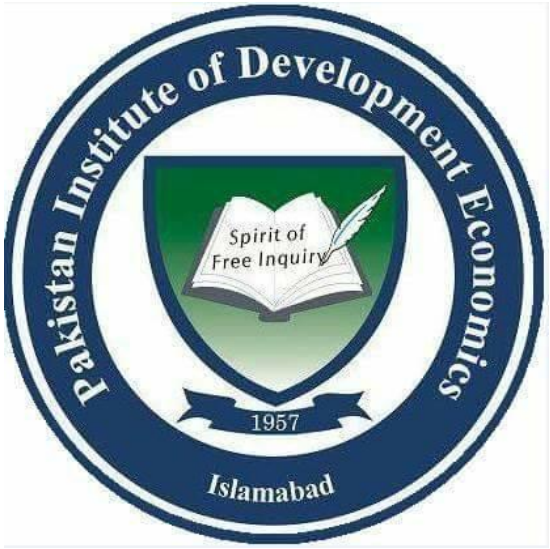
Role of Poverty in Fuel Choice and Exposure to Household Air Pollution. Does Information matter?



by

Ayesha Ali

Supervisor:

Dr. Nasir Iqbal

(Associate Professor)

PIDE SCHOOL OF PUBLIC POLICY

Pakistan Institute of Development Economics, Islamabad
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Pakistan Institute of Development Economics, Islamabad

PIDE School of Public Policy

CERTIFICATE

This is to certify that this thesis entitled: **Role of Poverty in Fuel Choice and Exposure to Household Air Pollution. Does Information matter?** submitted by **Ms. Ayesha Ali** accepted in its present form by the School of Public Policy, Pakistan Institute of Development Economics (PIDE), Islamabad as satisfying the requirements for partial fulfillment of the degree in Master of Philosophy in Environmental Economics.

Supervisor:

Dr. Nasir Iqbal
Associate Professor,
Pakistan Institute of Development Economics,
(PIDE) Islamabad.

External Examiner:

Dr. Heman Das Lohano
Professor and Program Director PhD/MS
(Economics) & BS (Economics) – Economics
IBA Karachi.

Head,
PIDE School of Public Policy:

Dr. Iftikhar Ahmad,
Assistant Professor/HOD
Pakistan Institute of Development Economics,
(PIDE) Islamabad.

Abstract:

Household air pollution and solid fuel use due to poverty is responsible for a significant burden of disease in third world countries especially Pakistan. This study examined the association of household air pollution with poverty in respondence to cooking fuel choice. This paper also observed the impact of technological change on poverty alleviation with poverty status as independent variable. The data used in this study was taken from Pakistan Demographic Health Survey (PDHS) in year 2017-18. The selected dependent variable was cooking fuel choice which includes clean fuel and unclean fuel. The independent variable taken was poverty status of household which was estimated using Wealth Index. The potential control variables were taken as place of residence, demographic, human capital, social infrastructure and ICT. To examine the result, a series of Binary logistic regression model was used in this study for complex survey design. In Pakistan, almost 44.28% households use unclean fuel. The results showed that although poverty makes a major contribution in cooking fuel choice, some other factors such as household site, size of household, low level of human resources, as well as access to essential services are the crucial links. The information and technological factor can somehow reduce the level of poverty if household pollution exist in the case of Pakistan.

Keywords: Household air pollution, Poverty, Cooking Fuel Choice, Environment, Information, Technology, Pakistan.

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Chapter 1
Introduction

1.1. Background

Household air pollution is the biggest global challenge facing by the developing world. Most rural and poor urban households depends on solid fuels to meet their cooking needs. Around 3 billion households despite everything utilize strong powers for example (wood, animal dung, charcoal, coals and compost and lamp oil) by cooking in open flames and wasteful ovens. The majority of these households lives in low and middle-income nations and are poor. These cooking practices are unproductive and the use of unclean fuel produces high level of indoor air pollution that creates health damaging pollutants which are dangerous for the individuals in poorly ventilated housings, indoor smoke can be multiple times higher than worthy levels for fine particles. Eventually, ladies and little youngsters face especially elevated level of introduction, who invest the most energy close to the chimney.

Household Air Pollution is the biggest risk factor for bad health and is accounted for nearly 2 million deaths annually and 2.7% burden of disease globally. Developing world is more susceptible to household air pollution. In Pakistan, most of the people cook by using wood (54%), followed by animal dung (18%), agricultural waste (14%), natural gas (7%), electricity (4%), LPG and kerosene (3%) according to the report of HIES Pakistan. The importance of this study in Pakistan is that most of the population lives in rural areas where solid fuel is the main source of cooking fuel. Almost 875 of rural households use solid fuel for cooking purpose (DHS, 2013)

Poor people may be more vulnerable, but poverty also fosters increased pollution. Household air pollution is responsible for a significant burden of disease in developing countries, due to household solid fuel use. Fuel choice is often connected with household income. However, many other factors such as environmental and socio-economic also

influence the choice of fuel and the exposure of resultant indoor air pollution. The smoke which generates from burning wood, animal dung and cigarettes is also dangerous to the environment causing a lot of damage to human beings and the atmosphere. Around 2.7 billion people rely on traditional use of solid fuels and it is expected to increase by 2.8 billion by 2030, worldwide. However, 400 million people use coal as a cooking fuel (IEA, UNDP and UNIDO 2010).

Low income families with a lower level of education are likely dependent on fuel wood, dung cake and crop residues. The quality of household energy use is directly linked to the sustainable development. Crop residue (dirty fuels), animal dung and use of firewood has a dangerous negative impact on human life and environmental health. Hence, access to and use of cleaner fuels are important for improving people's health, protection of ecology, and socio-economic development. Also, information does matter because low education level and less information and knowledge in poor people brings more pollution and resulted in damaging effects of air pollution. The basic purpose of this paper is to examine the role of poverty on household air pollution and fuel choice in Pakistan. Also, this paper examine ICT as a mediator to explain the nexus between income, poverty and fuel choice.

This research uses PDHS of the year 2017-18 where poverty is estimated using wealth of the households. It explores different type of fuel usage and its connection with poverty status and other characteristics of households in Pakistan. Here, fuel choice is the categorical dependent variable which is categorized as clean and unclean fuel. There is a persistent decline in poverty and it is becoming difficult to reduce because of high levels of income inequality in many developing countries. Most of the poor people lives in unhygienic and remote areas or in distant villages. They often lack essential assets like productive capital and technology. Their income is seasonal and employment situation is uncertain and fragile. Their poverty marks from low level of incomes, less education, poor health, lack of social welfare networks and

discrimination. Assistance may also not reach them because of the inappropriate awareness programs and policies. Thus, poverty is a complex socio- economic problem that needs to be managed for sustainable development.

1.2. The Case of Pakistan

In Pakistan, Natural gas, biogas and LPG is the most ordinary type of fuel used for cooking purpose, which constitutes almost 50% of the total. The use of clean fuel i.e. electricity, LPG, natural gas and biogas is more in urban areas which is 88% rather than rural areas which is only 27% of the total. Communities of color and those with less information and education, high poverty and unemployment may face larger health risks even if their air quality meets federal health standards. Around 93% of the cooking is done inside the home while only 6% is done in separate buildings in Pakistan (PDHS, 2019). According to the study conducted in rural and urban areas of Pakistan PM10 meditations of up to 8,555ug/m3 were remarked in those kitchens where biofuel was used as an energy source (Colbeck et al., 2007). There is a need for advanced technology and awareness to the poor people of developing nations to overcome the damaging effects of household air pollution. In case of Pakistan, it is important to study because most of the population lives in rural areas where solid fuel is used for the cooking purpose. 72.9% of the rural households use unclean fuel for cooking purpose. The latest poverty estimates shows that 24% of population of Pakistan lives below the national poverty line, out of which 31% in rural areas and 13% in urban areas. In addition, 38.8% of the national population is low on the basis of the Multidimensional Poverty Index (MPI), that includes 9.4% in urban areas and 54.6% in rural areas.

1.3. Statement of the Problem

Household air pollution is responsible for a significant burden of disease in many developing countries, due to solid fuel use. Nearly 3 billion people depends on solid fuel combustion to fulfil their basic household needs. Also, poverty is one of the challenges facing by the developing world when fuel choice is connected with household income. Here, ICT plays an important role to enhance the activity and productivity of the poor. This study addresses the following questions: What would be the impact on household air pollution by different fuel choices? Does ICT can mediate the nexus between income, poverty and fuel choice? The aim of the paper is to respond the following questions by keeping in view their impacts on the households.

1.4. Objective of the study

- To examine the role of poverty on household air pollution and fuel choice in Pakistan.
- To examine the role of ICT as a mediator to explain the nexus between income, poverty and fuel choice.

1.5. Contribution of the study

Household air pollution and poverty are the problems often arising in the developing countries. Around 50% of people in the least developed countries depends on unclean fuel that are usually damaged in plain stoves with very inadequate combustion. Women and children are visible to high level of inside air pollution, causing many chronic diseases and deaths among the children under age 5. Nasir et al, (2015) in his study used multinomial logit model to predict fuel choice determinants found out that although poverty is linked with poor fuel choices other socioeconomic factors such as household area and region, household size and ownership of asset structure also influences the fuel choices of the people. The World Health Organization assessed that 2 billion individuals pass on consistently from the resultant smoke because of family unit strong fuel use. Of these passing's, 65% occur in low-salary nations and

35% in center pay nations. Evidences exist among indoor air pollution and other factors like harmful diseases, child mortality, women health and wealth etc. but very few are found about poverty and low-income groups. So, this study will help us to find out the role of poverty in cooking fuel choice and also ICT as a mediator to explain the nexus between poverty, income and fuel choice. We will combine data by examining poverty status of the households by considering the wealth index. ICT (Information and Communication Technology) in itself is accepted as a powerful tool to eradicate poverty. The advancement of policies, strategies and programs to achieve common access to clean cooking fuels requires awareness of how clean and unclean stove and the cooking fuels are used in practice. Though, poverty makes a significant effect, more reasons such as household site and region, size of household, low level of human resources, property possession structure and access to basic services are the key factors of fuel choice.

1.6. Data and Methodology

This research uses the nationally representative Pakistan Demographic Health Survey (PDHS) 2017-18. Poverty is estimated using wealth Index. Methodology is important to study the proximate determinants. This paper uses fuel choice as a dependent variable. It is further categorized as clean and unclean fuel. Binary logistic model is used to predict the determinants of fuel choice. Here, independent variable is poverty status of the household and other control variables are Location, demographic, social infrastructure, human capital and ICT.

1.7. Organization of the Study

This study is organized into six chapters. Chapter one includes the introduction, which explain importance of the research topic, issues and phenomena in context of poverty and exposure to indoor air pollution along with objectives of the study, the case of Pakistan, statement of the problem and contribution of the study. Chapter 2 focuses on the literature review for different countries and including conclusion of the study. Chapter 3 includes

dynamics of poverty and fuel choice. Chapter 4 presents conceptual framework, methodology, source of data and descriptive statistics. Chapter 5 includes the results and discussion of data analysis and Chapter 6 presents the conclusion and policy recommendations.

Chapter 2

Literature Review

2.1. Introduction

This section will incorporate an outline of studies that are identified with impact of fuel decision and also, indoor air contamination. There are various perspectives on various authors which are examined beneath. The presence of tireless poverty is one of the most concerning issue of creating nations. Additionally, it is the greatest worldwide difficulties too. About 22% of the population lives in extraordinary deprivation in creating world (WB, 2013). poverty is a multifaceted idea which is related with numerous non-financial reasons as level of instruction, socioeconomics, work, region, home, admittance to fundamental advantages, wellbeing assets, network and political inclusion. Subsequently, there is a critical need to understand the connection of hardship, fuel decision and disclosure to inside air contamination. By joining writing survey, we won't just give an instinct into fuel decision and deprivation yet in addition would be helpful in making control strategies and advancing consciousness of family air contamination.

Rehfuess et al. (2006) in his study discovered that the household vitality use is related with a considerable lot of the Millennium Development Goals (MDGs). The quantity of the individuals utilize strong energizes for food is an indication for estimating enhancement for natural manageability. Indeed, diminishing local air contamination because of strong powers is a significant part in the decrease in youngster mortality and improvement in maternal wellbeing. Barnes featured Income as a significant factor of fuel decision. The decision of family fuel use is identified with numerous socio monetary variables. They utilized the energy ladder model in their paper which demonstrated that families changed from messy and dirtier fuel, for example, strong powers to cleaner and modern fuel, for example, gas and power, as

their salary increments. The reliance of the energy ladder model on salary exhibited the strong connection of poverty with fuel decision and thus family unit air contamination (Barnes et al., 2005).

Suliman (2013) in his paper inspected the elements that influences the essential cooking fuel decision in Sudan, its symptoms, and the significant strategies to diminish them. He utilized the strategy of possibility arrangement and discrete decision investigation by directed the information from Household Wellbeing Survey. The discoveries demonstrated that messy strong biomass rules the fuel-determination in numerous territories of the nation by utilizing smokier energizes emerging backwoods devastation and wellbeing dangers. Particularly among kids and ladies are the primary externalities. It is too found that low instructive achievement, and female dominancy of family units are indispensable parts preventing the execution of clean powers. The outcomes suggested that burdening smokier fuels may potentially not be sensible. nonetheless, a duty on selected biomass fuels and different measures could be represented to control biomass utilization, increment its creation furthermore, improve the effectiveness of its usage with diminished dangers. In including, techniques focusing on at rising pay and improving instruction would lead the move to inventive powers.

Pfaff et al. (2004) in his paper guaranteed that families can't quickly achieve ecological quality, however it tends to be improved by supplanting all the more outrageous cleaner contributions to make for more affordable dirty sources of information. Nonetheless, they saw that a change for the cleaner contributions with increment in salary just represents center pay family units. With poor families as pay floods, the contamination likewise ascends because of a huge amount of messy sources of information and their hesitance to elective. They demonstrated long pull wellbeing impacts by giving clean and messy powers to various families. The outcomes recommended high mortality information in houses that were utilizing

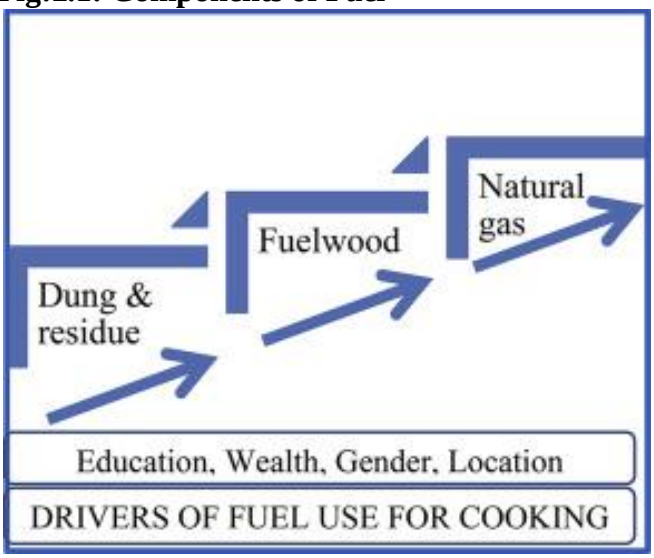
messy fuel in introduction to indoor air contamination. Additionally, long pull open doors for the family units that were provided with gaseous petrol.

The WHO (2009) determined that 2 billion individuals kick the bucket each year from the resultant smoke because of family strong fuel use. Of these passing's, 65% occur in low-pay nations. furthermore, 35% in center salary nations. Around, 21% of lower respiratory disease passing's, 35% of interminable obstructive pneumonic passing's and 3% of cellular breakdown in the lungs passing's are caused by indoor air smoke comprehensively. An investigation in Myanmar demonstrated the utilization and use designs of kindling. During the year 2009, about 70% of all essential vitality utilization was gotten from wood fuel. Studies in Myanmar have detailed that, there was an issue of deforestation because of kindling assortment and charcoal creation. Understanding the interest for wood fuel. what's more, its control could assume a fundamental job in overseeing and executing woodland strategies and supportability. They assessed wood fuel utilization rate and use design in urban territory and contrasted the outcomes and provincial territory in a similar municipality. They inspected the impacts of urbanization and wood fuel use through this analysis (Win and Mizoue, 2009).

Hassan et al. (2005) in their study led that there are some different imperatives too which keeps family unit people from utilizing spotless and proficient wellsprings of vitality, for example convention, social and sexual orientation standards, instruction level, admittance to vitality and riches. As per them, riches and decision of fuel use are emphatically related. As people groups pay expands, their eagerness to pay for quality fuel increments. They have a higher potential for cleaner vitality. They additionally watched Human Capital assessed by long stretches of tutoring influences cooking fuel decision in two distinct manners: first, instruction expands pay (capacity to pay more for more clean items and furthermore expands estimation of time) second, instruction improves information and mindfulness. Family units with an informed part (head) are probably going to utilize perfect and current fuel because of

usability and medical advantages. Training plays out a basic part in fuel exchanging. It is the degree of instruction which diminishes the admission of fuelwood as training improves the chief's understanding about expense and advantages of using present day innovation too.

Fig:2.1: Components of Fuel



The figure 2.1 shows the drivers of clean fuel use for cooking. Where education, wealth, region and gender are the important determinants of fuel choice. Showing higher potential for cleaner and protective energy. As, households income increases their willingness to pay for cleaner fuel increases. Due to increase in income, households may have more options to move from traditional to transition and then to modern fuels.

Zulu and Richardson (1999) emphasized Charcoal as a central source of household energy as it provides a valuable source of family income. They conducted a study in south Africa. Charcoal has the ability to power growth of economy as decreasing the dependency on expensive energy imports in weak developing countries. Also, It is a source of energy. The added advantage of using charcoal over firewood is that charcoal has a higher energy content per kg of fuel consumed, is less bulky and easier to store and transport, and burns with fewer smoke emissions. The longer it takes to coordinate, produce and transport fuels, however, decreases prospects for meaningful work and education in women and children.

The traditional view on fuel exchanging of creating nations has been that the families step by step raises the energy ladder hypothesis from moderately wasteful powers to more effective and defensive powers with expanding pay. In any case, salary is a significant factor. As pay expands, it builds the choices accessible to the family unit. Which in reality inspires family units to switch between various fuel utilization. The reliability and quality of the energy supply also have a big impact. For specific circumstances, families like to lead more than one fuel since they want to help security of supply. In different cases, decision can depend on cultural , social and taste preferences (Masera et al., 2000).

Fuel switching can be used to replace inefficient fuels with protective and economical alternatives like coal and kerosene for natural gas. It not only reduces carbon emissions but also reduce energy consumption and cost for end users. The use of traditional fuel causes a lot of damages to the environment and also deteriorate the air quality. It also affect the human health mainly in women and small children due to their exposure and close contact with burning fuel in many areas. We can look at the generation plants in terms of efficiency to calculate fuel cost. By this we mean how efficiently the plant converts natural gas or coal into electricity. It would take 3412 Btu to generate 1 kWh of electricity at 100% efficiency in a perfect plant.

The basic element of the energy revolution is that there are a number of large incoherent steps in which household members swap from conventional fuels to advanced and cleaner fuels. Yet at the other hand, in the light of an enormous number of proof, the energy stacking hypothesis developed as an alternative understanding of household energy progress. It keeps up that, as family unit earnings rise, the move to the utilization of modern fuels happens in the adoption of the concurrent utilization of various sorts of powers. In this conclusion, low-salary families normally utilize little types of traditional energizes, for example, kindling, creature waste and charcoal. As incomes rise, households practice advanced fuels, but still tend to use

conventional fuels for some operations, thereby 'mixing' different energy sources. Price changes, tastes, taste, reliability of supply, cooking and consumption patterns, availability of equipment, employment, household composition and other cultural or habitual factors also influences the fuel usage patterns (Masera et al., 2000).

There are several other factors that may have an effect on shifting household fuel habits. The literature indicated a crucial shift in the energy ladder hypothesis. This model also builds a classified relation of fuel types, however restricts the possibility that families don't consequently switch towards better powers and simultaneously abandon inferior ones. Or maybe, the fuel stacking speculation expect that families depend on different sorts of fuel, expending a higher proportion of high grade fuels with expanding income. Poverty makes a significant contribution to fuel choices yet other financial factors, for example, family area and zone, family unit size, low degree of human capital, resource proprietorship structure and admittance to fundamental utilities are the significant determinants of fuel decision. Moderate and lower socioeconomic status explained by middle income, education and low income, low education respectively causes an increase of the highest level in air pollution and bad self-reported health quality (Nasir et al., 2015).

Fig:2.2 Nexus between Energy and Food

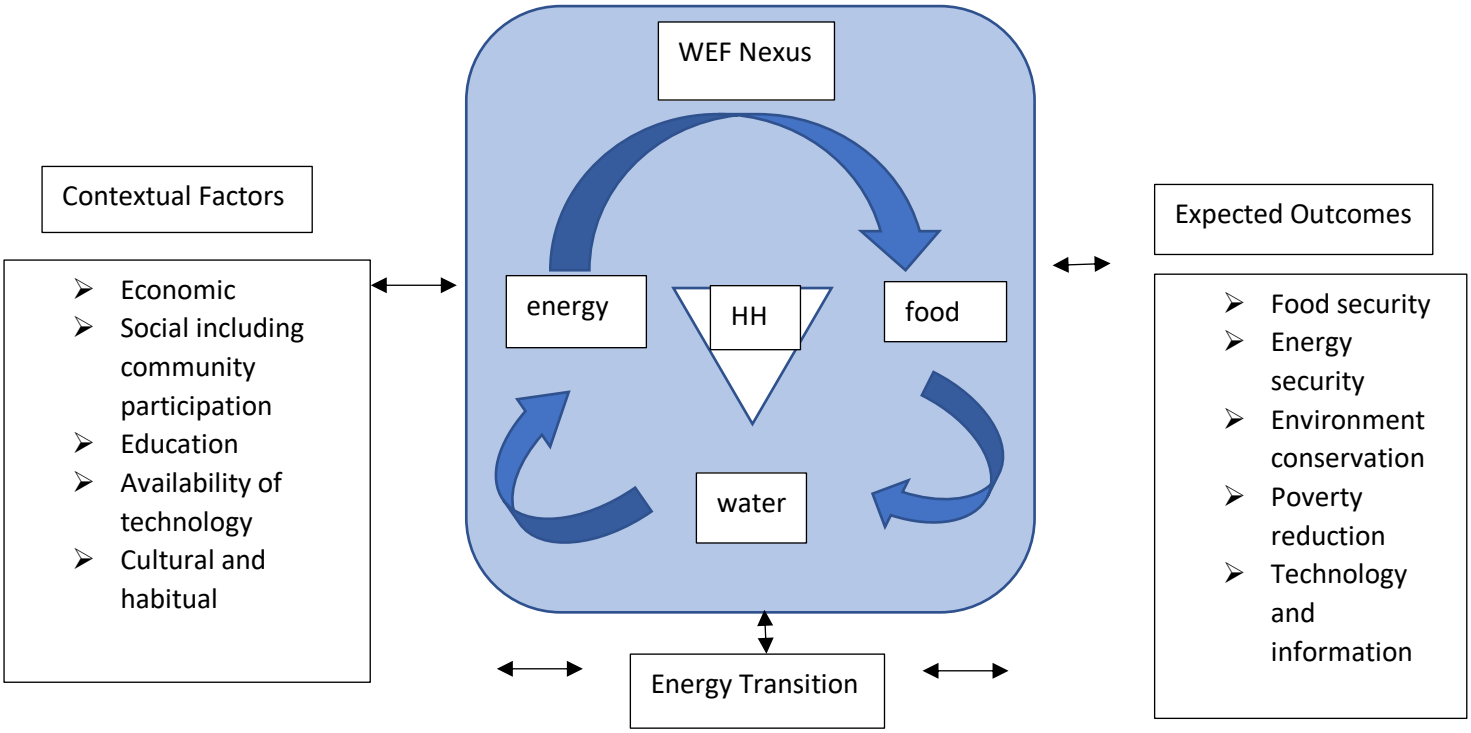


Fig 2.2 explains, The lower the household income, the more they rely on biomass fuels, such as wood and dung. A transition happens as households begin to move to cleaner and more costly fuels. (LPG & electricity) when their income increases. Therefore, the process of switching from low grade fuel to high grade fuel is known as Energy Transition. There are even more factors that could affect the fuel-switching pattern of household i.e. price changes, taste, preferences, irreliability of supply, consumption habits and cooking, availability of technology, education, household composition and further cultural or habitual factors, which the energy transition hypothesis has failed to include. These three sectors are essential for poverty reduction, human wellbeing and sustainable development. Energy transition is required to run water, energy and food nexus. According to the 'Fuel Stacking theory', households do not fully switch to different fuel types even increase in their incomes. They rather use an energy

mix. In that case, households rely on multiple fuels for their energy use, using higher proportions of superior fuels in combination with lower ones.

Most of the things are considered as the sources of indoor air pollution in the literature review. The common sources are cooking fuels and indoor smoking. Pesticides can also cause household air pollution (Pesticides Impact Indoor Air Quality). Around 60% of the world has access to clean cooking fuels. Roughly 3 billion people cook using unclean open fires or simple stoves fueled by kerosene, wood, animal dung, crop waste and coal. Developing world is more vulnerable to household air pollution. There are two ways to overcome the adverse effect of indoor air pollution either by empowering the women or by switching towards modern fuel completely (Ritchie and Roser, 2020).

Rampedi (2017) conducted a study in which he used Energy Ladder model, where households tends to move towards convenient and less polluting energy carriers with increase in their disposable income. However, many other authors criticized on this school of thought in recent years. Masera observed that people do not ascend the energy ladder as their income increases in rural Mexico. Rather, they 'stack fuels', where polluting fuels are not discarded completely but used together with modern fuels due to cultural preferences. On the other side, According to HeltBerg, the prospect for modern fuels to combat indoor air pollution is better in urban areas than in rural areas therefore, there is a lot of fuel stacking in urban communities compared to rural communities.

Table: 2.1 Summary table I

Author/ year	Methodology	Findings
Barnes et al (2005)	Energy Ladder model	The findings showed that households shifts from traditional and un cleaner fuels to modern and cleaner fuels as their income increases.
Suliman (2013)	Discrete Choice analysis	Examined the factors that affects the primary cooking fuel choice in Sudan, its side effects and relevant policies to mitigate them.
Pfaff et al (2004)	Environmental kuznet curve	Talked about environmental quality. They proved that shifts towards cleaner inputs with expanding income only holds for middle income households.
Win and Mizoue (2009)	Qualitative analysis	Evaluated wood fuel consumption rate and pattern of use in urban areas and compared the results with rural communities.
Masera et al (2000)	Energy ladder hypothesis	Presented the traditional view on fuel switching of developing countries and founded that households move from relatively inefficient fuels to efficient ones with increase in their income but gradually.

The World Health Organization announces the cooking with strong biomass energizes as one of the primary motivations to overall sick wellbeing. It was extended that Household Air Pollution (HAP) was at risk for more than 1.6 million yearly passing's and 2.7% of the worldwide heap of infection in the year 2000. There are various synthetic compounds in

biomass smoke that are harmful for wellbeing, for example, Nitrogen oxide, Carbon monoxide, Sulphur oxides and different cancer-causing agents, for example, formaldehyde and benzene. Besides, the flaming of strong biomass powers additionally delivers little components into the air, which block aviation routes and lungs and weaken immune system. The substances run from a width of 2.5 microns (PM 2.5) up to 10 microns (PM10). The finer particles which enter deeper into the lungs can damage more. (WHO, 2006).

Shukla (2009) showed the pattern of domestic fuel consumption in which he described the switching from traditional to modern fuel along with increase in income and availability of modern fuel. These changes towards cleaner fuel also demonstrates improvements in living conditions especially for the poor women and children, most affected by indoor air quality. The drive to switch to protective fuel is still a long term option due to many barriers such as expensive infrastructure, which is not easily affordable for many households.

The Author Rousse (2002) in his paper talked about traditional fuel sector and fuel switching policies in which he highlighted informal fuel suppliers like fuel collectors, transporters and vendors. Also fuel switching policies such as promoting and subsidizing, restrictions and improving the fuel efficiency. He concluded that fuel switching have successful intervention and produce considerable environmental and social benefits but also concluded the impacts which affected the lives of people in terms of loss of jobs, declining incomes, increased vulnerability and insecure access to natural resources. According to the author, there are insufficient employment opportunities in the allotment and sale of modern fuels to compensate for the high livelihood losses experienced by traditional fuel suppliers.

Budds et al. (2001) described the challenge of Indoor Air Pollution as being clearly related with poverty, in the context that it is the helpless whom rely upon lower grade fuels, and frequently don't have the fundamental establishment for a very much ventilated cooking

region. Those most influenced are normally ladies in low salary family units, who spend extended periods of time inside and are basically responsible for cooking. Little youngsters are additionally arranged to wellbeing dangers connected with Indoor Air Pollution, as they are all the more near their mothers as they cook and their invulnerable frameworks are not completely evolved to withstand the destructive impacts of smoke. Intense respiratory contaminations, lung sickness and Chronic diseases are the most noticeable wellbeing impacts connected with Indoor Air Pollution. Likewise connected with elevated levels of smoke contact is the risen introduction to Tuberculosis, Cataract and Asthma. The wellbeing impacts from family unit air contamination have consequences for the efficiency of poor people, which thus unfavorably influence both their expectations for everyday comforts and personal satisfaction.

Table: 2.2 Summary table II

Author/year	Methodology	Findings
Malhotra et al (2004)	Structural equation modelling	Argued about gender dimensions in developing world. founded health burdens which are more likely felt by women associated with traditional bio mass cooking.
Malla and Timilsin (2014)	Qualitative analysis	Founded the conversion efficiency. They observed the transition efficiency of households cookstoves fluctuates widely by energy source.
Nasir et al (2015)	Multinomial logit model	Founded out the determinants of fuel choice other than poverty which influences the lives and fuel choice of the households.

According to PREDAS (2009) Health issues associated with smoke are often not restricted to the home. Indoor air pollution, caused by a high number of users of biomass stoves in a given area, may have a health effect at regional level. Pollutants may disperse through entire neighborhoods, affect air quality and pollute the environment. There are gender dimensions in the developing world. He discussed that the Males and females do not share the same responsibility of the health and the environment issues associated with the use of biomass. Women are responsible for gathering, transporting, refining and storing materials, and also cooking tasks, while men usually make financial decisions in many developed countries. It is also plausible to conclude that females associated with conventional biomass cooking are more likely to experience the health burden. The participation of women is much higher than that of men due to their high involvement in cooking. Also, the health effects of both outdoor and indoor air pollution in children hence, figured out that indoor cooking with unclean fuels was the source of wheezing among children.

Malla and Timilsin (2014) in their study founded the conversion efficiency. In which they observed the transition efficiency of households cookstoves fluctuates generally by energy sources. A broad range of stove cook conversion efficiencies has been obtained from a number of site-specific situations in developing countries. Cooking fuels also vary in their energy strength. Advanced fuels have a high energy density per kg of fuel used, whereas conventional biomass fuels have a low energy content. The consumption of biomass energy is ineffective or open stoves is known to be a conventional means of cooking. On the other end, natural gas, LPG, kerosene, electricity and biomass energy consumption are effective or less polluting stoves and are considered modern cooking strategies. Although poverty is linked with poor fuel choices other socioeconomic factors such as household area and locality, household size and asset ownership structure also influences the fuel choices of the people.

Mirza and Szirmai (2010) talked about the consequences and features of the use of different energy services using Energy Poverty Survey (EPS) data conducted in the year 2008 and 2009 found out that the rural population of Pakistan used a range of energy resources such as firewood, plant waste, kerosene oil and animal waste. Given these sources of energy, Pakistan 's population had to face energy shortages or energy deprivation. Estimates have shown that 96.6 per cent of rural households have had to suffer short energy cuts. In the Punjab province of Pakistan, 91.7% of rural households in the total rural population face extreme energy deprivation.

Lavaine (2015) conducted his study in France and examined the relationship between environmental disparities, atmospheric pollution and overall mortality rates by using pooled data from the year 2000- 2004. He estimated the positive impact of ozone (O3) on environment. The results concluded that presence of NO2 affects the health of women more than that of men which made the country (France) to change their policy for health perspectives. However, the findings of the study were consistent with the previous studies related to environmental disparities.

2.2 Conclusion

All the past and current researches are done on the indoor air pollution and other factors like infectious diseases, child mortality, women health and wealth etc. No such research is done on the role of communication technology as a mediator between income, poverty and fuel choice. So that it would be easy to sustain the livelihoods of the households in Pakistan. Therefore, this study will help us to find out the role of poverty on household air pollution and fuel choice in Pakistan and also the role of ICT to decrease household air pollution. The study also highlights the impact of technology and information in the perspective of Pakistan to reduce poverty.

Chapter 3

The Dynamics of Poverty and Fuel Choice

This chapter explains the dynamics of poverty and fuel choice and also how technology and information affects the household air pollution in correspondence with fuel choice. In addition, early literature of poverty dynamics, choice of cooking fuel in both rural and urban areas and the nexus between poverty and traditional fuel are also described.

The two theories Individual Poverty Theory and Structural Poverty theory are framed to analyze the dynamics of poverty and fuel choice. When income rises, consumers discontinue the use of traditional fuels and, often by transition fuels, shift towards to the adoption of modern fuels such as electricity and gas (Kroon et al., 2013). The two theories (Individual poverty theory and structural poverty theory) shows the dynamics of poverty. According to individual theory, there are the same type of people who needs the intervention and contribution of paternalist to get their responsibilities and actions together. On the other hand, structural poverty theory reveals that the people in a circle are different and furthermore we need to change the economic and social structure to make things even better. The longitudinal survey predicts that underprivileged individuals are not the same individuals every year. The PSID (Panel Study of Income Dynamics) data showed that households between age 25 and 60 experienced an entire year of poverty of around 4 in 10 adults. The number of years increases if we count children in it. The spinning door of poverty reveals that the structural theory is even correct if we find out where the underlying holes are. Poverty and Unfairness addresses so many households who experience poverty by pointing out that households who enters in poverty will not be poor long on average but, households who currently are poor, will be poor for long on average. It is the developmental problem that have negative outcomes on the lives of the poor households. Individual poverty is the type of poverty in which someone is being

raised in poverty without any advantage and far more likely to end up in poverty. This type of poverty is not just a arbitrary economic hole that most households will fall into at some point in life. There is a need for more programs for the poor people to improve their capital and physical abilities. On the other hand, temporarily poor people can be helped with motivations and programs that compliment with their own abilities and resources. It is observed that large households suffer more, in terms of welfare and income source whereas, smallholders manage better with diversified income in both rural and urban areas. Education is an important correlate of fuel choice and poverty because education is associated with higher level of welfare and also helps households manage better with economic decline. Murray (2014) classified poverty in two theoretical groups: individual and structural. He presents empirical data and reveals that poverty is a structural phenomenon. He concluded that as, problem is structural so solution must be structural too. Bruening (2014) highlights the Individual theory as follows: According to the study, households are in poverty because they are not enlightened, uneducated, lazy and inferior in some style. So, education, information and technology plays a vital role in these theories. We could help poverty by promoting more awareness and training programs particularly to lower class households. On the same way, households are in absolute poverty because there are holes in economic system that brings them insufficient income. Because lives of the individuals are dynamic so, people don't stay in same hole forever. If they stay in a hole this year, they will move to another hole (they may get promotion or job) next year. But the hole remains there because of economic instability. Other people may move to the previous hole and it goes on. Therefore, it follows the phenomenon that impoverished people are different people every year. Furthermore, there is a need to modify the structure of economy to reduce poverty and its dimensions to decrease the number of low income holes in it. Bruening (2014) also gave poverty solutions in terms of individual and structural poverty. He suggested that if behavior of Individual does not change, there will be no change in structure. If

individual's behavior changes, structural change of the economy automatically changes. He summarizes poverty as a structural change. As a whole, ICT plays a mediating role in the above theories. ICT technologies can be used to improve efficiency, competition and access to market structures in many developing countries. poverty itself is a highly complex problem that needs to be tackle through new innovations and information. Poor households are often unaware with their basic rights, entitlements and various government schemes. Therefore, information and technology can be used to reduce poverty although, it is a multidimension phenomenon but it can make possible through better quality education and awareness programs. Economic growth, supporting infrastructure, education and better living standards are the solutions to the problem of poverty whereas ICT provides tools and functions like all other technologies. ICT can become an empowering tool for broader socio-economic development.

Fig: 3.1. Cooking Fuel Choice in Rural and Urban areas of Pakistan.

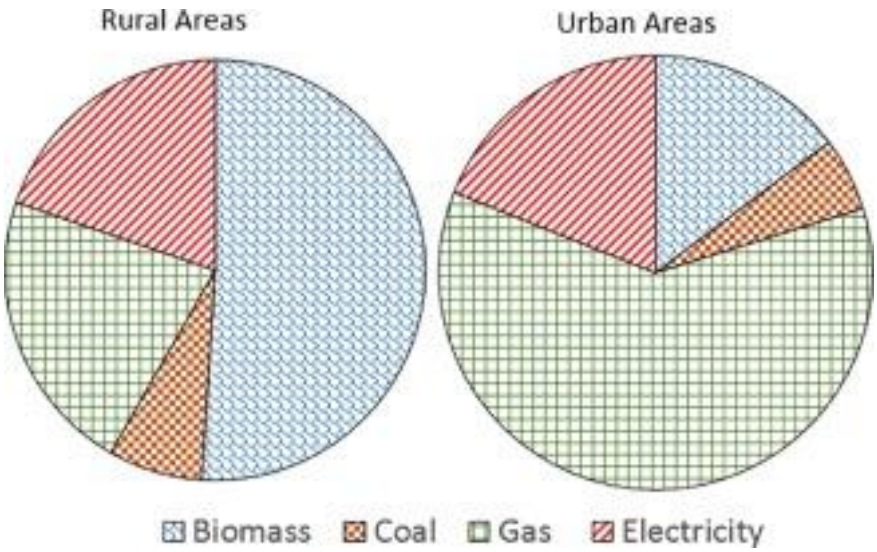


Fig 3.1 shows the complete picture of cooking fuel choice of both rural and urban areas of Pakistan. Usage of biomass fuel in rural areas is more than urban areas. Whereas, urban households mostly uses cleaner fuels (gas) as compare to rural areas. Similarly, because of less

information and awareness households of rural areas uses high amount of coal than urban households. Electricity is available in both areas and its use is almost same in both urban and rural areas of Pakistan.

3.2. The Early Literature for Poverty Dynamics

The literature for dynamics of poverty has two models: The covariance structural model by Lillard and Willis in 1978 and The Hazard model by Bane and Ellwood in 1986. The covariance structure model says that households do not stay in poverty for a long time. In fact they have poverty turns, they enter into poverty and gets out of it. The author has shown the parametric model of poverty. The model was used to make decision about the persistence of Poverty turns in order to measure the economic value of the households in USA. PSID data set was used to estimate the model. They founded that average period spent in poverty is longer if the head of the household is black or if it is a women. The Hazard model says that poverty is heterogeneous in nature in a view that Only few people are poor for a long time. By targeting anti-poverty policies, this issue can be tackled. So, it is important to study the length of poverty turns and the determining factors of poverty entry and exit. The study has defined poverty turn as, a duration in which cash income of the household is below the poverty line. The research estimated exit probabilities of poverty by using longitudinal survey. The results showed that, there is a situation of entry in poverty when income of the household head decreases and exit from poverty happens when household head recovers his income pattern. Chronic and transitory poverty was also explained in the paper. Chronic poverty is a fact in which households or a group of people are in poverty for a long period of time. Here, implicit poverty line and duration is needed to identify the type of poverty, it is important to consider because it needs different policies to cope with the economy. Chronically poor people remains poor forever or they may have poverty inherited in their generation as well. On the other hand,

transitory poverty may indicate some priorities given to the households with safety measures such as credits, insurance policies and safety precautions to the poor households across the poverty line. It is planned to smoothen the income and consumption expenditure.

3.3. Nexus between Poverty and Traditional Fuel

According to the latest global data from the World Health Organization (WHO), Around 7 million people die every year from Air borne pollutants, mostly in developing countries because of the pollution inequality between world's rich and poor. In terms of household air pollution, which contributed to 3.8m deaths, the gap is also wide because families in poorer nations depends more on burning wood, coal and kerosene for cooking and heating. Pollution is costly so poor people suffer more. Households who uses unclean fuel are more prone to health risks as well as environmental degradation. Pollution-related sicknesses bring about direct clinical costs, expenses to social insurance frameworks and opportunity costs coming about because of less efficiency and financial development. Because of contamination, welfare losses are estimated at $4.6 trillion per year, 6.2% of global monetary output. Also, poor people do not have enough information to know the damaging effects of pollution. Education plays a vital role to reduce household air pollution in terms of formal education, information, public awareness, and training should be recognized as a process by which individuals and societies can reach their highest potential. Education and information is essential for promoting sustainable development and improving the capacity of the people to secure environment and development issues. Many new technologies are naturally more energy efficient and less polluting. Therefore, pollution-preventing technologies should be used to improve product's lifecycle. Technology based approaches such as cleaner stoves and fuels, adequate ventilation and housing design, and access to clean household energy/electricity sources can be a solution to break nexus between poverty and traditional fuel.

Table: 3.2 Cooking Fuel usage in Pakistan

Region/province	Clean fuel usage (%)	Unclean fuel usage (%)	Both clean and unclean fuel usage (%)	Poverty incidence (%)	Population (in millions)
National	**21.25**	**71.83**	**6.92**	**35.09** (0.0051)	**118.89**
Urban	65.75	29.12	5.13	23.13 (0.0079)	28.2 (%)[a]
Rural	3.95	88.44	7.62	39.97 (0.0064)	71.8 (%)[a]
Punjab	**19.36**	**76.51**	**4.13**	**33.33** (0.0075)	**67.11**
Urban	61.42	34.01	4.56	25.51 (0.011)	27.8 (%)[b]
Rural	3.37	92.66	3.97	36.9 (0.0094)	72.2 (%)[b]
Sindh	33.33	**65.17**	**1.50**	**35.5** (0.0093)	**31.00**
Urban	78.28	20.71	1.01	19.28 (0.0125)	38.5 (%)[b]
Rural	5.35	92.84	1.81	45.88 (0.0122)	61.5 (%)[b]
KP[c]	**7.68**	**64.06**	**28.26**	**40.79** (0.0119)	**15.34**
Urban	39.89	29.10	31.00	29.55 (0.0205)	12.8 (%)[b]
Rural	2.96	69.19	27.85	42.71 (0.0135)	87.2 (%)[b]
Balochistan	**13.58**	**74.37**	**11.78**	**37.12** (0.0137)	**5.45**
Urban	45.99	39.75	14.25	27.01 (0.0220)	17.4 (%)[b]
Rural	7.09	81.65	11.26	39.25 (0.0159)	82.6 (%)[b]

Source: Household Integrated Economic Survey (HIES) (2001–2002).
Note: Values in parentheses are standard errors.
[a]Percentage of national population.
[b]Percentage of respective province population.
[c]Khyber Pakhtunkhwa.

Chapter 4

Theoretical and conceptual Background

This chapter explains the conceptual framework of poverty and household air pollution and also how technology and information affects the household air pollution in correspondence with fuel choice. In addition, data sources, variables, methodology, statistical techniques and descriptive statistics used for the study are also described.

4.1. Conceptual Framework

The two theories Energy Ladder model and Fuel Stacking theory are conceptually framed to analyze the effect of poverty and household air pollution. Energy ladder hypothesis says, Households use to discontinue the use of unclean or polluting fuels as their income increases and, now and again by method of transition fuels, move towards the reception of present day or clean powers, for example, power and gas (Hosier and Dowd, 1987). The significant component of energy transition views that, there is a progression of discrete steps in which households unit change from traditional fuels to modern and cleaner fuels. On the other hand, considering a large body of empirical proof, the energy stacking hypothesis has emerged as an alternative understanding of household energy transition (Masera et al., 2000). It holds that as family salaries expands, the progress towards the utilization of modern fuels happens in a setting of the synchronous utilization of different types of fuel. In this view, low pay family units ordinarily utilize a little sort of traditional energizes, for example, kindling, creature buildup and charcoal. As incomes increases, households increases the utilization of modern fuels, but also keep utilizing traditional fuels for some activities, thus ‘blending’ various energy sources. Price changes, preferences, taste, reliability of supply, cooking and consumption habits, availability of technology, education, household composition and further cultural or habitual factors, these are some other factors that could affect the switching of fuel

pattern of households. The literature suggested a critical modification of the energy ladder hypothesis. This model despite everything develops a classified relationship of fuel types, however contradicts that family units don't quickly rise to improved powers and at the same time abandon inferior ones. Or maybe, the fuel stacking theory expect that families depend on numerous kinds of fuel, expending a higher extent of superior fuels with expanding income. In spite of the fact that, Poverty settles on a remarkable commitment to fuel decisions however other financial factors, for example, family unit area and zone, family size, low degree of human capital, resource proprietorship structure and admittance to essential utilities are the significant determinants of fuel decision (Colbeck et al., 2015). Moderate and lower socioeconomic status explained by middle income, education and low income, low education respectively causes an increase of the highest level in air pollution and bad self-reported health quality (Jiao et al., 2018).

$$\boldsymbol{FC = f\,(WI, Y)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (\boldsymbol{i})$$

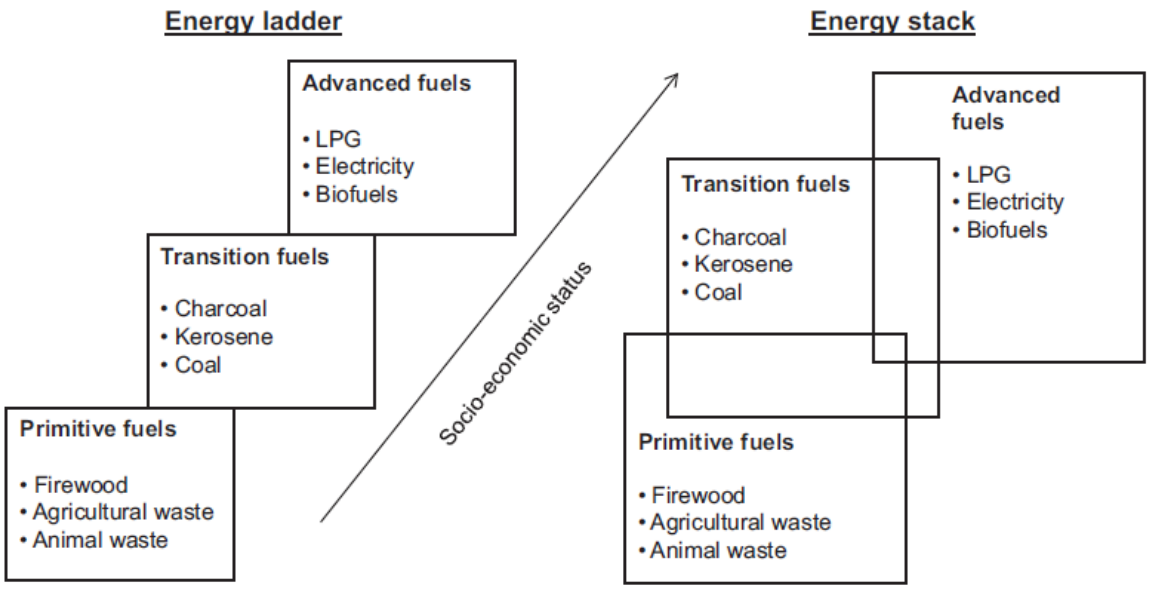
$$\boldsymbol{ICT = f\,(FC)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (\boldsymbol{ii})$$

These two equations shows the statistical relationship of fuel choice (FC) and information and communication technology (ICT). Equation (i) shows the direct association of fuel choice (FC) with wealth Index (WI) and income (Y) because poverty is estimated using wealth index and income of the households. Equation (ii) shows the relationship of technology and choice of cooking fuel. Technology and innovation plays an essential role for the progress and development of the economy.

4.2. The Energy Transition and Fuel Stacking

The lower the income of the households, the more they depend on biomass fuels, such as wood and dung. A transition occurs where the households start shifting towards cleaner and more expensive fuels (LPG & electricity) when their income increases. Therefore, the process of switching from low grade fuel to high grade fuel is known as Energy Transition. There are even more factors that could affect the fuel-switching pattern of household i.e. price changes, taste, preferences, reliability of supply, consumption habits and cooking, availability of technology, education, household composition and further cultural or habitual factors, which the energy transition hypothesis has failed to include. Fuel Stacking theory reveals that households do not fully switch to different fuel types even increase in their incomes. They rather use an energy mix. The households in that case, rely on multiple fuels in their energy-use, using higher proportions of superior fuels in mixture with inferiors ones.

Fig 4.2 Energy Transition and Fuel Stacking



Data

4.3. Data Sources

The nationally representative Pakistan Demographic Health Survey (PDHS) of the year 2017-18 was used for this study (http://www.dhsprogram.com/). This PDHS is the fourth to be conducted in Pakistan since 1990-91. Information and demographic data were obtained from ever married women and men aged 15-49 using stratified sampling of households based on two staged cluster design. This stratification was gained by separating each of the eight regions i.e. KPK, Sindh, Baluchistan, Punjab, ICT, FATA, AJK and Gilgit Baltistan into urban and rural areas. Total of 16 sampling strata were created. Samples were selected independently in every stratum through a two-stage selection procedure. Probability-proportional-to-size selection was done at the first stage of sampling by selecting the enumeration blocks. Total 580 clusters were selected consisting of EBs. The second stage included systematic sampling of households. Fixed number of 28 households per cluster was selected with an equal probability systematic selection process, for a total sample size of approximately 16,240 households.

National figures and background characteristics of the 2017-18 PDHS excludes Azad Jammu and Kashmir and Gilgit Baltistan regions. For the research purpose both urban and rural households of KPK, Punjab, Sindh, Baluchistan, Islamabad Capital Territory and FATA were considered. Out of 12,815 households in Pakistan excluding AJK and GB, 12,338 were occupied out of which 11,869 were interviewed. Out of 13,118 eligible women of age 15-49 in Pakistan excluding AJK and GB, 12,364 were interviewed with the response rate of 94.3%. Both Rural and Urban households were considered for the research purpose.

4.4. Variables

4.4.1. Dependent Variable

Cooking Fuel choice is considered as the dependent variable for this study. The cooking fuel will be divided into two categories: Traditional fuel i.e. kerosene, coal/lignite, charcoal, wood, straw/shrubs/grass and animal dung and modern fuel i.e. electricity, liquid petroleum gas (LPG), natural gas and biogas. Several other literature classified this category (Rahman et al., 2017). Since the usage of different types of fuels is primarily associated with their availability. Also, economic and social conditions of a household are important determining components.

4.4.2. Independent Variable

For this study, the independent variable is chosen as Poverty status (PS) of HH i.e. Poor. It is estimated using Wealth Index .Wealth is one of the essential parameters determining a household's choice of fuel. Willingness to pay for quality fuels is higher for the households with high level of income and assets. Also, have a higher potential to pay more. Therefore, as the means and revenue of the household increases, it is more likely to shift from the use of dirty fuels to clean and protective fuels (Rosenthal et al., 2017).

4.4.3. Control Variables

For this study, the control variables were chosen from a range of socio-economic factors such as location (LOC) , demographics (DMG), human capital (HC), social infrastructure (SI), and Information (ICT) keeping in view their potential role in household fuel choice. These are the variables which are measurable and considered to have a statistical relationship with the dependent variable.

- Location (Region of Residence, Province of Residence)
- Demographics (HH size, no of working people in HH, sex of HH head, Age of HH head)
- Human Capital (no of literate persons in HH, maximum Education level, no of schooling years HH head completed, no of schooling years spouse HH head completed).
- Social Infrastructure (Electricity availability, Gas availability, Drinking water availability)
- Information and Communication Technology (network availability)

4.5. Methodology

This study utilizes the Pakistan Demographic Health Survey (PDHS) of the year 2017-18. Poverty is assessed utilizing wealth Index. This paper investigates how decision for various fuel types is associated with the poverty status and different characteristics of family units in Pakistan. Selection of methodology is important to study the determinants of Fuel Choice. Here, fuel choice is the categorical dependent variable. Fuel Choice for this reason has been classified as: Clean and Unclean fuel. Unclean fuel incorporates wood, charcoal, lamp oil, animal dung and crop residue. A family unit utilizing any of these fuel types is arranged under

the unclean fuel utilization class. Though, Clean fuel incorporates melted oil gas (LPG, natural Gas or petroleum gas).

A Binary logistic model is utilized to foresee the determinants of fuel decision. One of the focal points of this methodology is that it can straightforwardly uncover the determinants of fuel decision by assessing the likelihood of utilizing one kind of fuel connected with various informative factors. The associated models were developed for relationship between family unit air contamination coming about because of cooking fuel in connection with poverty.

$$\boldsymbol{CF} = \alpha\circ + \boldsymbol{B1}(\boldsymbol{PS}) + \boldsymbol{B2}(\boldsymbol{LOC}) + \boldsymbol{B3}(\boldsymbol{DMG}) + \boldsymbol{B4}(\boldsymbol{HC}) + \boldsymbol{B5}(\boldsymbol{SI}) + \boldsymbol{B6}(\boldsymbol{ICT}) + \boldsymbol{e}$$

$$\boldsymbol{CF} = \alpha\circ + \boldsymbol{B1}(\boldsymbol{PS}) + \boldsymbol{B2}\Sigma(\boldsymbol{CV}) + \boldsymbol{e}$$

Where CF is the dependent variable i.e. cooking fuel choice either traditional fuel or modern fuel. Traditional fuel includes (kerosene, coal/lignite, charcoal, wood, straw/shrubs/grass and animal dung) and modern fuel consist of (electricity, liquid petroleum gas (LPG), natural gas and biogas. As for independent variable PS which is Poverty status of HH either poor or rich. All the dependent and independent variables are dichotomous 1 for ‘yes’ if the condition exists and 0 for 'no’ if the condition does not exist. CV stands for control variables which includes area of residence (rural or urban), demographic (household size), human capital (maximum level of education), social infrastructure (electricity, gas and water availability), and Information and Communication Technology (network availability). All the control variables or explanatory variables are also dichotomous in nature.

4.6. Statistical Techniques

Binary logistic regression models were used to explore the association between type of cooking fuel such as (traditional or modern) and household Air pollution for the selected control variables of area of residence, demographic, human capital, social infrastructure, and Information and Communication Technology. The effect of poverty on household air pollution was analyzed by estimating wealth index after adjusting for the respective control variables. The effect of Information and Communication Technology (ICT) and household air pollution was also analyzed separately using logistic regression analysis. The sample was not self-weighting, due to non-proportional sample distribution. Therefore, Weighting factors have been calculated and previously added to the data file and applied so that results are representative at the national level for Pakistan. Weights were applied before the evaluation and then regressions were run using SVY command for complex survey design.

4.7. Expected Signs of the Variables

- The literature recommends that as we move from non-helpless families to poor family units, utilization of clean fuel diminishes (-).
- With reference to Education, more literate persons in a household increases (+) the chances of using clean fuel.
- Having admittance to open utilities increments (+) the likelihood of utilizing clean fuels.
- The choice of cooking fuel varies in different areas. It could be due to different fuel usage patterns i.e. socio-eco factors, availability of different fuel types, local env conditions and social practices.
- ICT (Information and Communication Technology) positively (+) relates with cooking fuel decision.

4.8. Descriptive Statistics

The descriptive statistics of the variables has been shown below. The figures show that the households uses clean fuel type has total of 14,540 observations, mean value of .4892022, standard deviation of .4999006 and has a minimum maximum value between 0and 1. Whereas, The type of fuel choice is a dependent variable and is categorized into clean and unclean fuel. Poverty status is defined as an independent variable which is categorized as poor and non- poor households. Here, poverty status has total 14,540 0bservations which has a mean and standard deviation of .408597 and .4915914, minimum value is 0 and maximum value is 1. All other variables place of residence, number of households, age and sex of household, level of education, social infrastructure, and information and communication technology (ICT) are considered as the control variables for such study. Place of residence is the location type. Rural is for 1 and urban is for 0. Total 14,540 observations. Mean of rural areas is .5001376, standard deviation calculated is .5000172 and minimum value is 0 and maximum value is 1. Number of households for the study is a continuous variable which has 14,540 observations. It has mean 6.937345, standard deviation is 3.624605 and minimum maximum value lies between 1 and 44. Similarly, education level is categorized into 4 divisions i.e. primary, secondary, higher and no education attained. For this category total observations are 14,537. Where no education has a mean of .3913462, standard deviation is .4880684 and a range of min and max value is between 0 and 1. Primary education has a mean of .1452844, SD .3523995 and a range of 0 and 1. Furthermore, secondary education has a mean of .272202,SD is .4451086 and minimum maximum value between 0 and 1. On the same way, mean of higher education is .191098 standard deviation is .39318 and range between 0 and 1. Standard deviation shows the measure of dispersion and the average distance of the values from the data set. Low value of standard deviation shows the closeness to the mean and a large SD indicates that data is spread overall with a long distance. Social infrastructure is categorized into two: availability and non-

availability of electricity and availability and non-availability of clean and polluted water. The data shows the total observations of 14,540. Where mean for electricity availability is .931549, standard deviation is .2525265, minimum and maximum values lie between 0 and 1. Clean water access has the total 14,540 observations. Having mean value 24.12036 and standard deviation 15.66707 and minimum value and maximum value 11 and 96. ICT is considered as a mediator for the study. It has following categories : internet facility, television, telephone, mobile phone and radio facility. The data shows total 14,540 observations. Mean for internet facility is .1513212, television facility is .6254128, telephone facility is .0878509, mobile phone facility is .9402133, and radio facility has a mean of .1090396. standard deviation for internet is .35837, television has .4840328, telephone has a standard deviation of .2830876, mobile phone has .2370994, and radio has a standard deviation of .3116996. The minimum and maximum values for all the ICT factors are between 0 and 1.

Table: 4.8: Descriptive statistics

Variable	Obs	Mean	SD	min	max
Fuel choice (clean=1) (unclean=0)	14,540	.4892022	.4999006	0	1
Poverty status (poor=1) (non-poor=0)	14,540	.408597	.4915914	0	1
Place of residence (rural=1) (urban=0)	14,540	.5001376	.5000172	0	1
No of HH	14,540	6.937345	3.624605	1	44
Sex of HH head	14,540	1.115681	.3198529	1	2
Age of HH head	14,540	47.84553	14.18058	15	95
ICT (internet=1) (no internet=0)	14,540	.1513212	.358374	0	1
(television=1) (no television=0)	14,540	.6254128	.4840328	0	1
(telephone=1) (no telephone=0)	14,540	.0878509	.2830876	0	1
(mobile phone=1) (no mobile phone=0)	14,540	.9402133	.2370994	0	1
(radio=1) (no radio=0)	14,540	.1090396	.3116996	0	1

The table 4.9 shows the type of cooking fuel used by households. Cooking fuel choice is divided into two types clean and unclean fuel. The data shows 21% of households has access

to electricity which lies in the cleaner fuel category. Whereas, 1,904 out of total 14,538 households uses LPG which is 13.10% in total. 35.09% households has access to natural gas and only 75 households has biogas in their houses. 238 out of total 14,538, uses charcoal which is 1.64%. use of wood is comparatively higher which is 6,538 in figure and constitutes 44.97%. households uses straw, shrubs and grass are 121 in total. Usage of agricultural crop is 85. Total 345 households uses animal dung for cooking purpose and 84 out of total 14,538 households cooks no food in their houses. The statistics also shows that 7,111 out of total 14,538 households lies under cleaner or modern fuel category whereas, 7,427 households are under unclean fuel category.

Table 4.9. Type of Cooking Fuel Usage in Pakistan

Cooking fuel choice	**Type of cooking fuel**	**percentage**
Clean fuel type	Electricity	0.21%
	LPG	13.10%
	Natural gas	35.09%
	Biogas	0.52%
	Kerosene	0.01%
Unclean fuel type	Coal, lignite	0.10%
	Charcoal	1.64%
	Wood	44.97%
	straw, shrubs, grass	0.83%
	Agricultural Crop	0.57%
	Animal dung	2.37%
	no food cooked in house	0.58%

Chapter 5

Results and Discussion

5.1. Results

5.1.1. Household Air Pollution and Poverty

The table below shows the association of household air pollution with poverty and shows some basic effects about the dependent and independent variables and the control variables. The use of traditional fuels for cooking (coal/lignite, charcoal kerosene, animal dung, wood, straw/shrubs/grass) was associated with poverty status of the households. Poor people are more affiliated with unclean fuel which is estimated as coefficient of -2.915949 which is a negative figure showing less use of clean fuel by poor people after adjusting for place of residence, number of households, level of education, social infrastructure, and information and communication technology (ICT). It has odd ratio of .0840361. here, odd ratio is less than 1, means less chances of using cleaner fuels by poor households. Middle and rich income groups are considered into non-poor households and are less affiliated with unclean fuel according to the data estimates. The results shows that households with poor status are directly linked with unclean fuel usage, after adapting with explanatory variables. Various studies in Europe and North America has been shown an increase in health related issues due to low level of education and air pollution (Finkelstein et al., 2005) Households in urban areas practices traditional fuels or a mixture of both fuels when there is availability of protective fuels. The reason observed was the households with a large number of size. As, there is a rise in household size, they wanted to fulfill their needs even if modern fuel is available they do not switch. Income and wealth status is an important factor for this situation. The reliance of the energy ladder concept on income indicates a close correlation between deprivation and choice of fuel and, therefore,

exposure to indoor pollution. The data of household size also shows the association between poverty and household air pollution with a coefficient of -.0332803, odd ratio .9608797 and a p-value 0.000 which is highly significant. As, odd ratio goes more than 1, there is a more chance of using cleaner fuels. Level of education is categorized into primary education, secondary, higher and no education at all. Here, primary education has coefficients .4101943, which is showing positive relationship of clean fuel usage by the households with a little education. Odd ratio is 1.107756 and a p-value is 0.158. whereas, households with secondary education has a coefficient of .9522063, odds of 1.595685 which is more than 1, showing chance of using cleaner fuels with even less education. Higher education shows the coefficient of 1.320849 with 2.056964 odd ratio and a 0.000 significant p value. Social infrastructure is divided into two sub categories, availability and non- availability of electricity and clean water. Electricity availability has a positive coefficient of 1.82164 with odd ratio 2.42574 at a significant level 0.000. coefficient here shows one unit change in variable keeping all other factors constant. Clean water accessibility has .1100208 level of coefficient. Odd ratio for clean water is 1.005099 and p value 0.919. Sex and Age of HH head is considered into demographics. Sex of HH head has coeff= .147482, with odd ratio .8628812 and p value 0.005. coefficient for age of HH head is .0020856 with odds and p value 1.002088, 0.075 respectively.

Table 5.1.1 Household Air pollution and poverty

Variables	Coeff	Odd Ratio	P-value
Poverty status (PS) (poor)	-2.915949	.0840361	0.000
Place of Residence (rural)	2.098117	5.464896	0.000
No of households	-.0332803	.9608797	0.000
Sex of HH head	-.1474782	.8628812	0.005
Age of HH head	.0020856	1.002088	0.075
Level of education (primary) (Secondary) (Higher)	.4101943 .9522063 1.320849	1.107756 1.595685 2.056964	0.158 0.000 0.000
Social infrastructure (electricity) (clean water)	1.821644 .1100208	2.42574 1.005099	0.000 0.919

5.1.2 Role of Information and Technology on household air Pollution, Poverty and Fuel Choice

When we discuss regarding the use of ICT and the eradication of poverty, we mean referring to the effective and effective use of modern (PC, internet, cell phone) and traditional (radio, television) information, communication and support technologies to support growth, people's and organizations' objectives. The table below shows that choice of cooking fuel is linked with the magnitude of education, technology and innovations. Households having internet facility have the coefficient 1.407359 with odd ratio 1.965666 and p-value 0.000. this is showing that the households who uses cleaner fuels and also have internet facility has more odds of using protective and modern fuel. Television, telephone and mobile phone facility also have positive odds of using more of modern fuels with p-values 0.000, 0.362 and 0.000.coefficient of television is 1.646639 and odd ratio 1.39757. telephone facility has coefficients of .8837327 with odds 1.09466. coefficients and odd ratio of mobile phone is .9131284 and .6729472. similarly, households having availability of radio also have a coefficient of -.7173046 with odd ratio .4423188, showing negative relationship with fuel choice and significant p-value 0.000. Household heads who are not educated at all are not encouraged. The odds of household heads who are educated till primary are 1.107756 times more. The findings show that poverty status of households and fuel choice are negatively associated with rural areas. There are 5.4648 time more odds of fuel choice being polluting when in rural area. As income decreases the odds of household air pollution increases. Education also has a negative relation with household air pollution. Odds of having polluting fuel decreases with type of education. Households with no education shows higher times occurrence of polluting fuel at significance level. Whereas households with higher education showed the least odd ratio at the significant level. The findings showed that, as the status of

households is poor and also not educated, they are using more of unclean fuel. Accordingly the middle income grouped and not educated also belongs to the same category of using more of unclean fuel and a mixture of both while rich income grouped households with higher education used most of clean fuel with the odds 2.056964 at the significant level. The table below shows the poverty*ICT as an interaction term. This variable is showing the relationship of poor with technology and advancement. Poor*internet is the variable which shows poor households with internet facility having coefficients and odd ratio as -.0020057 and .9979963. poor*television shows the relation of poor households with television facility at homes with odds 1.16234. similarly poor*telephone and mobile phone has the odds of .4190965 and .0465162. more the households are poor and less technology they have, shows more usage of unclean fuels hence, less efficient.

Table: 5.1.2 ICT as a mediator

Variables (ICT)	**Coeff**	**Odd ratio**	**P-value**
Internet facility	1.407359	1.965666	0.000
Television facility	1.646639	1.39757	0.000
Telephone facility	.8837327	1.09466	0.362
Mobile phone facility	.9131284	.6729472	0.000
Radio availability	-.7173046	.4423188	0.000
Poverty*ICT			
(poor*internet)	-.0020057	.9979963	0.998
(poor*television)	.1504356	1.16234	0.092
(poor*telephone)	-.8696541	.4190965	0.001
(poor*mobile phone)	-3.067955	.0465162	0.000
(poor*radio)	-1.979847	.1380904	0.000

5.2. Discussion

This study examined the association between poverty and household air pollution through fuel choice using nationally representative Pakistan Demographic Health Survey (PDHS). Likewise, this study observed the effect of data and innovation in decrease of deprivation. Our discoveries demonstrated that nearly lion's share of Pakistan utilizes unclean energizes and most country family units are presented to numerous wellbeing issues because of salary hole too. The outcomes demonstrated that unclean fuel is straightforwardly related with poverty status of families (poor and non-poor), size of family units what's more, spot of living arrangement. It is additionally discovered that advantage, deprivation, low instructive accomplishment, what's more, female headship of families are significant variables hindering the appropriation of clean powers.

Household Air Pollution is a problem that is strongly linked to poverty, because it is poor people who rely on low-grade fuels and often do not have the necessary arrangements for a very well-ventilated cooking area. Women in low-income households, who spend long hours indoors and are primarily responsible for cooking, are the most affected (Budds et al., 2001). The findings pointed that, as household size increases they use most of unclean fuel or both clean and unclean fuel together. Household size has the odds of .9608797 time more of clean fuel with significance at 0.000. In addition, the areas where there is availability of electricity are more likely to cleaner fuel with the odds .2.42574 at the significance level (0.000) after adapting for control variables. Similarly, it is directly related with no education or preschool and with less technology innovation.

In this study, the control variables or explanatory variables are classified by demographic (household size, age and sex), location (rural, urban), social infrastructure (electricity availability, drinking water availability) and ICT (network availability). Rural areas showed an increase in unclean fuel usage with a higher chance of health problems as compare to urban areas. This correlates with the previous study which states that poor are more likely to suffer from indoor air pollution (Suliman, 2013). 49.99% of rural population out of total 14,540, uses unclean fuel whereas 50.01% of urban population lies under unclean fuel category. As number of people increases, people usually practice mixture of fuels.

The results showed that unclean fuel is directly linked with poverty status of households (poor and non-poor), place of residence and size of households. It is also noticed that properties, deprivation, low educational achievement and female household leadership are important determinants that hinder the adoption of clean fuels. The effect of a household head education has also been examined in this study. It is clearly recognized that as heads education increases its degree of skills and decision making also increases. Switching to modern fuel is relatively influenced by the educational qualification of the household head (Sekar and Subburajz, 2015). The association of household head with indoor air quality and poverty status has also been studied. The results showed that when poverty status is interacted with technology it decreases the odds of cooking fuel choice.

This means that technology plays a fundamental role in choice of fuel as well. While ICT itself is now widely recognized as a powerful tool for eradicating poverty, its added importance for bringing about social change is not fully appreciated. While obstacles to economic growth differ and poverty do need to be addressed. Within a particular country, the root issues can often be reduced to a combination of three main factors: a weak education system, poorly-performing sectors, and a weak business environment. ICT can make a huge

difference, especially with regard to under-performing industries. The data also showed the more information and technology you have, the more well aware you are, less polluting or unclean fuel you will practice. Approximately 84.82%, 37.45%, 91.19%, 6.01%,89.07% households has no network connection and also utilize polluting fuel affecting environment and health standards respectively. Households having ICT networks are more likely uses cleaner fuel types with odds greater than 1 at a significant level. This shows that poor people suffer more with the usage of polluting fuel and health standards as compare to non- poor households

Chapter 6

Conclusion and policy Recommendation

The goal of this study was to explain the influence of poverty in the exposure of household air pollution by identifying the next determinants of fuel choice in Pakistan. A binary logit analysis was used to predict the factors that affect the choice of fuel. The findings demonstrate that household location and area, poverty status, household size, low rates of human capital, and access to basic utilities are key factors in Pakistan 's fuel choice. The study found that poor families tend to have a large household size and less education, while rich families are small in size and more trained. Poverty status has been described as one of the most significant determinant of fuel choice above all other variables. Other factors were the greatest the probabilistic effect on the household of using one form of fuel. Education is also playing and significant role to play.

The reason behind this study was to examine the need for the implementation of a family unit of air contamination by identifying the next fuel decision determinants in Pakistan. A binary logit model was used to test the components that had an effect on the fuel judgment. Results have shown that the region and district of the family, neediness status, family unit size, low degree of human resources, and admission to basic utilities are key elements related to fuel decisions in Pakistan. The investigation revealed that helpless family units would usually have an enormous family size and even less education, while rich families are small in size and are more educated.

Poverty status was discovered to be the most significant determinant of fuel decision among every single other factor. Different components had the biggest probabilistic impact on a family unit to utilize one kind of fuel. Likewise, Education assumes a significant job. Even so, the analysis revealed that families using clean fuel profit from an educated head (female) than from an educated head (male). The study found that access to decent services, i.e. electricity, gas, drinking water, all of which are important factors, is related to the choice of fuel in Pakistan, as these facilities represent living conditions of the households. Although ICT on its own has been commonly acknowledged as a key force for eradicating poverty, its added value for trying to bring about innovation process is not fully appreciated.

The advancement of policies, strategies and programs to achieve common access to clean cooking fuels requires awareness of how clean and unclean stove and the cooking fuels are used in practice. According to the PSLM data of 2018-2019, around 35.4% of population has a primary reliance on clean fuel and technology. Poor communities and those with fewer knowledge and education, high poverty and unemployment may face greater risks to health even if their air quality meets federal health standards.

There is a need for advanced technology and awareness to the poor people of developing nations to overcome the damaging effects of household air pollution. The study showed that the effects of poor quality fuel and household air pollution can be mitigated through new innovations and technology. The health quality and fuel choices can be made cleaner through educating and giving awareness to women of the households. Pakistan is a third world country with limited resources. Financing mechanism should be designed to fund biomass energy projects including the development and deployment of efficient cookstoves. Subsidies are the main financial mechanisms to encourage use of modern cooking fuels, particularly, LPG, in developing countries.

Most of the country is consisted of rural areas where there is no electricity or natural gas available. Clean sources of energy and technical innovations is vital for good health and environment. Spreading awareness regarding cleaner fuel can be effective. Various programs have been implemented in the Asian developing countries to promote clean cookstoves which is a global alliance for opting cleaner cookstoves and technologies and reducing burden of disease. Initiatives should be taken to promote biogas for cooking and heating purposes. The accessibility of cleaner fuel decisions easily will advance its utilization. Despite the fact that this examination utilized information from Pakistan Demographic Health Study the discoveries could likewise be applicable to other low-pay nations with unnecessary utilization of strong fuel to hold the intricacy and availability of different socio monetary elements in the progress from conventional to present day fuel utilization, so as to structure supportable intercession methodologies and to improve indoor ecological quality in creating world.

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