Journal of Positive School Psychology http://journalppw.com
2023, Vol. 7, No. 3, 459-470

Investigating Potential Hazards Of Domestic Fuel Sources And Associated Medico-Social Issues Among Rural Women In Punjab, Pakistan

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Abstract

Rural areas of developing countries are still facing severe energy crisis for domestic consumption. The residents are bound to use easily accessible, low-cost biomass, in the form of agricultural crop residue and animal dung, which have adverse implications on the health of rural inhabitants and those who are directly involved in domestic fuel handling and consumption. The exploitation of such resources for domestic purposes poses a direct adverse impact on women's health who are directly exposed to the hazardous gas emissions, released from utilizing raw and low-quality domestic fuel. This research work was initiated with the purpose to examine the ill-health impact on the lives of rural women due to their long-term exposure to hazardous energy resources. Furthermore, social determinants were investigated for their association with the rate of exposure to gas emissions. Data collected from 480 women from three districts of Punjab province, was analyzed by using multivariate regression models such as (mediation, moderation and interaction). Odd ratios for agricultural waste, wood and dung showed a significant correlation for various diseases. Long-term exposure to hazardous gases emitted from domestic fuel burning was strongly associated with a higher risk of chronic diseases including, chest pain, coughing, asthma, allergy and stress level. The research work leads to the development of a policy framework for the uplift of rural women's health more effectively.

Keywords: air, pollution, energy, health, environment, women.

INTRODUCTION

Around the world 3 billion people use solid biomass fuel for heating, cooking and other purposes (World Health Organization, 2006). In Asia, more than 1.2 billion people use biomass fuel (Qasim et al., 2013). The percentage of using biomass fuel for domestic purposes in Pakistan is 67% (World Health Organization, 2006). In 11 developing countries like Pakistan, the traditional biomass fuel smoke is responsible for 3 million deaths annually. The dependence on agricultural waste, wood and dung has a significant association with health outcomes. Even a traditional way of cooking gives an alarm to rural

people who spent most of their time in small and congested kitchens (Ezzati and Kammen, 2002). Biomass fuel smoke is responsible for serious health threats but very few people know about it. The most prominent names of these countries are Nepal, Mexico, Philippines, Viet Nam, India, Myanmar, Bangladesh and Pakistan. The energy situation in these countries was found very critical. While the world aims to move ahead with sustainable practices accompanied by United Nations presented 17 Sustainable Development Goals (SDGs), there is a complex relationship shared between the two SDGs, namely gender equality (SDG 5) and access to affordable and clean energy (SDG 7) (Shupler et al., 2021). There is a long persisting inequality within the households, making it unable for women to access affordable energy with adverse impacts on their health (Shyu, 2021). In rural households it was examined, that they have never been efficient actors; therefore, resource availability is performed through a bargaining way and is moulded by social and cultural norms (Musango et al., 2022; Shupler et al., 2021). Therefore, they practised negatively impacting health and resulting in concerns like asthma, breathing issues, lung cancer, irritation, cough, etc (Boudewijns et al., 2022).

Pakistan still has so many gaps to accomplish the energy requirements (International Energy Agency, 2013), these energy challenges and shortfalls exist at both domestic and commercial levels (Wakeela et al., 2016). Although many countries have found ways to create easy, accessible, and reliable energy sources, these are not applicable in Pakistan. One of the main factors is the climate of Pakistan (Santos Silva and Klasen, 2021). In Pakistan, only 31% population has access to modern fuels and 63% population relies on traditional fuels (International Energy Agency, 2013). Nearly 54% of wood, dung 18% and crop residues 14% used for cooking (Qasim et al., 2013). An inadequate supply of clean fuels creates hardships for rural population. As fulfilling their needs demands, it contributes to ill health with every passing day. Poverty is linked to rural people and forcing them to use lower-quality fuels including wood, dung and agriculture residues (Fatmi et al., 2010). Pakistan is facing these challenges due to its poor planning and population explosion especially on the rural side (Wakeela et al., 2016). A large number of people in rural areas in Pakistan depend on forests for their livelihood, fuelwood and shelter. In most rural areas, livestock and cattle farming is the most common profession followed and practised by rural households or those in the countryside (Ahmar et al., 2022). Therefore, this livestock holding appears to them as an opportunity that provides them with dairy products and meats and the availability of a sufficient amount of animal manure that can be used for fuel purposes (Belmin et al., 2022). It is also studied that most household expenditure is utilized on food commodities and rent, resulting in a very minimal amount left for choosing suitable fuel sources (Li et al., 2022). Mussida and Sciulli, (2022) mentioned that wealth distribution across the rural areas of Pakistan is low, and most of the population makes ends meet to accommodate their daily needs. In this case, the price fluctuations and economic recession directly affect their choice of modern or traditional fuels. In other words, it can say that forests satisfy the domestic energy needs of many especially the people who are living in northern areas. Consequently, forest depletion and degradation are major challenges (Food and Agricultural Organization, 2016). Therefore, rural households stick themselves to the traditional mediums; meanwhile, health continues to get influenced negatively (Drew et al., 2022). The burning of polluting fuels is linked to impacting the air quality and exposing household members to several non-communicable respiratory and cardiovascular diseases (Rahut et al., 2020). Moreover, in Pakistan, there are no parameters

for measuring the impacts of fossil-fuel burning as part of the cooking process. In most cases, the hazard limit is much higher than the Internationally described (Nawaz and Iqbal, 2020). Chest pain and cough remain the common symptoms demonstrating the ill impacts on health. Another study reported similar symptoms among biomass fuel users with high throat infection and irritation (World Bank Report, 2020). Shortness of breath alongside wheezing and dyspnea was also observed. Females were observed facing issues in breathing after they woke up (Shankar et al., 2020). However, it is studied that charcoal, compared to other biomass fuels, has relatively reduced adverse outcomes on health.

REVIEW OF LITERATURE

Situation in Punjab (Pakistan):

The rural population in Pakistan was reported at 62.56% and (World Bank collection of development indicators, 2021) Punjab is the largest province and more than half population lives in rural areas (Government of Pakistan, 2022). Poverty is a root cause for rural people of Punjab and they had a least socioeconomic status which push them to use traditional fuels. In rural Punjab, over 65% population spend less than 1% US$, whereas 23.5% population spend 0.5% US$ or less in a day. The primary economic sectors of Punjab are Agriculture, livestock and fishery. The majority of the population in rural Punjab relies on the agriculture sector, 85% female population depend on it (Asian Development Bank, 2014). The latest energy policy in Punjab was formulated by the Government of Pakistan in 2013 (National Energy Policy, 2013). The distribution of fuel and lighting expenditures depend on natural gas and electricity but rural Punjab has diverse mix sources of energy (agricultural waste, dung cakes, firewood, kerosene, LPG).

Health relevance of emissions:

Agricultural residues considered as cheapest fuel and their long-term smoke exposure becomes a cause of a wide range of health effects such as respiratory infections, breathing issues, chronic obstructive pulmonary disease (Jindal et al., 2012), tuberculosis (TB) (Behera and Aggarwal, 2010) and cataract (Lakshami, 2013). Likewise, particulate matter of wood fuel becomes the cause of headache, respiratory infections, eye diseases, asthma, coughing and breathing problems (United Nations Environmental Protection Agency, 2017). Similarly, the health outcomes are worse and very common with the use of dung cakes such as cardiac, irregular heart rhythms, cataracts, eye infections and breathing problems. Findings show that dung, wood and agricultural residues considered as cheapest sources and cause poor human health (Teertha, 2012). In other words, it can be said that acute and chronic health conditions have resulted from indoor air pollution (Akhtar et al., 2007). Inhalation of polluted smoke drives respiratory infection or diseases and hence increases mortality in various developing countries. And female death ratio in countries with poor socioeconomic status has occupied 5th and 6th highest places on the list (June et al., 2011; Noonan, 2010). Nearly 80, 000 deaths happen every year due to polluted indoor air and World Health Organization enlisted Pakistan as the most affected country (World Health Organization, 2018).

Women and gender equity in development theory:

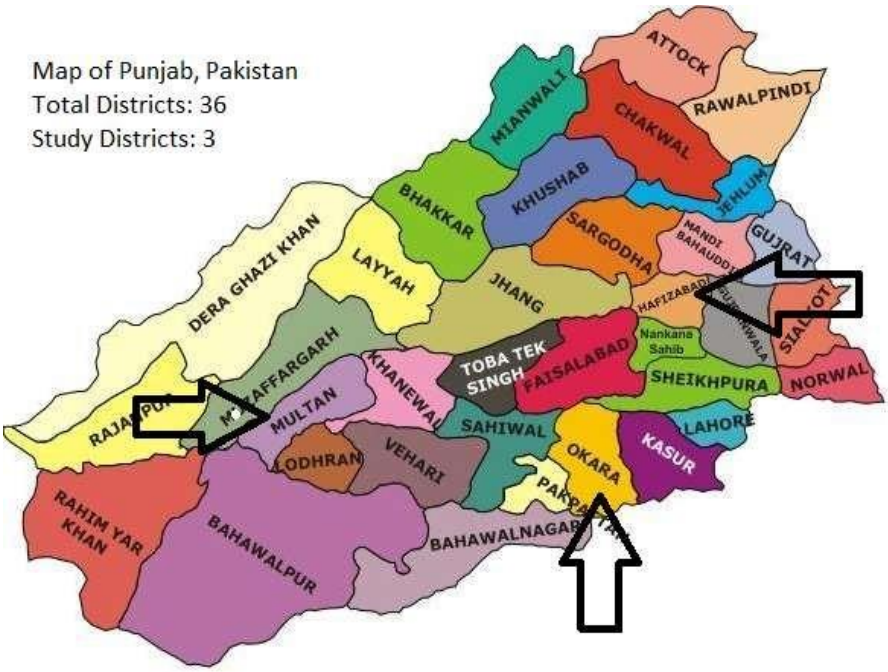
Gender plays a very significant role in energy source preferences. It's universal thought that females are mainly accountable for cooking (Baruah, 2017). Therefore, women also face unhealthy energy sources while cooking and in other households (Warnecke, 2015). Therefore, it is identified that the consideration of adult females in the household and negatively related

to firewood usage, inferring that a large number of adult women (Khavari et al., 2022). Firewood consumption is reducing the likelihood in households. It indicates that women are more worried about the harmful effects of consuming dirty fuels in daily house chores. It is identified in much research that women are more conscious about choosing effective energy sources compared to men (Alex et al., 2018). The current study identifies that women are positively concerned with clean, effective modern energy resources, likewise natural gas and LPG. Significantly studies find a risk between firewood and small kids' presence in household areas where is the usage of firewood. Small kids decrease the household's consumption of firewood (Falk and Hermle, 2018). Gender Equity theory is rooted in justice and equality among the genders based on economic, power, social, nutrition, and health among males and females. The theoretical practices account for delivering justified and equal opportunities for both genders (Musango, 2022). However, gender equity relatively fails to get practised because of the power dynamics. Using power and energy resources for the best purpose and support remains a troublesome issue for females. Due to economic and cultural barriers, their access to clean and energy-efficient resources remains limited (Listo, 2018).

The previous account indicated that indoor air pollution is linked with household biomass fuel use in Punjab (Pakistan). The link between biomass fuel use and health is well established in developing countries in general, and the connection is both direct (lack of better fuel and better health services) and indirect (awareness about fuel use and health-related issues). In Punjab, the female population is about half of the total population. A woman is responsible for looking after her family and taking care of all domestic activities. She collects fuel, cooks and serves food. But she is completely unaware of the environment that she breathes in. She inhales smoke that contains dangerous gases but she is not mindful of the fact that biomass smoke is dangerous for her. Studies explain that women's death due to heart diseases is double that of their male counterparts. Due to smoke exposure, she faces complications during pregnancy. In her everyday cooking, she suffers from eye issues (irritation, swelling, watering) and skin burns. Coughing, asthma and other respiratory diseases are all mainly suffered by rural women. In addition, her diseases go untreated due to inefficient physical and cultural access to health facilities. A few numbers of studies have been done over the last two decades in Pakistan regarding indoor air pollution, exposure to such pollutants and the effect of these on poor rural women's health. Many studies do not have a statistically representative approach to the population. The deficiency of the studies is lacking estimation of exposure level. Studies have been done previously not considered different variables like type of fuel and fuel use hours, location and ventilation system. Therefore, the study takes into consideration all these variables and develops a way for determining the level of indoor solution as well.

METHODOLOGY

The present study was employed in rural Punjab to estimate the health outcomes with the use of local fuels (agricultural residues, wood and dung) at domestic level. For this purpose, a cross-sectional study was designed and conducted in rural Punjab. In Pakistan, Punjab is the most populous province and has 36 districts (Pakistan Bureau of Statistics, 2022). For the present research, a multistage sampling technique was used to make an oversample of 480 women. In the first stage, three districts were selected randomly (Multan, Hafizabada and Okara).



In the next stage two tehsils from each district (Shuja Abad, Jalalpur Pir wala tehsils from Multan district), (Hafizabad, Pindi Bhatiyan tehsils from Hafizabad district) and (Depal Pur, Renala Khurd tehsils from Okara district) were selected randomly, then four villages from each tehsil were selected randomly and in the third stage four villages from each tehsil[1] were selected randomly and in the last stage, 20 women from each village were selected purposively. An interview schedule (in which most of the questions were close-ended) was developed for data collection. For the analysis, multivariate regression models (mediation, moderation and interaction) were taken out to regulate the relationship between independent and dependent variables and to estimate the level of significance.

RESULTS AND DISCUSSION

In social sciences analysis, it has worth evaluating the relationship between one dependent and numerous independent variables, while controlling for another set of variables that are potentially related to both the dependent and independent variables. So the purpose to use the multiple logistic regression model was to identify how the independent variables (other than biomass fuel) were useful to predict the relationship between fuel use and health outcomes and bring a variation in their relationship. The models were constructed in three different ways (mediation, moderation and interaction). These three models are different from each other and explain the role of predictor variables in different ways. The construction of hypotheses in this section was based on the role of predictor variables that further shaped a model.

[1] A Tehsil (Hindi pronunciation) also known as tahsil, taluka or taluk) is an administrative division in some countries of the Indian subcontinent that is usually translated to the township.

Hypothesis: 1

Alternative= The income-related breathing problem is attributed to the use of agricultural waste

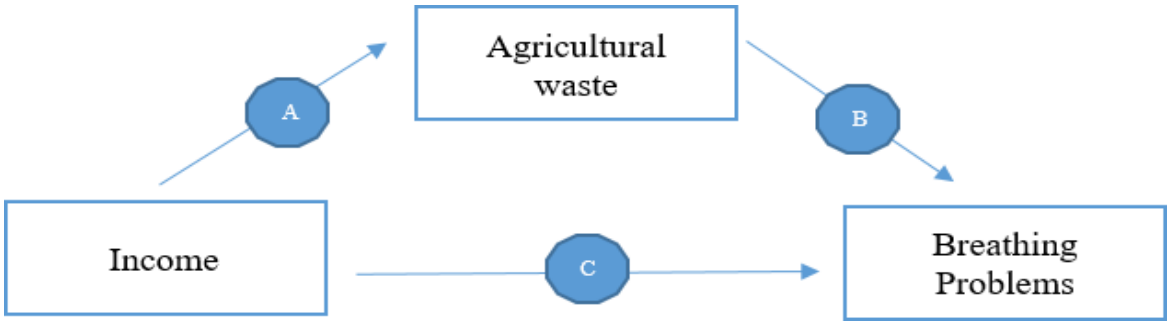


Figure-1: Graphical representation of mediation (Income, Agricultural waste and breathing problems)

Table-1: Mediating effect logistic regression (Income, Agricultural waste and breathing problem)

Mediating effect	Sig	OR
Breathing problems (Never)	.000	2.04
Breathing problems (Rarely)	.000	9.03
Income (Low)	.002	2.32
Income (Average)	.024	1.57
Agricultural waste	.000	9.66
Age (41 and above)	.000	3.40
Age (21 to 40)	.231	1.28

Hypothesis: 2

Alternative= Time spent in kitchen is related to the relationship between dung smoke and cardiac.

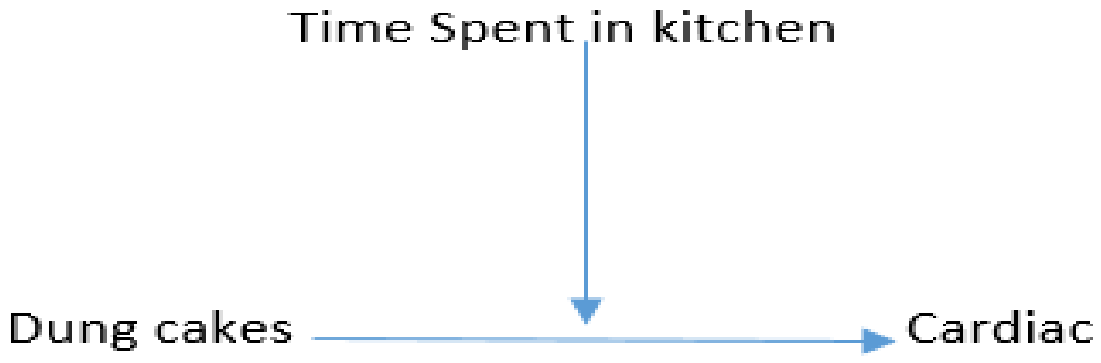


Figure-2: Graphical representation of moderation (time use, dung use and cardiac)

Table-2: Moderation in multiple regression model (time use, dung use and cardiac)

Moderation effect	Sig	OR
Cardiac (Never)	.005	2.55
Cardiac (Rarely)	.000	5.63
Dung cake	.008	4.31
Time spent in kitchen (4-6 hours)	.000	4.89
Dung cake*time spent in kitchen	.028	5.04
Age (41 and above)	.000	0.41
Age (20 to 40)	.443	1.17
Income (Low)	.034	0.55
Income (Average)	.000	0.36

Hypothesis:3

Alternative= The use of wood in a living room affects coughing.

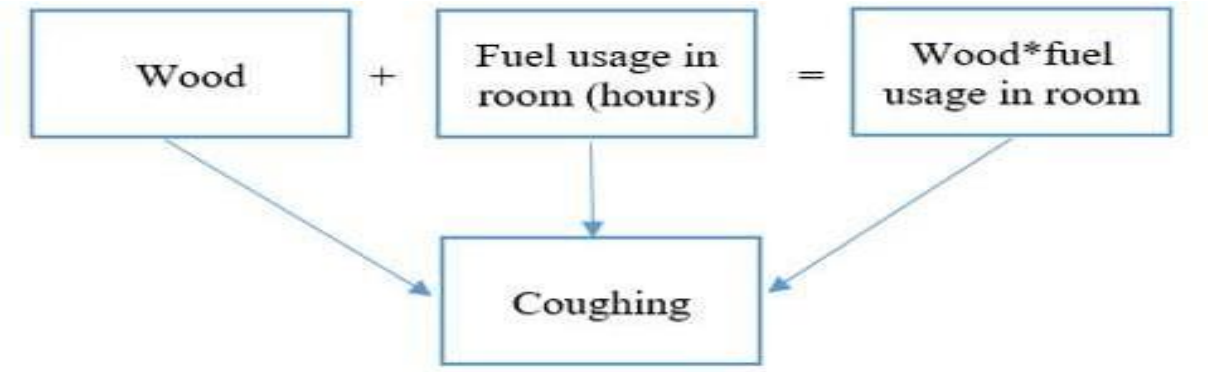


Figure-3: Graphical representation of interaction (wood, usage duration and cough)

Table-3: Interaction in multiple regression model (wood, usage duration and cough)

Interaction	Sig	OR
Coughing (Never)	.000	2.68
Coughing (Rarely)	.000	13.27
Wood	.029	1.70
Fuel usage in rooms (4-6 hours)	.010	1.91
Wood*fuel usage in rooms (4-6 hours)	.005	4.39
Age (41 and above)	.000	3.34
Age (20 to 40)	.132	1.37
Income (Low)	.000	2.61
Income (Average)	.004	1.79

DISCUSSION

The obtained result shows there are three pathways within the model. Path "A" describes the connection between income and fuel use, and path "B" explains the connection between fuel use and health outcome, with age as a control variable. The most path "C" presents the connection between income and

health outcome. there's strong evidence that income plays a serious role in physiological state status and also the selection of fuel depends on the amount of income similarly the selection of fuel encompasses a relationship with health status. For this purpose, a hypothesis was generated that the connection between income and health outcomes is mediated by agriculture waste use. This table shows that the chances of more frequent breathing problems are higher within the low and average-income groups compared to the high-income group. The percentages of more frequent breathing problems within the low-income group are over double (2.32) that of the high-income group, and about 1.5 times as high within the average income group (1.57) compared to the high-income group. Similarly, agricultural waste is related to increased odds (9.66) of more frequent breathing problems, with a P-value (.000). The association between income and fuel use, also generalized "Energy ladder theory", which explained the people's use better fuel as their income increases, and therefore the choice of biomass fuel only depends on their low income. There's also an assumption that peoples with high incomes face fewer health risks compared to people with low incomes. The fuel utilized in this model accounts for significant variation between income and health outcomes explains the fuel used here presents a partial mediating role and worked here as a control variable.

The results of the second hypothesis were drawn with a moderator relationship. The Moderator hypothesis is supported if the moderation effect is significant. It had been assumed that the moderation effect includes a significant relationship with cardiac keeping others as control variables. Within the second table, dung cake is an independent variable, the moderator variable is time spent within the kitchen and therefore the dependent variable is cardiac. The moderator variable has two categories, where category 1 represents time 4-6 hours spent within the kitchen and category 2 the (omitted category) represents 7-9 hours within the kitchen. Findings show that dung use is significantly associated with cardiac and time spent within the kitchen significantly moderated that relationship. Results indicate that the effect of dung use on cardiac is different depending on time spent within the kitchen. The odds ratio (4.31) indicates that dung use increases the percentages of higher cardiac category, or having more frequent cardiac disease, by a factor of 4, while the percentages of cardiac disease are about 5 times greater for those women who spend 7-9 hours within the kitchen. The interaction between dung cake and time spent within the kitchen is critical, suggesting that the chances of getting a more frequent cardiac disease by a factor of 5 when dung cake is used and women spend 7-9 hours within the kitchen. The results of this model indicate that the connection between fuel use (dung cake) and cardiac is moderated by time spent within the kitchen controlling for age and income.

Fuel usage plays an important role in human life and its demand changes seasonally. Fuel usage becomes hazardous when we use them for longer hours for cooking, lighting or heating with poor ventilation. In rural Punjab where biomass fuel is used for cooking, it uses in rooms for heating in winter. The third table analyzed the hypothesis, that was generated to explain the relationship between the interaction effect (Wood*fuel usage in the room) and coughing. It was assumed that the interaction variable has a significant relationship with coughing keeping others as control variables. The results of the third model showed a significant association between the interaction variable and coughing. The odds of having more frequent coughing increase by nearly two-fold (OR =1.70) with the use of wood and about two-fold (OR=1.91) with fuel usage in the room (7-9 hours). Before the interaction, the use of wood and fuel usage in the room was less significant with P-values (.029 and .010)

respectively. The odds ratio (4.39) indicates that the interaction variable increases the odds of being in a higher coughing category or having more frequent coughing, by nearly a factor of 5. The joint effect (wood*fuel usage in the room), shows a stronger significant relationship with coughing rather than their individual effect. So, the findings of this framework highlight the importance of wood with fuel usage in the room (7-9 hours) as the main predictor (interaction) in explaining the frequent coughing, keeping age and income as control variables. The interaction variable supports to rejection of the null hypothesis.

CONCLUSION

The present study concluded that women inhale less oxygen and more harmful gases which cause adverse health outcomes. It was found actually in rural areas that biomass fuel burns improperly in open fires causing peak levels of indoor air contamination domestically. These factors lead to many times higher exposure to indoor air pollution. Furthermore, medical studies and reviews strengthen the present study that explains the association between biomass smoke and poor health outcomes for rural women. This study gives us a basic foundation for the implication of solid policy. With the modernization of energy supplies and energy strategy, we can develop methods of more sustainable energy production. The study concludes that the strategy needs the provision of electricity and measures to overcome poverty. Females' poverty can be overcome by reducing cooking hours and education mediatory policies. Changing house structures such as separation of kitchen from living areas and proper ventilation through government subsidies alternative methods and affordability. It is time to resolve the problem regarding provide facilities of environment-friendly resources, and medical facilities and reviving females' health.

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