

An assessment of Risk Factors and Health Impacts Associated with Indoor Air Pollution and Tobacco Smoke in Lahore, Pakistan.

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Abstract:

Exposure to indoor air pollution and tobacco smoke has given rise to different risk factors and adverse health outcomes throughout the world especially in developing countries such as Pakistan. This study aimed to analyze the exposure of people of Lahore to secondhand smoke and indoor air pollutants to determine the risk factors along with the health impacts. An online questionnaire survey with a sample size of 208 was conducted in Lahore. The questionnaire consisted of 60 questions and was divided into five sections dealing with the respondent's profile, exposure to indoor air pollution and tobacco smoke, and health impacts. The results showed that out of 208 individuals, 33.2% of individuals rated their Indoor Air Quality as fine. While 30.8%, 8.2%, and 2.9% of individuals rated IAQ as good, bad, and poor, respectively. The percentage of non-smokers and active smokers was 90.1% and 9.1%. 50% of individuals considered headaches as the symptom of a major health concern due to exposure to IAP. 38% of individuals suffered from headaches while, 22.6%, 21.2%, 16.8%, and 15.9% of individuals suffered from coughing, sneezing, eye irritation, and runny nose because of exposure to IAP, respectively. There is a strong association between health impacts and exposure to indoor air pollution and tobacco smoke. Therefore, public awareness and proper mitigatory measures can play a role to prevent such risk factors and health impacts caused by IAP and tobacco smoke.

Keywords: Indoor air pollution, Tobacco smoke, Secondhand smoke, Health impacts.

Introduction:

Indoor Air Pollution has emerged as an alarming type of air pollution with several causing factors and health impacts associated with it. The factors of indoor air pollution include Environmental Tobacco Smoke, asbestos, radon gas, molds, dust mites, paints, and dust particles. The burning of conventional fuels for cooking purposes along with inappropriate conditions such as location of stoves and heaters (fireplaces) are also the leading factors of indoor air pollution in the form of CO₂ and Particulate Matter (PM 2.5) emissions (Junaid et al., 2018). Conventional cooking fuels may include animal dung, biomass, crop residues, coal, and domestic litter. The practice of using conventional cooking fuels is highly common in rural areas of developing countries where there is not enough supply and affordability of natural gas, liquefied petroleum gas, and stoves based on kerosene oil and electricity. The global progress in the innovative infrastructure is not sustainable in terms of indoor air pollution as it results in indoor air emissions due to paints and other construction materials consisting of asbestos and formaldehyde etc. Some natural risk factors also lead to poor indoor air quality i.e., dust mites, molds, Radon, and dust particles (Cao et al., 2015). Environmental tobacco smoke also called Second-hand smoke or Passive smoke is one of the major factors of indoor air pollution. Various tobacco products are used by the people which become the sources for the production of environmental tobacco smoke. The trend of environmental tobacco smoke is more dynamic in rural areas where people

ignorantly share the tobacco products among themselves which ultimately leads to more severe health impacts on non-smokers. Environmental tobacco smoke in urban areas is a significantly harmful indoor air pollutant as the homes in the cities are not spacious enough for the easy escape of this type of smoke (DiGiacomo et al., 2019). Globally, 4.5 million deaths occur annually due to indoor air pollution with the total contribution of 12%, 34%, 26%, 22%, and 6% to pneumonia, stroke, ischemic heart diseases, chronic obstructive pulmonary diseases, and lung cancer respectively (Amoatey et al., 2018). However, if the exposure to indoor air pollutants is short-term, the severity of existing asthma multiplies and may lead to hospital admittance (Ferguson et al., 2020). Worldwide, various studies have been conducted in developing (India, China, Bangladesh) and developed countries (USA, Russia) to assess the increasing and decreasing exposure rate of non-smokers to passive smoke due to the absence and presence of awareness, respectively. Also, some studies of these countries specifically target to assess the behavior of some smoker pregnant women towards the health impacts of passive smoking on non-smokers (Zhang et al., 2015). Other case studies describe various indoor air pollutants, and their health impact rates in these countries. According to World Health Organization (WHO), European region is highly exposed to this than all other regions in the world with 29% prevalence rate of tobacco usage above the 15 years of age (WHO, 2019). Exposure to second hand smoke has become another

leading cause of death. According to WHO, approximately 7 million people are dying every year due to the direct smoking while about 1.2 million people are dying every year due to the exposure of passive smoking. Each year 65,000 children are dying due to diseases caused by second hand smoke which is an alarming situation for the entire world (WHO, 2021). Several studies conducted in Pakistan show that conventional fuel burning is the main cause of indoor air pollution in Pakistan which leads to a number of related diseases. A study shows that children under the age of five in Pakistan are highly affected by indoor air pollution and are exposed to a higher rate of pneumonia i.e., 16.8% in the year 2012-2013 (Naz and Ghimire, 2020). With respect to outdoor air quality, Lahore is ranked the World's top city with the poorest air quality, therefore, the air conditions of the indoor environment are also not healthy in the city. In addition to cooking, cleaning and smoking practices which are primary sources of indoor air pollution, infiltration of particulate matter and hazardous aerosols from outdoor environment such as semi-urban and industrial zones are also the secondary contributors to the poor indoor air quality of Lahore city. Although, distinct stats regarding the morbidities and mortalities associated with poor indoor air quality of Lahore have not been identified, but it is possible that a significant proportion of deaths due to outdoor air pollution are attributed to indoor air pollution in Lahore (Colbeck et al., 2019). The present study makes an addition to the existing literature of Pakistan in the context of environmental tobacco smoke, other targeted indoor air pollutants, and their health effects. The main objectives of the study were to determine the existing contributing factors and health impacts of Indoor Air Pollution (IAP) in Lahore city, to analyze the level of Passive Smoking/ Environmental Tobacco Smoke (ETS) and other targeted Indoor Air Pollutants in Lahore, to evaluate the public awareness of the residents of Lahore regarding the cause and effect of IAP and the last objective was to provide numerical data related to the vulnerability of people to various diseases/health impacts caused by IAP in Lahore.

Materials and Method:

Sample Area

The primary area of study was Lahore city which lies in Punjab, Pakistan; however, a few responses were also obtained from other cities such as Islamabad, Sahiwal, Sheikhpura, Gujranwala, Multan, Dera Ghazi Khan and Hafiz-Abad in the province of Punjab, Pakistan.

Sample Size

The originally targeted sample size was 200 and by the end of this study, a total of 208 responses (n=208) were obtained.

Study Design

It was an observational study based on a questionnaire survey. Since the research was conducted

amid the outbreak of COVID-19, thus digital administration software of Google Forms was used to gather the responses. The time-frame of the study was 10 days, starting from 6 May, 2020 and ending on 16 May, 2020. Data from the willing participants both male and female, of average age group ranging from 15 to 40 years was collected.

Study Tool and Data Collection

This study was conducted based on a Survey in which the Questionnaire was used as a Research Tool. The questionnaire consisted of total 60 questions that were divided in 5 sections including information regarding personal profile, tobacco smoking, health impacts of tobacco smoking, indoor air pollutants, and health impacts of indoor air pollutants, respectively. The data was collected online and then analyzed using Microsoft Excel (2013 Version) to make graphs. The statistical analysis involved calculation of frequencies, percentages and mean value of the data collected from questionnaires.

Results:

Keeping in view the socio-demographic profile of studied population, results were recorded regarding the respective portions of the questionnaire. The results depict the state of occurrence of risk factors and health impacts of Indoor Air Pollution (IAP). From the recorded results, awareness, vulnerability of people can be evaluated.

Socio-Demographic

The obtained results had a percentage response of 57.2% females and 42.8% males with the respondents having a mean age of 21. About 95% of the people belonged to the city of Lahore, Punjab while only 5% of the responding people belonged to other areas in Punjab, Pakistan.

Tobacco Smoking

The responses (Table 1) showed that among relatives a very low percentage of 36.5% smokers exist and a high percentage is of non-smokers i.e., 63.5%. It has been indicated that 27.5% population has 0 smokers in their houses while 52% have 1 smoker, 12.2% have 2 smokers, 6.1% have 3 and 2% have 4 or more than 4 smokers. The most common form of smoking was Cigarettes with a percentage of 83.3%, followed by Hookah as the 2nd most common form of smoking in the indoor environment with a percentage of 7.4%. The other less common forms of smoking included Cigars, Shisha, E-Cigarettes with percentages of 3.7%, 2.8%, and 2.8%, respectively. Approximately, 50.7% and 61.2% of women and children are not exposed to cigarette smoke at all, 11.6% and 13.4% of 1 woman and child each are exposed to the smoke of a cigarette, 8.7% and 10.4% of 2 women and children are exposed to the smoke, respectively, 14.5% and 7.5% of 3 women and children are exposed to the smoke, 7.2% and 3% of 4 women and children are exposed to the tobacco smoke

Table 1: Exposure to Tobacco Smoking

Data	Options	Percentage
How would you rate the Indoor Air Quality (IAQ) of your home?	<ul style="list-style-type: none"> • Poor • Bad • Average • Fine • Good 	<ul style="list-style-type: none"> • 8.2% • 2.9% • 25% • 33.2% • 30.8%
Do you smoke tobacco/cigarette?	<ul style="list-style-type: none"> • Yes • No 	<ul style="list-style-type: none"> • 9.1% • 90.0%
Does anyone in your house or among relative's smoke tobacco/cigarette?	<ul style="list-style-type: none"> • Yes • No 	<ul style="list-style-type: none"> • 36.5% • 63.5%
How many numbers of people smoke?	<ul style="list-style-type: none"> • 0 • 1 • 2 • 3 • 4 or > 4 	<ul style="list-style-type: none"> • 27.5% • 52% • 12.2% • 6.1% • 2%
Which form of smoking is common in your house?	<ul style="list-style-type: none"> • Cigarettes • Cigars • Hookah • Shisha • E-Cigarettes 	<ul style="list-style-type: none"> • 83.3% • 3.7% • 7.4% • 2.8% • 2.8%
What is the frequency of smoking at your home?	<ul style="list-style-type: none"> • Daily • Weekly • Monthly • Less than Monthly 	<ul style="list-style-type: none"> • 72.2% • 4.4% • 7.8% • 15.6%
How many numbers of cigarettes are smoked per day?	<ul style="list-style-type: none"> • Less than 5 • 5-10 • More than 10 	<ul style="list-style-type: none"> • 51.7% • 32.2% • 16.1%
Which room is preferred for smoking in your house?	<ul style="list-style-type: none"> • Separate room • Common room • Outside the house 	<ul style="list-style-type: none"> • 32.2% • 23.3% • 44.4%
What is the level of exposure of nonsmokers to the cigarette smoke in your house?	<ul style="list-style-type: none"> • Not at all • Slight • Moderate • High • Extreme 	<ul style="list-style-type: none"> • 27.2% • 34.8% • 17.4% • 15.2% • 5.4%
What percentage of the day does the smoker typically spends in the house?	<ul style="list-style-type: none"> • 0– 25% • 51– 50% • 51 – 75% • 76 – 100% 	<ul style="list-style-type: none"> • 47.2% • 22.5% • 16.9% • 13.5%
Is there proper ventilation in your house?	<ul style="list-style-type: none"> • Yes • No 	<ul style="list-style-type: none"> • 90.4% • 9.6%

Health Impacts of Tobacco Smoking

The statistical analysis of the responses (Figure 1) showed that 8.2% of people agree that passive smoking can highly affect the health of their children. The 46.7% of the people responded to 'not at all' for this question which shows that the awareness level among people is still low. 20.5% of the people agreed that smoking can bring rare behavioral changes to the non-smoker. While 14.8% responded that smoking can bring behavioral changes occasionally. 54% of the people responded that they think

headache will be the major symptom of passive smoking, 42% response was recorded for symptom of coughing, 19% response for shortness of breath, and 18% response for eye irritation. 47.9% of the people responded that the respiratory issue is more in older people in their house, 19.8% of the people responded for adult women, 15.6% persons responded for adult men and 16.7% responded for children their houses having the respiratory issue. Shortness of breath can become a major health effect for 47.9% fraction of the people with old age

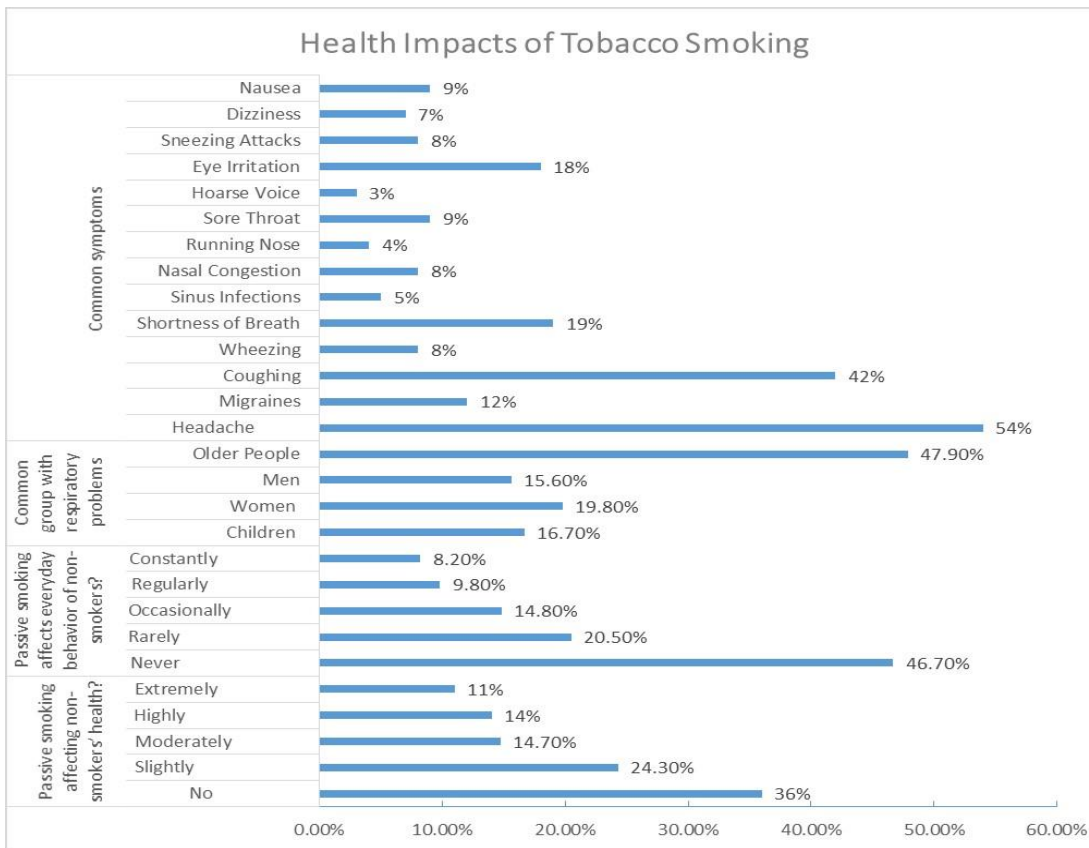


Figure 1: Health Impacts of Tobacco Smoking

Indoor Air Pollution

The results of the survey (Table 2) showed that 58% of people use brick during construction, 30% uses concrete and only 4.3% uses wood. Air fresheners are now frequently used in homes to keep the house atmosphere pleasant, but their excessive use can be dangerous for your health. About 38% of people use it occasionally, 36.1% of people use it rarely and only 8.2% of people use it regularly. 79.8% of people use natural pipeline gas which reduces the emission of harmful gases, only 4.8% people use LPG/LNG cylinders and 2.4% uses electricity along with the type of cooking approach there should be proper ventilation in the kitchen for which 53.8% people use exhaust fan a good approach, 26% people use windows, 11.1% use chimneys and 9.1% use an open kitchen. In winters, people use different methods or appliances to keep the temperature warmer of the house 57.2% use gas heater for this purpose, 34.1% use electric heaters, 6.3% use firewood and 2.4% use coal because of the lack of gas and electricity they have to use coal and firewood

Health Impacts of Indoor Air Pollution

The results (Figure 2) highlighted that dust affected 47.6% of the people under study and after dust, the pollutants that have more adverse health impacts are air fresheners. It is seen that the fuel used for the stove is the third major cause of diseases and health problems. A similar trend has been seen in the health aspects of children. Children's health is mostly being affected by the dust everywhere around and secondly by the air fresheners we frequently use. Among all the people it has been seen that the headache due to indoor air pollutants is the major health concern 79 people of 208 suffers from headache. The same is the case in children, they are more vulnerable to these adverse outcomes. Children majorly experience respiratory infections due to indoor air pollution. At the first question, though 69.7% of people say that they do not experience health issues due to indoor air pollutants but then after filling the answers to the rest of the questions 59.1% of people agreed that they feel bad air quality at their homes either rarely, occasionally, regularly, or constantly.

Table 2: Exposure to Indoor Air Pollutants

Data	Options	Percentage response
Where is your house located?	<ul style="list-style-type: none"> • Main Road • Inner Street/Society 	<ul style="list-style-type: none"> • 13.5% • 86.5%
How many windows does your house have?	<ul style="list-style-type: none"> • 6-8 windows • 8-10 windows • More than 10 windows 	<ul style="list-style-type: none"> • 61.1% • 15.4% • 23.6%
How frequently is your house painted?	<ul style="list-style-type: none"> • Every year • After few years • After every 6 months 	<ul style="list-style-type: none"> • 27.9% • 67.3% • 4.8%
Anyone feel breathing problems after the house is freshly painted?	<ul style="list-style-type: none"> • Yes • No 	<ul style="list-style-type: none"> • 31.3% • 68.8%
How often do you use air fresheners in your house?	<ul style="list-style-type: none"> • Never 1 • Rarely 2 • Occasionally 3 • Regularly 4 • Constantly 5 	<ul style="list-style-type: none"> • 15.4% • 36.1% • 38% • 8.2% • 2.4%
Which fuel type is commonly used in your house for cooking?	<ul style="list-style-type: none"> • Piped Natural Gas • Electricity • LPG/LNG Cylinders • Other 	<ul style="list-style-type: none"> • 79.8% • 2.4% • 4.8% • 17.8%
What kind of ventilation is in your kitchen?	<ul style="list-style-type: none"> • Chimneys • Exhaust Fans • Windows • Open Kitchen 	<ul style="list-style-type: none"> • 11.1% • 53.8% • 26% • 9.1%
How do you keep your house warm in winters?	<ul style="list-style-type: none"> • Firewood • Electric Heater • Gas Heater • Coal Burning 	<ul style="list-style-type: none"> • 6.3% • 34.1% • 57.2% • 2.4%
Are there any cracks in in the walls or floor of your house?	<ul style="list-style-type: none"> • Yes • No 	<ul style="list-style-type: none"> • 31.7% • 68.3%
If yes, then; What is the level of cracks in the walls or floor?	<ul style="list-style-type: none"> • Few • Many 	<ul style="list-style-type: none"> • 90.9% • 9.1%
Do you have proper maintenance of underground water pipes?	<ul style="list-style-type: none"> • Yes • No 	<ul style="list-style-type: none"> • 84.1% • 15.9%
Is there any kind of moisture and seepage in your house walls?	<ul style="list-style-type: none"> • Yes, not much • Yes, very much • No, not at all 	<ul style="list-style-type: none"> • 58.2% • 11.5% • 30.3%

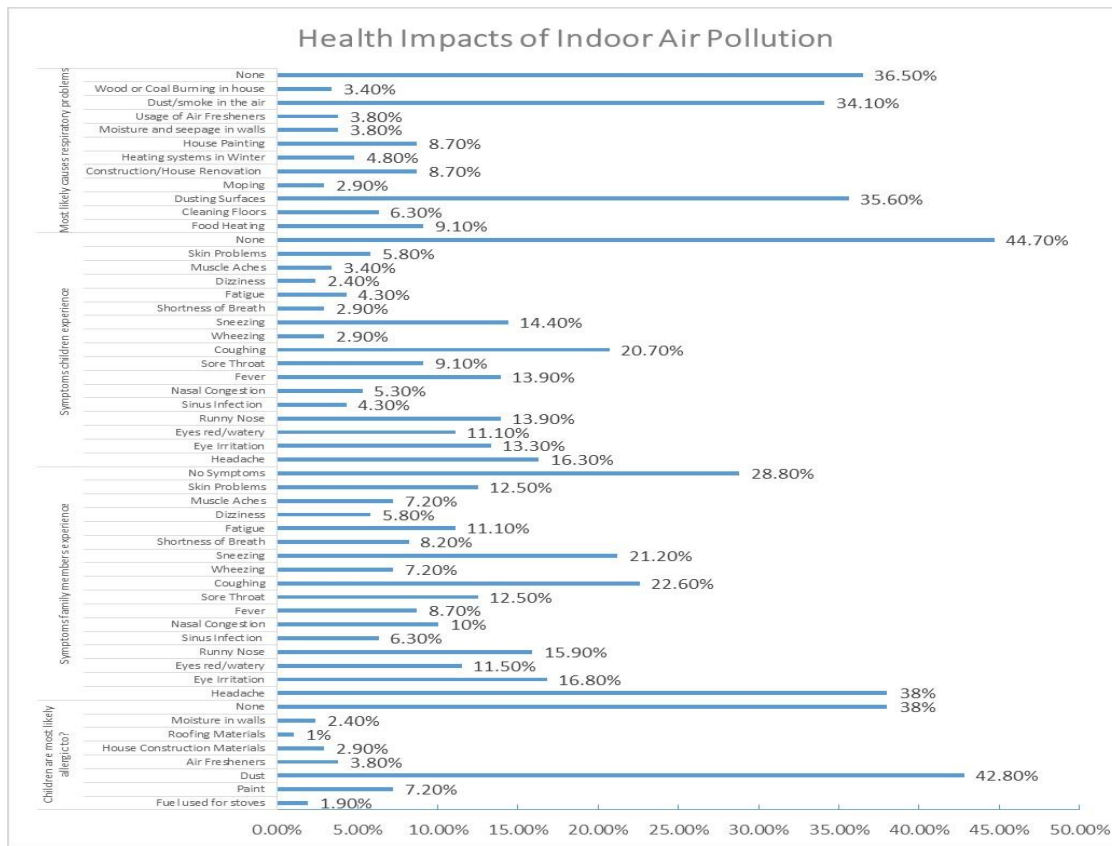


Figure 2: Health Impacts of Indoor Air Pollution

Discussion:

The evidence from the literature suggests that in developing countries the smoking through cigarettes is more common in males than in females which verifies the obtained data that the high non-smoker percentage was because the respondents were majorly female. The women and children in houses are adversely impacted and exposed by the passive smoke but the data in the present study gave an otherwise result due to lack of people's knowledge. A study in China showed that 65% of household women were exposed to Environmental Tobacco Smoke (ETS) (Zhang et al., 2015). Similarly, a study conducted in India gave results that 30% of women are directly exposed and affected by the passive smoke in their homes (Tripathy, 2020). The number of children exposed to China second hand smoke is 66%. While in India 44% of children are exposed to ETS in their homes (Mbulo et al., 2016). Another study was conducted in the district Kerala, India to estimate the impact of second hand smoke on adolescents and results showed that only 15.2% adolescents were exposed to second hand smoke in their home while 62.9% exposed to second hand smoke outside (Aswathy et al., 2021). The comparison of this exposure to passive smoke is rather low in developed

countries like the USA where it has been found out that the exposure of children to passive smoke in homes has declined drastically from 24.9% to 11.4% because of increased awareness regarding the dreadful impacts of tobacco smoking on the health of children (Zhang et al., 2018). Similarly, the overall exposure of non-smoking members to passive smoke has also greatly reduced from 87.5% to 25.2% owing to smoke prohibiting policies and laws, public awareness, and education in the context of the drastic repercussions of passive smoking on health (Tsai et al., 2018). People responded that 54% of non-smokers in their homes develop the symptom of headache due to passive smoking. On the other hand, 46% responded that passive smoking does not have any health effect on non-smoker women and children in their homes (Figure 1). This shows the low awareness among the public regarding the health impacts of smoking. Similarly, research was conducted in India (Jharkhand) to assess that the awareness level of pregnant women regarding secondhand smoking (Singh et al., 2015). The results showed that only 20% of pregnant women agreed that smoking done by them can have adverse health effects on the non-smokers while 80% denied this fact. Another study conducted in Bangladesh showed that 83% disagree that passive

smoking can affect children or women in their homes (Driezen et al., 2016). Whereas research conducted in Russia regarding the health impacts of tobacco smoking showed the optimum level of awareness among the women, i.e., 50% of smoker women agree about the health impacts of passive smoking on non-smokers (Inglik et al., 2019). The awareness level in Russia, which is a developed country, is thus quite suitable. According to recent study about 74.8% pregnant women expose to passive smoking which caused stunted growth in 40% children, 10% children grow with low birth weight (Astuti et al., 2020).

In literature, it is observed that indoor air pollution is mostly due to burning fuels (coal) and wood which are used for both cooking and heating purposes especially in rural areas of developing countries and women and children are badly exposed to it. A study conducted in Shanghai, China revealed that 30% population was exposed to polycyclic aromatic hydrocarbon (PAH) through the burning of fossil fuels and woods (Chen et al., 2019). A similar study was conducted in India which revealed that 80% population was exposed to solid fuels and in Pakistan, 86% population is exposed to fuels and wood (Junaid et al., 2018). In the present study, it was observed that the major cause of indoor air pollution is not the burning of fuelwood and coal, but it is dust from outdoor pollution and air fresheners because the data is collected from the most urbanized city of Pakistan, Lahore. In the developed world USA, only 8% of populations which are low-income people rely on solid fuel for cooking and heating purpose as people are highly aware of its bad impact on health (da Silva and Smith,

2019). In the USA the major sources of indoor air pollution are formaldehyde, dampness, and radon gas (Sharpe et al., 2020).

The literature of India suggests that the most prevalent health impacts of indoor pollution are respiratory infections including, bronchitis, lung cancer and pneumonia (Maharana et al., 2018), but the current study showed that the most prevalent health impact in Lahore is a headache due to dust, and the second most prevalent health issue is respiratory malfunctioning. The leading mortality cause in the developing world in children under 5 years is respiratory malfunctioning due to exposure to indoor air pollutants (Gordon et al., 2014). A trend similar to the literature of India was observed concerning the health impacts in children, the most common one being respiratory disorders. In developing countries like India, there were a huge number of premature deaths approx. 2 Million in a year related to indoor air pollution (Maharana et al., 2018). The major concern in a developed country, the USA is the formaldehyde release indoors from various home products (Logue et al., 2012) but still, the condition is not as worst as in the developing world due to the implication of effective policies and regulations (Orru et al., 2017). Indoor air pollutants especially cooking fuel that include coal imposes highly hazardous impact on women especially on pregnant woman in terms of premature birth, low birth weight etc. and especially on children below 5 years of age because their organs are developing at this stage so it may affect the immune system cause neurological disorder, stunted growth and severe respiratory problems (Ali et al., 2021).

Table 3. Comparative analysis of current study with other recent studies

Variable	Current Study	Literature		
		Study Area	Findings	Reference
Women exposure to passive smoking	42.0%	China	65.0%	(Zhang et al., 2015)
		India	30.0%	(Tripathy, 2020)
Children Exposure to passive smoking	34.3%	District Kerala, India	15.2%	(Aswathy et al., 2021)
		China	66.0%	(Mbulo et al., 2016).
		India	44.0%	
Impacts of Tobacco Smoking on non-smokers	54.0%	India (Jharkhand)	20.0%	(Singh et al., 2015).
		Russia	50.0%	(Inglik et al., 2019)
		Indonesia	74.8%	(Astuti et al., 2020).
Use of coal and wood as a fuel	4.8%	India	80.0%	(Junaid et al., 2018)
		Pakistan	86.0%	
		China	30.0%	(Chen et al., 2019).
		USA	8.0%	(da Silva and Smith, 2019)

Conclusion:

Our findings show that there is a strong association between health impacts and exposure to indoor air pollution and tobacco smoke. Non-smokers are highly vulnerable to different respiratory health outcomes as they are exposed to passive smoking. Similarly, people living indoors are exposed to IAP by different sources out of which one is conventional cooking practice, and the other is poor ventilation. The common symptoms such as consistency in headache, coughing, sneezing, and eye irritation can lead to the development of serious diseases such as tuberculosis, reduces lung function, respiratory and other cardiovascular diseases. Throughout this research, we have found that lack of awareness is a significant risk factor for developing such health outcomes due to exposure to IAP or passive smoking. If more and more people are aware of the association of their health with the indoor environment, people will move toward interventions to avoid the chances of developing such diseases. Moreover, public awareness, policies, and proper mitigatory measures can play a role to prevent such risk factors and health impacts caused by IAP and tobacco smoke.

Authors Contributions:

Aamna Naeem has designed the questionnaire and done final editing

Laiba Rafiq & Rubab Nazar have gathered all data

Maida Kashif & Syeda Hamayal Zahra Naqvi have written the manuscript.

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Conflict of Interest:

The authors declare that there is no conflict of interest with respect to the publication of this article.

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