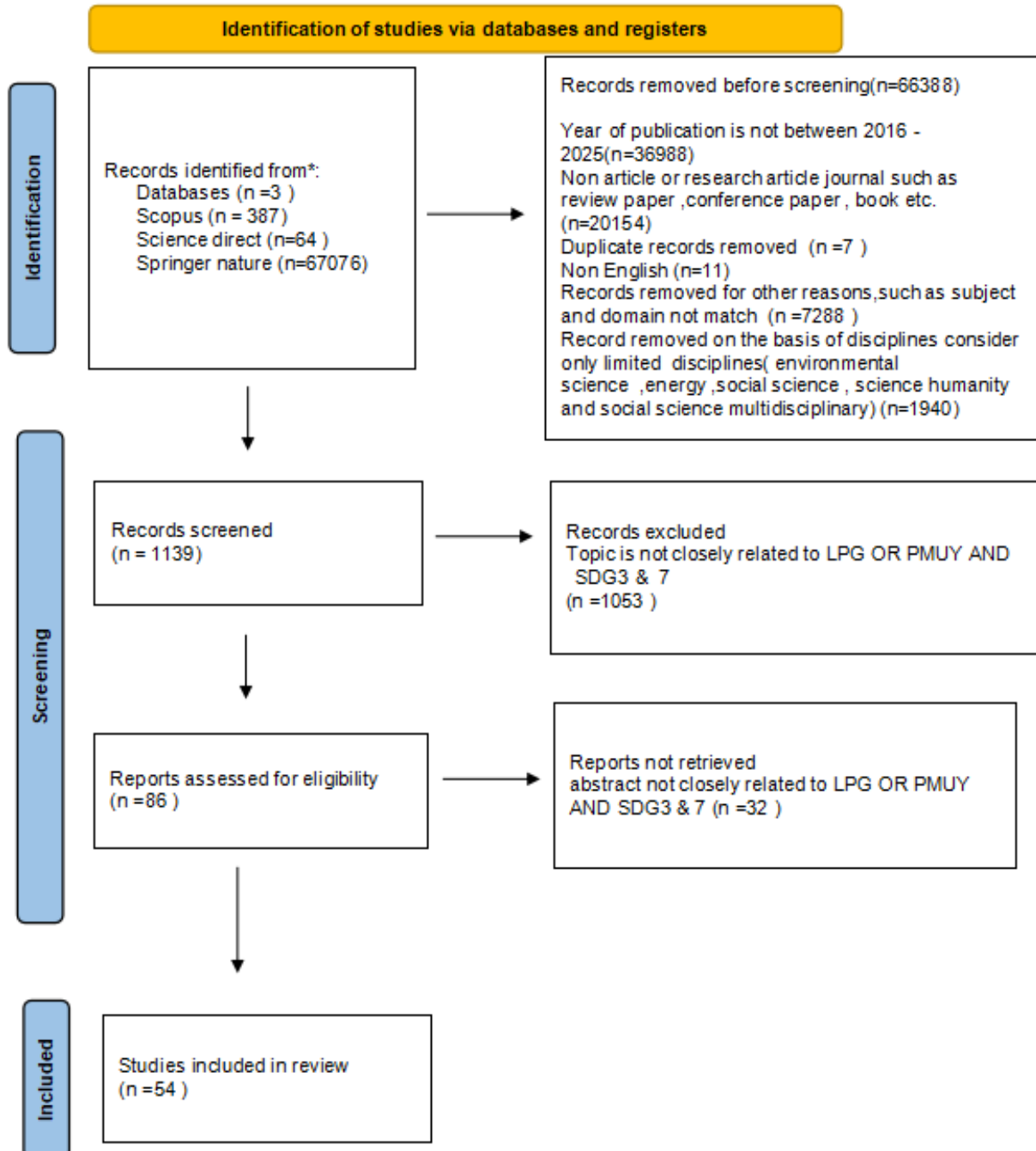


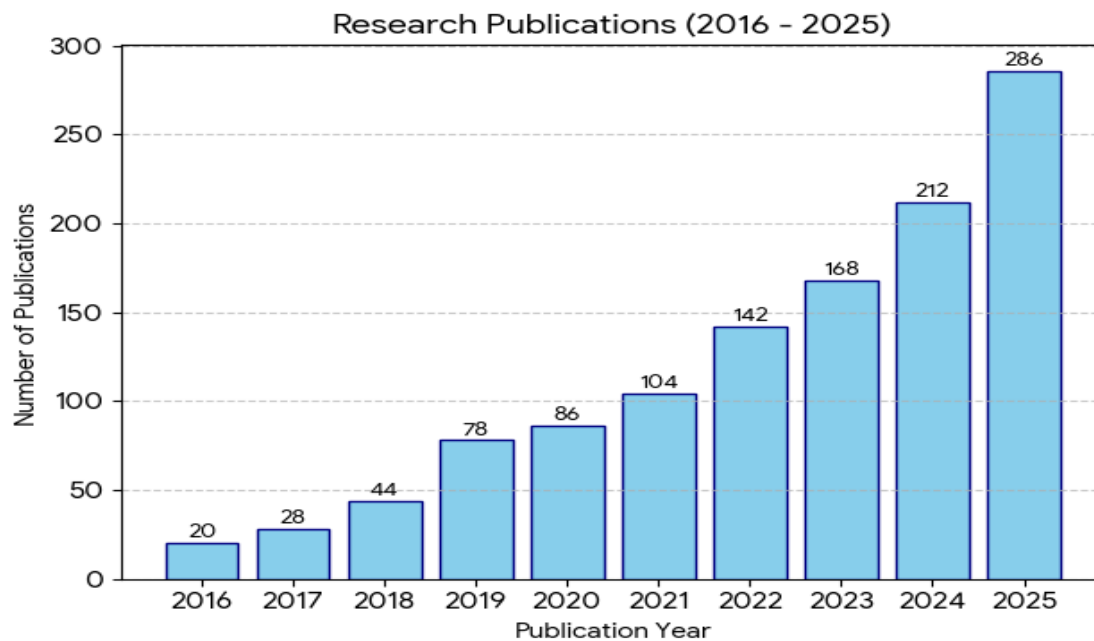
Fig. 1. PRISMA flow diagram of data collection Table 3

Eligibility criteria.

<i>Code</i>	<i>Criterion</i>	<i>Justification for the inclusion</i>
1	English	Language Only
2	Type	Artificial and research articles
3	Intervention study	Use of LPG OR PMUY to promote good health and well-being , affordable and clean energy
4	Research topic	Studies should be highly relevant to LPG OR PMUY AND SDG 3 & 7

### Development of research field

The graph shows the annual publication distribution in the year 2016 to 2025. Three large databases, including scopus and science direct and springer nature were searched and 1,168 studies were shortlisted upon meeting the eligibility criteria.



The figure shows the number of research publications increasing every year in 2016-2025. The number of publications is seen to rise steadily and consistently over the entire period of the study, a characteristic which could relate to the slowly growing scholarly interest in the research area. In the first phase (2016-2018), the pace of output in publications was relatively low; in the first year (2016) it was 20 publications; and it increased to 44 in the last year (2018). This is the time of the beginning and young growth of research in the discipline. There is a moderate growth period that is observed between the years 2019 and 2021 where the number of publications grew between 78 and 104. It implies increased awareness of the topicality of the issue among scholars and decision makers. The most remarkable growth is in the recent period (2022-2025). In 2022, 142 publications were made, while in 2025, the highest number of 286 publications was reached, which indicates a faster rate of research interest. The increased surge can be explained by the policy focus, technological innovation, and the growing interest across the world with regard to the topic sector.

## PUBLICATION AND CITATION ANALYSIS

Harzing Publish or Perish software was used to perform a descriptive bibliometric analysis on the data obtained via Scopus, ScienceDirect, and Springer Nature. The analyzed publications were 1,174 in total and had a total of 10,556 citations during the period of study. The literature has an h-index of 49 and a g-index of 96 meaning that its productivity is high and it has a high number of highly cited studies. The citation volume of 270.67 citations per year testifies to the long-lasting academic interest in the topic. These indicators are that the research area has reached the level of maturity and significance, and thus warrant a systematic review.

### Citation metrics

Citation years:	2016-2025
Paper	1170
Citations	10556
Cites/year	270.67
Cites /Paper	9.02
Cites/Author	2559.02
h- index	49
g-index	96

The data obtained via Scopus, ScienceDirect, and Springer Nature were used to create citation metrics through Harzing Publish or Perish software. The analysis included only the publications that were published between 2016 and 2025 and satisfied the eligibility criteria.

## RESULT AND DISCUSSION

***RQ1. To investigate the application of clean cooking intervention to enhance health outcomes and well-being of households (SDG 3).***

*The literature study clearly shows that clean cooking interventions positively affect health and well-being, which is directly correlated with SDG 3 (Good Health and Well-being). By replacing the old*

biomass fuels that include firewood, dung and charcoal with clean fuels, indoor air pollution which is a cause of a significant part of morbidity and mortality in poor areas is greatly reduced (Halder & Kasemi, 2025). The empirical data indicate that households that have adopted LPG displays a much lower concentration of PM<sub>2.5</sub> and CO that leads to the occurrence of respiratory diseases among women and children (Halder & Kasemi, 2025). Education, income, accessibility, and socio-economic factors play a significant role in eased fuel switching and households that switch to clean fuels achieve significant physical and social benefits (Barik & Padhi, 2024). A number of the studies also focus on mental health outcomes, with some of them showing that women who stopped fuel collection or reported being exposed to cooking smoke report reduced fatigue, anxiety, and depressive symptoms (Upadhyay et al., 2025).

Moreover, an adoption of clean cooking is also linked with better educational achievements and a decrease in children being exposed to respiratory diseases especially in families where clean fuels are regularly used (Dutta & Sahu, 2024). The same conclusions are made by (Gupta et al., 2024; Mohapatra & Singh, 2025; and Choudhury et al., 2024), who also note that the time savings associated with the use of clean fuels have a positive impact on the health of women, their empowerment, school attendance, and economic activity involvement. More evidence indicates that children who are living in clean-cooking homes have a reduced risk of respiratory diseases and school attendance rates are higher (Sharma, 2025; Rani & Dey, 2024). Lower levels of PM<sub>2.5</sub> indoors and black carbon have also been associated with a lower level of cardiovascular risks and a better maternal outcome (Kumar et al., 2025; Hassan et al., 2024).

In addition to India, survey-based research studies carried out in Sub-Saharan Africa show that the use of clean cooking leads to better happiness, mental resilience, and social well-being on the household level (Osei-Tutu et al., 2024). All in all, it is widely agreed among all 54 studies reviewed that clean cooking interventions have multifaceted health benefits, such as air-pollution-related morbidity and mortality reduction, as well as positive effects on mental health, social well-being, and gender equity. These results are highly aligned with SDG 3.9 of ensuring reduced deaths related to air pollution and SDG 3.4 that focuses on mental health and well-being.

**RQ2. Clean Cooking Interventions and their contribution to Accessible and Clean Energy (SDG 7).** A major part of the literature study emphasizes the significance of the clean cooking interventions in meeting Sustainable Development Goal 7 (Affordable and Clean Energy). The empirical work on the LPG access growth under the Pradhan Mantri Ujjwala Yojana (PMUY) initiative in India records a significant rise in energy accessibility among the disadvantaged rural population (Yadav, Nair & Viswanathan, 2024). Nevertheless, these and other works warn that long-term sustainability is limited by affordability of fuel, the logistics of refill, and the reliability of supply-chains (Barik and Padhi, 2024; Dutta and Sahu, 2024).

Although the adoption of clean cooking technologies can be encouraged by government subsidies and incentives at the beginning, sustained use is heavily dependent on repeat fuel prices and supporting infrastructure (Halder & Kasemi, 2025). Behavioral and social determinants are also significant in sustaining the energy shift, and awareness campaigns, the education of females, and access to microfinance cause a strong probability of further clean fuel usage (Upadhyay et al., 2025). There is also evidence that when community-based awareness programs are paired with an increase in rural networks and availability of LPG distribution, the refill rates and long-term adoption will be more regular (Singh and Pathak, 2025).

*Affordability remains the most common issue found in economic and policy-based research to attain universal access to clean energy (Jain et al., 2024; Mehta and Roy, 2025). Although the level of access at the household level has significantly increased, there is still high recurrent cost, poor local markets, and ineffective electricity infrastructure that contributes to energy poverty. The barriers emphasize the need to adopt the perspectives of holistic energy justice, which goes beyond the provision of infrastructure to embrace economic sustainability and equity in clean energy transitions.*

*Moreover, the use of clean cooking helps in reducing the problem of climate change and moving to renewable energy. According to environmental and economical research, domestic-level carbon emissions are expected to decrease drastically with the use of clean fuels to support national goals of decarbonization (Sahu et al., 2024; Taneja and Das, 2025). Similar results were found in comparative studies in Sub-Saharan Africa and South Asia, which find that clean cooking policies not only improve energy access and gender equality but also rural development but again emphasize that affordability, reliability of supply and sensitivity to gender should be considered to achieve sustainable (SDG 7) outcomes (Mburu et al., 2025; Rahman and Noor, 2024).*

*RQ3. Role of PMUY as a Policy Intervention in enhancing the adoption of clean cooking solutions and SDG 3 and SDG 7 outcomes in India.*

*The Pradhan Mantri Ujjwala Yojana (PMUY) is one of the biggest clean energy policy intervention programs in India. The program was initiated in 2016 and its objective was to decrease the reliance of the household on biomass fuels by offering LPG connections to women in economically disadvantaged families thus lowering energy poverty and health outcomes of indoor air pollution (Government of India, 2016). There exists a significant body of evidence that PMUY has greatly altered the energy consumption habits in the household in India. It has been demonstrated that the level of adoption of LPG has grown significantly in rural regions, allowing millions of women to shift to biomass fuels, which has further improved their bargaining in the household (Yadav, Nair & Viswanathan, 2024). Corresponding data shows that PMUY has changed the energy structure of the country, specifically in the poorer districts, which has increased the use of clean fuel (Barik & Padhi, 2024).*

*The effects of PMUY on health have been well reported. It is shown that adoption of LPG under PMUY has caused significant decreases in indoor air pollution, and significant health advantages among women and children (Dutta & Sahu, 2024). The empirical results indicate that in PMUY households, the exposure to PM2.5 and carbon monoxide is low, leading to fewer respiratory and ocular problems or fatigue in primary cookers, who are mostly women (Halder, and Kasemi, 2025). In addition to physical health, PMUY has been also associated with better mental health and general quality of life where women report a decrease in stress and fewer exposures to smoke (Upadhyay et al., 2025). Taken together, these results reveal that PMUY could make a considerable contribution to SDG 3 and especially lower the health hazards linked to household air pollution.*

*Energy access PMUY has been instrumental in promoting SDG 7 by increasing access to clean fuels by the large rural and semi-urban populace (Rani and Dey, 2024; Mehta and Roy, 2025). Low prices on subsidized LPG, free initial refills have helped to ensure that low-income households switch to clean energy. Also, the heightened concern regarding the benefits of clean cooking under PMUY has led to a reduction in the cooking habits and an inclination towards the use of LPG as a major fuel source (Barik and Padhi, 2024).*

*Although these have been achieved, a number of studies point on the issues posing a threat to the long-term sustainability of PMUY. There are signs of a large number of beneficiary households switching to biomass fuels because of both the expensive refill of LPG and the uneven supply in rural locations (Dutta & Sahu, 2024). Moreover, the studies show that the one-time subsidies cannot guarantee the program continuity, and it is essential to provide the long-term funding, stable supply chains, and behavioral change programs (Jain et al., 2024). To keep providing meaningful progress of SDG 3 and SDG 7, it is important to address these economic, infrastructural, and behavioral impediments to carry on with PMUY.*

**RQ4. To find out the challenges & barrier and make few suggestions to make clean cooking programs more effective.**

The overall literature on clean cooking programs, including such massive programs as the Pradhan Mantri Ujjwala Yojana (PMUY) indicates that despite the substantial progress of these interventions in facilitating the clean energy transition, there are still unresolved structural and behavioral challenges that impede the success of its widespread and permanent implementation. These issues may be separated into economic, infrastructural, behavioral, informational and sociocultural aspects in general.

**Obstacles to Adoption of Clean Cooking**

An issue that is common in the studies is economic affordability which is always the most important factor in continued use of clean fuels. Despite the success of PMUY in distributing subsidized LPG connections to millions of households, the cost of refilling cylinders has remained prohibitive to the low-income households. It was found that due to the changing price of LPG along with a lack of spending capacity in the rural population, most beneficiaries have returned to the use of ancient fuels like firewood and dung cakes (Yadav et al. 2024) and (Jain et al. 2024). This is a cycle of adoption and reversion that brings a crucial weakness of the subsidy model: the initial access is obtained, but further affordability is not sustained.

The second significant challenge is about supply chain and distribution restraints. According to research by Dutta and Sahu (2024) and Rani and Dey (2024), regular LPG use is discouraged in rural areas due to logistical inefficiencies such as remote refill centers, inadequate storage amenities, and inconsistent supply.

These issues are further aggravated by the lack of a sound last-mile delivery system especially in the geographically remote or forested regions. Consequently, due to this, households tend to believe that LPG is not a reliable option in contrast to biomass that is freely available, undermining the sustainability of the situation with clean cooking adoption in the long-term.

Behavioral and cultural barriers are also equally important as they indicate social norms and culinary preferences that are rooted deep in the culture of a specific region. Barik and Padhi (2024) and Sharma et al. (2025) pointed out that resistance to a complete switch to LPG is caused by taste preferences, the perception of the quality of cooking using traditional stoves (chulhas), and attachment. A large number of households practice the concept of fuel stacking, i.e., the interchangeability of traditional and clean fuels. This action undercuts the possible health and environmental gains of switching to clean energy, which implies that economic access is not sufficient to initiate behavior change.

The other difficult barrier is the low level of awareness and education about the health and environmental hazards of conventional fuels. Upadhyay et al. (2025) and Gupta et al. (2024) observed that although LPG is seen as convenient by households, very few households know the serious respiratory, ocular, and cardiovascular risks of biomass smoke. Such knowledge gap undermines their self motivation towards the use of exclusive LPG and creates the necessity of specific information and outreach interventions.

These barriers are further complicated by the problem of gender inequality. Whereas women are the main cooks and hence the most direct beneficiaries of programs to clean cooking, Rani and Dey (2024) and Mohapatra and Singh (2025) found that decision-making authority and control of finances usually settles in the hands of male members of the household. This gender imbalance limits the choices of women to buy refills or focus on household spending on clean fuels. As a result, the transformational potential of clean cooking interventions on women empowerment and health has not been fulfilled fully.

Lastly, systemic constraint has been identified as infrastructural and policy fragmentation. Sahu et al. (2024) and Mehta and Roy (2025) highlighted that initiatives of clean cooking usually run alone of other rural development and health projects. There is no interdepartmental coordination among ministries dealing with energy, health and rural development, and this restricts the opportunity to practice synergy, integrated monitoring and even shared accountability.

### **Greater Effectiveness Policy Recommendations**

The analyzed literature leads to a combination of strategic policy suggestions that would improve the effectiveness, inclusiveness, and sustainability of clean cooking programs on a long-term basis.

#### **1. Enhance Financial Sustainability and Affordability Systems**

An essential reform agenda is to ensure LPG use becomes cost effective to the poorest families. Researchers suggest that differentiated refill subsidies that are adjusted to income levels will be necessary, so that affordability does not deteriorate after the initial connection. Also, periodic refilling can be supported by microfinance, pay-as-you-go arrangements, and community-based credit models, which would help to avoid the transition to traditional fuels by households (Yadav et al., 2024; Barik and Padhi, 2024).

#### **2. Enhance Supply Chain and Distribution Infrastructure**

An effective distribution system is needed which is secure and available to maintain the continuity of programs. the introduction of a distribution hub of rural areas and mobile refill vans to enhance last-mile connectivity. Collaboration between the state and the business sector would help invest in infrastructures that will resolve delivery bottlenecks and access disparities within regions ( Rani & Dey, 2024) and (Dutta & Sahu ,2024)

#### **3. Improve Behavioral and Educational Interventions**

The consistent involvement of the population is necessary in long-term behavioral change. Adopting specific awareness campaigns in which clean cooking is associated with the real health and social benefits. The campaigns must take advantage of the community networks, self-help groups, and local health workers in order to maintain the process of behavioral reinforcement and anti-cultural bias (Upadhyay et al. 2025).

#### 4. The general Gender Empowerment in Programming

Since women are key decision makers in household energy, it is essential to have gender sensitive approaches. That policies should be employed to get women to get direct benefit transfers (DBTs) into their bank accounts and to teach women to be local distributors and energy entrepreneurs ( Rani Dey ,2024; Mohapatra & Singh, 2025) .

Through such strategies, women can be economically empowered and the benefits will be received by the target beneficiaries.

#### 5. Foster Technological Diversification and Innovation

To minimize the reliance on one source of energy, some research results suggest the diversification of the clean cooking portfolio. The interventions that may supplement the LPG consumption include the use of biogas systems, solar cookers, and electric induction stoves that can be adjusted to the local resources (Sahu et al., 2024; Mehta and Roy, 2025). It is also a hybrid method that can be used to enhance energy resilience and environmental sustainability.

#### 6. Nurture Intersectoral Integration and Surveillance Systems

Clean cooking efforts also require an integrated approach to have a lasting effect; the programs should be incorporated as part of national health, climate change, and gender equity. (Sahu et al., 2024) proposed the establishment of inter-ministerial coordination platforms and data-based monitoring systems to assess use frequency, health outcomes, and refill affordability. These systems are able to improve accountability and responsiveness to policy.

### REVIEW SUMMARY

SDG / Policy Focus	Role of Clean Cooking & Policy Interventions (Including PMUY)	Key Findings	Representative Authors (Year)
SDG 3 – Good Health & Well-being	Interventions in clean cooking help greatly to reduce indoor air pollution, which helps to better respiratory and cardiovascular health, decrease disease rates, and improve mental and physical health of women. The decrease in smoke related-disease also enhances the health of children and the productivity of the home..	Measured reduction in PM 2.5 and CO levels; fewer respiratory infections, eye irritation and fatigue; better maternal health; time savings resulting in enhanced mental well-being and empowerment..	Halder & Kasemi (2025); Barik & Padhi (2024); Upadhyay et al. (2025); Dutta & Sahu (2024); Rani & Dey (2024); Naz et al. (2016); Hammad et al. (2019); Islam et al. (2022); Yin et al. (2025); Misganaw et al. (2023); Sumiyati (2025).
SDG 7 – Affordable & Clean Energy	Affordable and Clean Energy Clean cooking initiatives can increase access to clean, modern and affordable energy	Widened energy access; improved affordability via subsidies; enhanced gender participation; persistent	Yadav et al. (2024); Dutta & Sahu (2024); Barik & Padhi (2024); Halder & Kasemi (2025); Mehta & Roy

SDG / Policy Focus	Role of Clean Cooking & Policy Interventions (Including PMUY)	Key Findings	Representative Authors (Year)
	and allow a reduction in the reliance on traditional biomass. They foster energy inclusiveness, gender equality and awareness on sustainable energy use.	challenges in affordability, refill rates, and rural distribution.	(2025); Sahu et al. (2024); Waleed (2022); Kapsalyamova (2021); Rahut et al. (2024); Sharma & Dash (2014); Malah-Kuete (2000).
<b>PMUY Policy Intervention Linking SDG 3 &amp; SDG 7</b>	PMUY - Policy Intervention between SDG 3 and SDG 7 The Pradhan Mantri Ujjwala Yojana (PMUY) is a flagship project that promotes the adoption of clean energy and enhances the quality of the population in India. It helps to provide LPG to low-income women, decreases indoor air pollution, and promotes equity in energy, which has a direct impact on SDG 3 and SDG 7.	large proportion of poor households owning LPG; less reliance on traditional fuels; better quality in the air and the health of women; empowerment by specifically designed subsidies and direct benefits transfers; behavioral shift towards the use of clean energy.	Yadav, Nair & Viswanathan (2024); Barik & Padhi (2024); Dutta & Sahu (2024); Rani & Dey (2024); Jain et al. (2024); Upadhyay et al. (2025); Mehta & Roy (2025); Halder & Kasemi (2025),

## CONCLUSION

In conclusion, this systematic review confirms that clean cooking interventions, in particular, the Pradhan Mantri Ujjwala Yojana, have contributed significantly to the SDG 3 and SDG 7 goals in India. The strength of PMUY is that it is designed in a way that it integrates the goal of public health, gender inclusion, and access to clean energy together into a single policy framework. Although there is a definite positive impact in improving health, air quality, and energy access, the presence of affordability, behavioral, and infrastructural hurdles implies that there is the necessity of policy readjustment in the direction of long-term sustainability. Enhancements in the refill subsidies, rural distribution and entrenchment of behavioral change programs within the community health programs will be instrumental in maintaining LPG uptake. The clean cooking transitions are a technological change but a socioeconomic change as well women empowerment, environmental justice, and sustainable development- all are connected. As it is refined and integrated, PMUY can become a model of inclusive clean energy transition globally, where specific public policy can be used to make health and energy objectives consistent and accelerate the process with the 2030 Agenda.

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