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INDOOR AND OUTDOOR ENVIRONMENTAL POLLUTION AND CARCINOGENIC EFFECTS ON HEALTH IN PAKISTAN: A CASE STUDY

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KEY WORDS: Pollutants. Fuel. Wood. Indoor pollution. Outdoor pollution. Kerosene.Pollutants.

Abstract:

The air pollution in Pakistan is a great problem. In Urban and Rural areas The people use wood, biomass, kerosene, and burn grass and tree wood in winter. The vehicle, industries, preparation of bricks, the dust, mining industries, cooking, tobacco, cleaning carpets cleaning vehicles, wood working, all contribute to outdoor/ indoor pollution in environment. In winter 98% peoples in urban and rural areas burn wood, biomass, and gas heaters. Instead gas stoves for cooking are also used in villages and cities. The world- wide report on deaths have been recorded. The annual burden of diseases due to indoor and out- door air pollution amounts 22000 premature adult deaths, 163432 DALYS lost while that for indoor pollution amounts cases of acute respiratory infections and 28000 deaths / year have been recorded by WHO/EMRO, 2024, MDPI KAUSAR 2023. In Pakistan biomass fuel is used frequently. The biomass stoves are used all over Pakistan. Biomass fule in traditional stoves produce high level of indoor pollutants. In Pakistan 98% of Rural and 75% Urban households depend on biomass fuels. This study investigates variations in indoor/ outdoor concentration of particulate matter. During various activities for different micro environments in Pakistan, a rural site average indoor/outdoor ratio for PM2.5, PM2.10 and PM[1] in kitchens using biomass fules were 5.65, 6.26, and 6.92 respectively. A large variation was recorded in the

mass concentration of particulate matter during cooking with concentration in range 5000-8500 micron per million recorded by WHO. In a living room at a Rural site, the average indoor/outdoor ratio for PM2.5, PM2.10, PM[1] were 3.1, 4.3, and 4.9 respectively. As the Urban site, the average cleaning and smoking were identified as main contributers to the high indoor levels of particulate matter. This study showed considerably high concentrations of particulate matter in kitchens using biomass fuels as compared to living area. It is estimated that 24% of the global burden of diseases and 23% of deaths can be attributed to environment. About 36% of the burden affects children from 0-14 y. WHO estimated health observatory 200 deaths/ 120000 due to environment in Pakistan. In villages where access is not possible deaths rate is > WHO. Pakistan annual burden of diseases due to outdoor air pollution are 22000 premature adult deaths. 163432 DALYS lost, while indoor pollution amounts 40million cases of acute respiratory infections and 28000 deaths/y. WHO estimated 30 deaths /100000 are due to indoor pollution. About 25 deaths /100000 are due to out- door air pollution. The survey in villages of Sindh, Punjab, Azad Kashmir and Khyber area showed > deaths than estimated. It was found that > 40 deaths /100000 are in villages due to indoor pollution and > 30 due to out- door pollution.

According to WHO Pakistan falls within the group of least developed countries. In terms of water observatory and sanitation need major efforts to improve the sanitation. This category countries has identified five priorities for protecting the environment promoting healthy lifestyle and improving quality of life.

INTRODUCTION

Indoor and outdoor air pollution is harmful to health. According to WHO, EPA, IAQ and other research agencies about 2.4 million people world- wide , 1/3 of global population use open fires and stoves fueled by the biomass [wood, Animal dung, crop], coal and kerosene for cooking] . These burns activities produce several harmful indoor air pollution. The indoor air pollution has been responsible for > 4 million deaths/y. Including over 2 million deaths of children[under 5 y].The effect of indoor pollution were observed in the form of > 6 million premature deaths /A. Indoor air pollution has led to diseases such as pulmonary infections , lung infections, strokes, heart diseases chronic lung diseases. The women and children are Influenced by indoor cooking activities which have cause great health effects. EPA refer to IAQ within and around buildings. According to EPA indoor pollution cause major risks to the public health. The common indoor pollutants include CO, radon, pests, dust, mites, lead, smoke, bacteria, bioaerosole, increase humidity and precipitation level.

Metals as pollutant in environment: The Hg, Pb, come from gold mines. This contaminates locally produced grains and vegetables [Areena et al, 2024, Imtiaz, et al, 2023, WHO, 2004]. Exceed WHO limits. and posed a potential health risk. Pb and Cd from iron mines resulted in concentration of Cd in livestock and grains > acceptable limits [EPA , WHO, 2004]. Environmental contamination by Pb, Cd, CU, Zn contaminate crops exceeding maximum level[IN Romania, WHO, 2004]. In China a research was conducted on Cd from Zn smelter, contaminated leafs and roots of vegetables.

A comprehensive research was conducted on food contamination. Pb was taken first in Neelum valley where Pb is mined for industrial uses. Grains vegetables, and water samples were taken to examine contamination which was a great risk for health. The Pb in grains and water effect nervous system, and red blood cells of human living in the area. The peoples were examined and found that they were reduced in cognitive development and intellectual performance. Children deaths were recorded.The Cd in food and water affect renal tubular dys function , associated with high risk of lungs and breast cancer. Ar the carcinogen a contaminant affect dermal respiratory nervous mutagenic and carcinogenic effects has been recorded. The Ni in water and vegetables affect body weight, and feto -toxicity among pregnant women. 60-70 women and men were selected and examined to know the effects of carcinogen. The Hg was detected in peoples fell in cardiovascular disease, neurotoxicity nephrotoxicity, immune -toxicity and carcinogenicity.

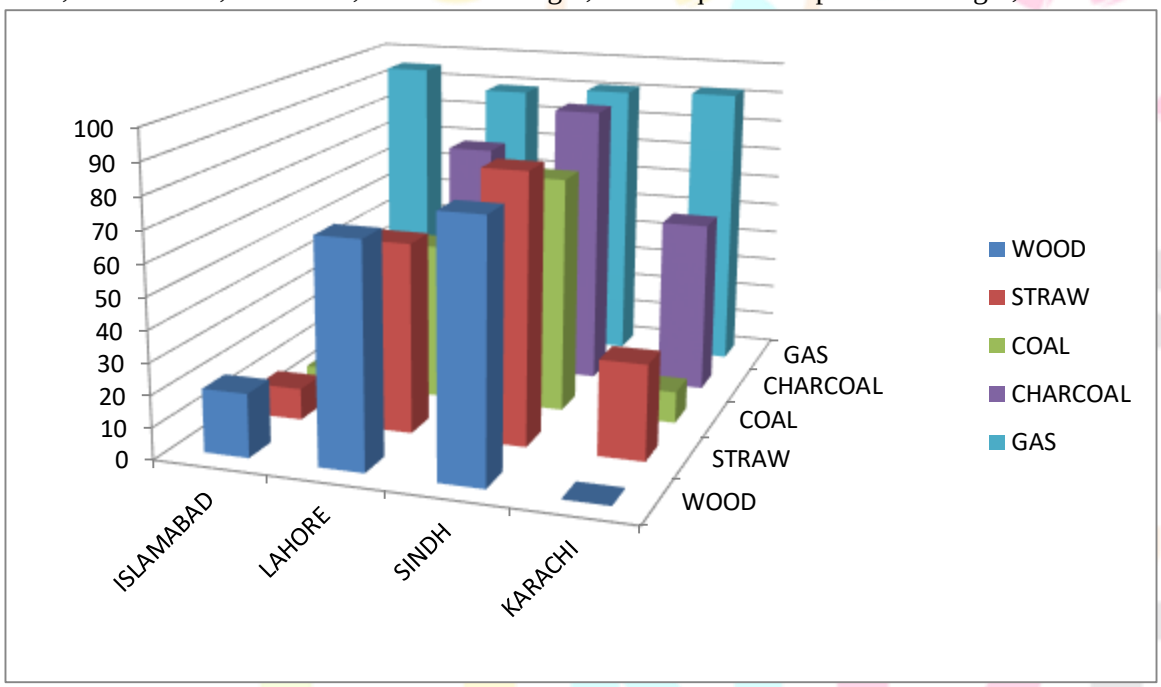
The region in Pakistan like Lahore in the living area smoking and seasonal changes P2.5 concentration is > 25 Um/m3 reported by [WHO, EPA, 2023]. In Karachi in resturants and clubs smoking, cooking, hospitals p2.5 concentration 25-390 Um/m3 was found [EPA, ASCO, WHO, 2022]. In rural areas of Pakistan in Kitchens indoor biomass burning pm10, pm2.5, pm[1] world- wide estimation is 4000-8555 Um/m3 [WHO, EPA, IAQ, 2023]. Rural/ Urban area of Pakistan PM2.5, PM10, PM10 > 50 Um/m3, PM2.5 > 25 Um/m3 [Ayesha et al, 2023, Colbeck, et al 2010, Nafees et al, 2021, WHO,EPA 2023]. Haripur City, was selected for investigation. Outside traffic contribute PM2.5, PM10, PM2.5 > 123.7-126.0 Um/m3, PM10 > 39.0-1663 Um/m3 [Aslam et al, 2022, Arif et al, 2021]. In Lahore, outside air due to industrial and traffic pollution, PM2.5, PM10, CO, NO2, SO3, highly contaminated air creating asthama and heart problems [Aslam et al, 2022].

In Northren Pakistan, living area kitchen, PM[1], PM2.5, PM10, concentration of POLYBROMINE 3377, 2305, 3567 was recorded [Qayyum et al, 2021, Colbeck et al, 2010, WHO/EPA, 2023]. In Rural area indoor dust exposure ingestion, di-phenyl poly chlorinated bi phenyl tri -2 butoxy-ethyl phosphate, were 16.2 mg/kg, Bw/day [Anwar et al, 2021, Khalid et al, 2022, Colbeck et al, 2010, WHO, 2023]. In Fasilabad, indoor, dust exposure, / ingestion polychlorinated, biphenyl concentration [Fig. 1] was found to, 34.39 mg/g, 9.94mg/g, 8.79 mg/g LFB [Khaja et al, 2020, Ahmed et al, 2018, Rafique et al, 2011, WHO/EPA, 2023]. In Rural region , unhealthy fuel, wood exposure, polychlorinated biphenyl, charcoal, coal, kerosene, indoor biomass fuel burning. Exposure to CO2, CO, was a cause of respiratory infections [Ahmed et al, 2018, WHO/EPA, 2023].

[impact of indoor pollution in Pakistan causes , Ayesha Kausar, Ishaq Ahmed, Tianlezhu, Hussain Shahzad [2023[3]2, 293-319]. [NLM, J Res Med SCI., 2016. Adel Ghorani -Azam Bamdad Riahi, Zanjani and Mahdi Bdali, MOOD, 2021].

SOLID FUELS:

In Pakistan in big cities like Islamabad, Rawalpindi, Lahore, Fasilabad, Sindh and Karachi the solid fules used affect peoples health, increasing indoor and outdoor pollutants, PM2.5, PM10. In villages peoples are unknown to environmental pollution or their effects on health. The Fig.1 indicates the use of Dung, Crop Waste, Wood, Charcoal, Coal, Non solid fuels, Kerosene, ethanol, methanol gas, liquefied petroleum gas, Natural gas and electricity.



Rawalpindi,-Islamabad, Lahore, Hyderabad Karachi

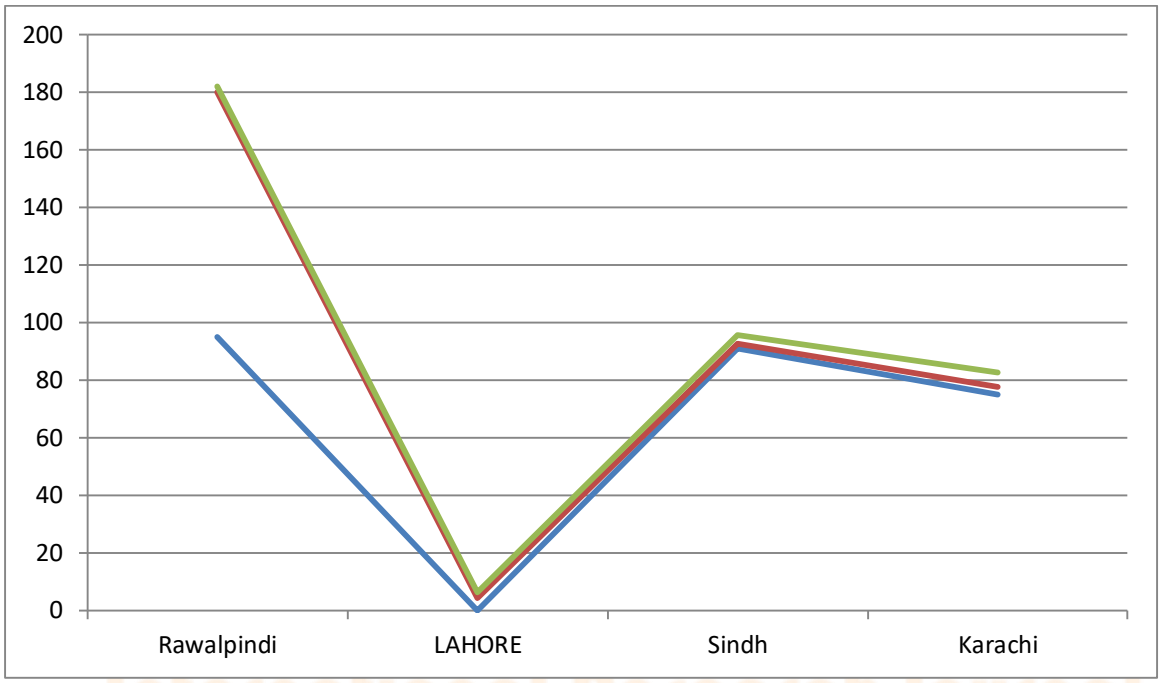
Fig. 1. Dung, Crop Waste, WoodCharcoal, Coal, Non- solid fules, Keerosene, ethnol, methanol, Gas, liquefied petroleum gas, Natural gas, Electricity used in big cities of Pakistan.

Indoor air pollution is one of the leading risk factors for premature deaths. Indoor air pollution is a great risk for deaths in poor countries [Hannah, R. Tchie and Max Roser, 2014, 2024 Revised]. The global distribution of deaths from indoor air pollution. The death rates estimated globally is > in low income countries. The poor countries cannot afford clean fuel. Mostly they use solid fuel , biomass, charcoal, coal, wood. Annual deaths from indoor air pollution increase in poor countries and declined in developed countries [Fig.1]. Data source IHME, 2021. The global burden of diseases is as follows:

Global burden of diseases	Deaths. 36% children deaths 0-14 y	WHO
Premature deaths 22000		28000
Deaths due to indoor pollution 30000/100000 Deaths due to outdoor pollution 25/100000		WHO estimated deaths 200/120000

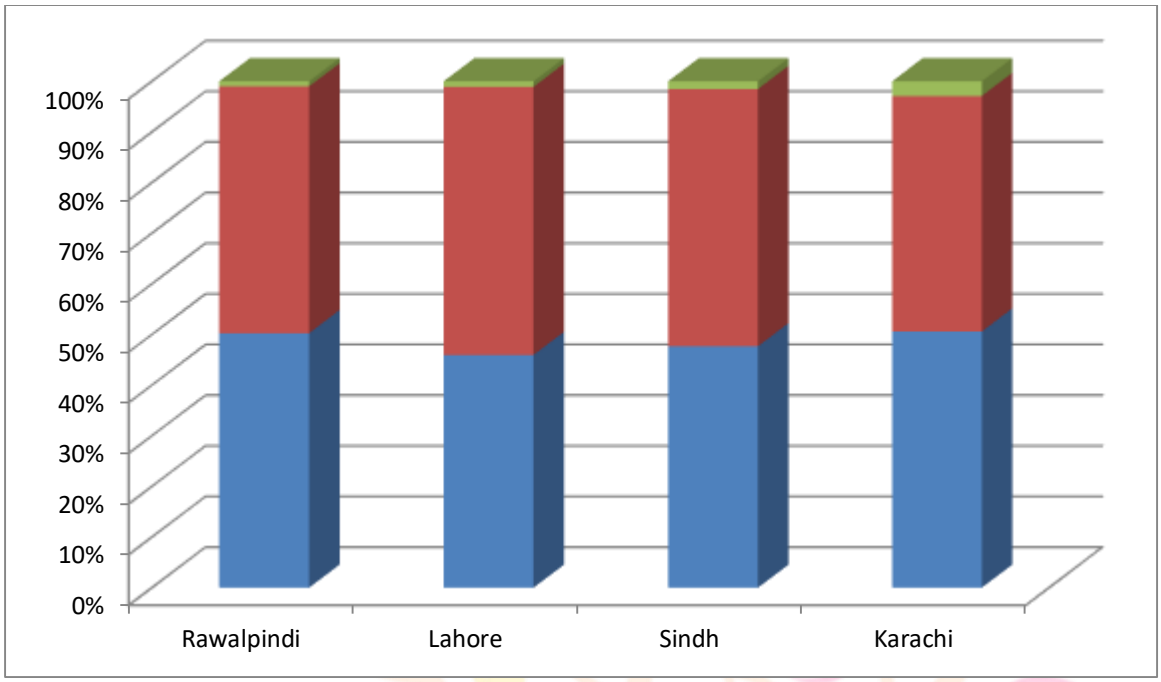
1990 1995 2000 2015 2010 2015 2021 202023

Fig.2. Global Burden of Diseases from 1990-2023 and deaths in millions in Countries where solid fuels are being used [Data



Source IMHE, 2024.

Fig.2. Global Burden of Diseases from 1990-2023 and deaths in millions in countries where solid fuels are being used[Data Source IMHE, 2024].



from indoor air pollution

Fig. 2. Deaths from indoor air pollution globally 1990 - 2023 in poor countries where solid fuel and biomass are mostly used. Clean fuel is not available [Data source IMHE 2024].

Indoor air pollution results from poor peoples where no access to clean cooking fuel is available. Indoor air pollution is mostly the result of burning of solid fuel such as wood crop wastes, dung, charcoal, coal,

for cooking and heating in households. In Sindh investigation in villages showed 100% use of wood and biomass for cooking. Burning these fuels produce particulate matter a major health risk. First quarter of the fig. show the major risk. The fourth quarter show the least. In countries like Pakistan where un cleaned fuel is used diseases like respiratory diseases are most common. A survey was conducted in Rawalpindi-Islamabad, Lahore, Hyderabad, Karachi, Nagarparker, Tharparker the villages of Sindh 1996-2023 and the data collected from other researchers , It was found that the burning of solid fuel in enclosed houses such as small houses is a major risk factor for such diseases. Low income people use solid fuel for cooking particularly in villages, because cleaner fuels are either unavailable or too expensive. Death rate and access to clean fuel are correlated. Air the people breath indoor is highly polluted with smoke, vapor, chemicals, furnishing, cleaners highly affect indoor air quality and health. Buildings we erect very closely and small space affect over all community living in [Khaja et al, 2020, WHO, 2020]. The most of the people have no space outside to breath in open air [USEPA, 2024]. They live throughout the day inside home. USEPA estimate Americans are indoor 90% spend their time in built environments such as houses, schools, workplaces, work-shopes or gyms.

The pollutants like smoking, burning, solid fuels, cooking and cleaning, vapors from building and construction material, equipment, furniture, biological contaminants like allergens, that can trigger immune system. Asbestos formarly used for making incombustible , fire proof building material such as roof shine siding, and insulation. In such places carcinogen like CO, Formdehyde, Pb, pesticides, radon, and smoke are risk for health [NIEHS, 2024, Areena, 2023, WHO,EPA, 2022].

ANALYSIS

About 3 billion people rely on solid fuel. 2.4 billion on biomass and the rest on coal [IEA, 2002, Smith Mehita and Feuz , 2004]. There is marked regional variation in solid fuel used. < 20% in Europe and central Asia and > 80 % in Africa. Solid fuel coal, kerosene , charcoal, is mostly used in poor countries. In Pakistan 90%, Urban areas 70-80% in Rural Sindh.

Lahore 50-80%, Karachi 40-75%, Islamabad 10-50%, Rawalpindi 50-80%. Azad Kashmir 98%. In a new survey contucted and data collected is as in Table-2.

Table-2. Solid Fuel used in Urban and Rural areas in Pakistan and Azad Kashmir.

	Karachi	Sindh	Lahore	Islamabad	Rawalpindi
Wood	20-30	80	70	20	50
Straw	30	85	60	10	60
Charcoal	10	75	50	5	55
Coal	55	90	75	35	85
Gas	92	91	89	95	86

- 20% in Europe and central Asia, > 80 % in Africa solid fuel, coal, kerosene, charcoal, mostly used in poor countries. In Pakistan 90% urban areas, 70-80 % in rural Sindh, Lahore 50-80%, Karachi 40-Pollution level in different parts of Pakistan75%, Islamabad 10-50%, Rawalpindi 50-80%, Azad Kashmir 98% [Fig.3].

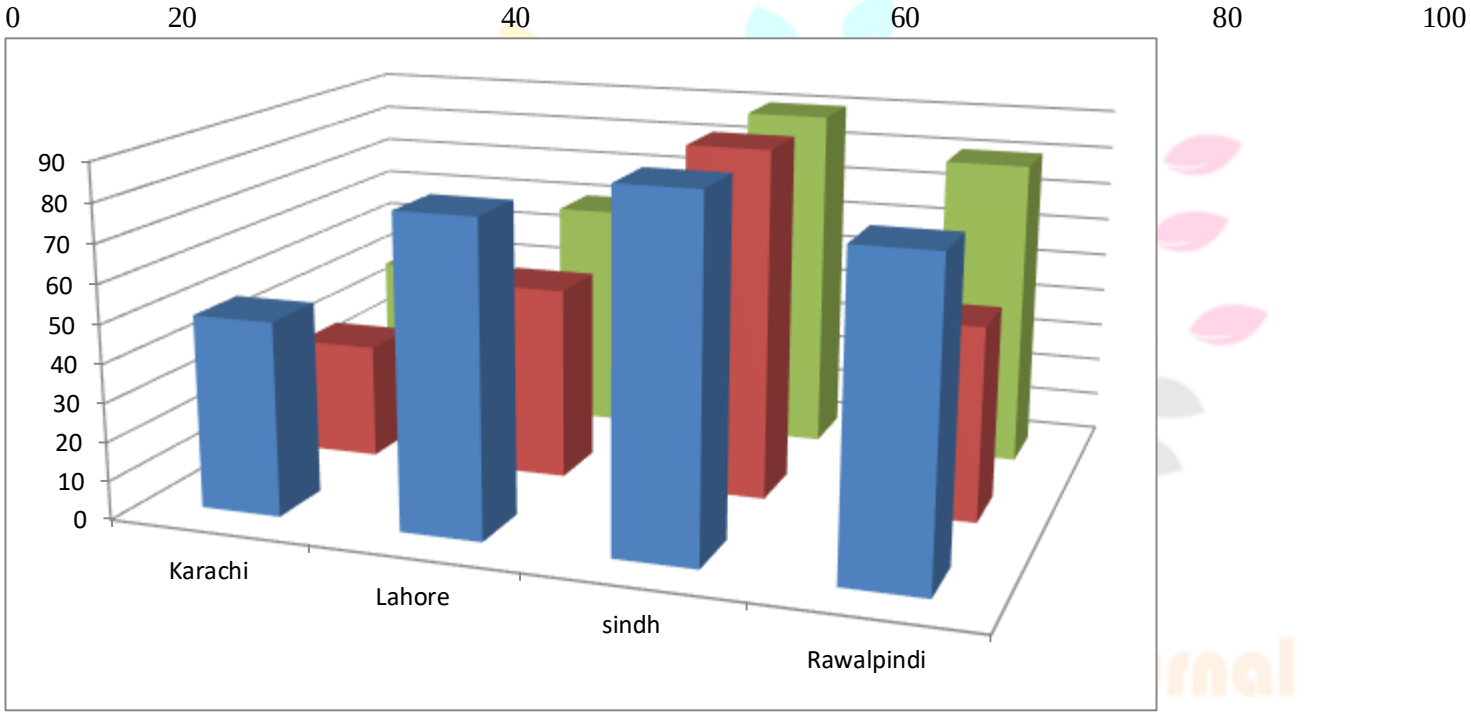


Fig. 3. Pollution Level in Different parts of Pakistan and Azad Kashmir.

Solid Fuel Used in Pakistan Urban and Rural areas. > 5 million people use wood, 4.5 million coal, biomass charcoal, 4.3 million gas, coal, wood, 2 million gas, coal and wood [Smith, 1978, WHO, EPA,2022].

Household energy is not available in Pakistan, India, Africa, where 80% people use fire wood. LPG available is only 9% peoples. Level of biomass and coal smoke emit many health damaging pollutants including particulate matter PM CO, SO4, NO2, NO3,, ALDEHYDE, BENZENE, AND POLYAROMATIC compounds[Smith, 1978]. Pollutants affect the lungs by causing inflammation reduced cleanness [Fig. 4].

Fig.4. show pollution level in kitchen and living rooms and distance of kitchen from living rooms sand the effect of pollution in living rooms.

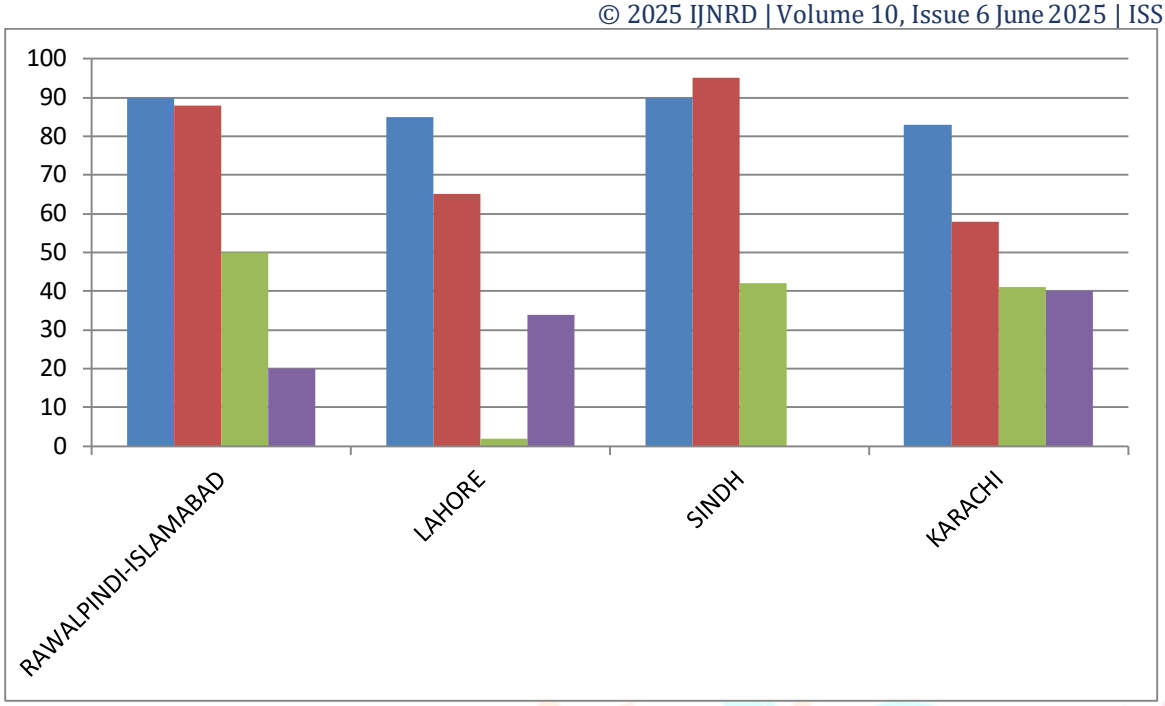


Fig. 4. Show pollution concentration in Rawalpindi, Islamabad, Lahore, Sindh, and Karachi. The fig . also show clearance which improve immune.

Table-3. Worldwide distribution of pollution and ranking of countries according to WHO and EPA Ranking. Also Ranking of Pakistani cities.

CITY	AQI	Pakistan cleanest city ranking . CITY	AQI	COUNTRY	POLLUTION
Multan	236	Abbottabad	162	Bangladesh	169,356,251
Lahore	229	Islamabad	172	Pakistan	160
Peshawar	218	Haripur	173	Indi	147
Rawalpindi	212	Karachi	187	Tajikistan	134
Karachi	176	Rawalpindi	205	Burkino Faso	128
Haripur	172	Peshawar	218	Iraq	121
Islamabad	172	Multan	260	United Arab Emrat	119
Abbottabad	156	Lahore	270	Nepal	118
				Egypt	118
				Congo	114
				Beijing	176
Abbottabad	PM2.5	cleanest	City	India	China, Iran, Afghanistan
Lahore	PM2.5	MOST POLLUTANT	CITY	Sizeable	Pollution

Pakistan is a country located in South Asia highly polluted i.e 13.7 [WHO , EPA, Smith, Khalid, et al, 2022 VALUE PM2.5 X 13.7]. Cleanest city is Abbottabad, Lahore the most polluted city PM2.5 182 [WHO, 2023, EPA, 2022]. India , China, Iran, Afghanistan all of which have sizeable pollution problems of their own. In 2019 Pakistan come in with PM2.5 rating. Hyderabad 5.5 moderate, 5.5 X WHO. I n Pakistan outdoor air pollution deaths are > 22000. Adult deaths and 1634432 DALYS[Table-3].

METHODOLOGY:

To find the presence of indoor air pollution readings of PM2.5 was used. The ordinary least square [OLS] method was used for data generation. The study found that indoor air pollution has a significant impact on physical and behavioral health symptoms. The study found that house hold head age, house size, income, environment and the use of air cleaning device are countable. The variables like age, education and income affect environment were tools to find the air quality. In door air quality is one to keep health good [Mubasher et al, 2023, Anjum et al, 2021, Aslam et al, 2022, Nafees et al, 2012]. In Pakistan the PM range is 4000-9000 Um/m3. In rural/Ur ban regions indoor smoking leads to high PM2.5 level ~ 1800 Um/m3 which can cause infections [WHO, EPAIAQ, 2023].

IAP a convenient sampling technique has been used and for sample selection Yamanes formula was used.

N = N/1+Ne2 where n is the sample size. N IS Population size. E is precession set at 0.05.

Total NO of population n = 758832/ 1+ 758832[0.05]2 = 399.78 =400 household were selected for data collection. This is an example for data collection. 1000 houses were selected from each city and 700 from each village to calculate air quality. A questionnaire was designed for household to answer to know income socioeconomic and environmental awareness of residents, education, economic condition, daily expenditure, salary of each person, use of fuel, quality of fuel, ventilation, cleaning system, smoking, use of stoves and their quality, cooking time, and many other factors were considered. Air quality meter was used to collection of data using PM2.5. The reading goes to 40 Um/m3 for 3 hours. The air quality was noted as unhealthy. This environment cause very difficult problems for peoples living in this environment. IAP calculations suggest that < 35 has no pollution. It was noted that some people were also effected in the pollution level , <35. Probably the reason is they use different environments in changing places from one room to other or different portions of household. It was also noted that different parts of houses have different level of environment. For example kitchen is > 35,, and outside the kitchen the environment is< 35. The combined effect of both environment effect the health of the people. Environment awareness has been measured by using 5 point like t-scale that contain 5 items used by Noor -din and Sulaiman. Cronbach,s alpha has been used to measure the reliability of data on environment concern and awareness. The Cron-bach,s value should be > 0.70. [kausar et al, 2021, WHO/EPA, Qayyum et al, 2021, Khalid et al, 2022].

Determination of Lagistic Model: Pi = f[b0 +bi xi = 1/ 1+ e-b0+bixi where

Xi - probability of ith household. X = vector of explanatory variable. E = Natural log.

MODEL DIAGRAM

Household Head Education
Kitchen Location

Head age

House Size

Income

Area of Residence

House Status

Environmental Awareness

Environmental Concern

IDOOOOR AIR POLLUTION

Cooking Hours

Use of Unclean Fuel

Presence of Ventilation

Use of air cleaning device

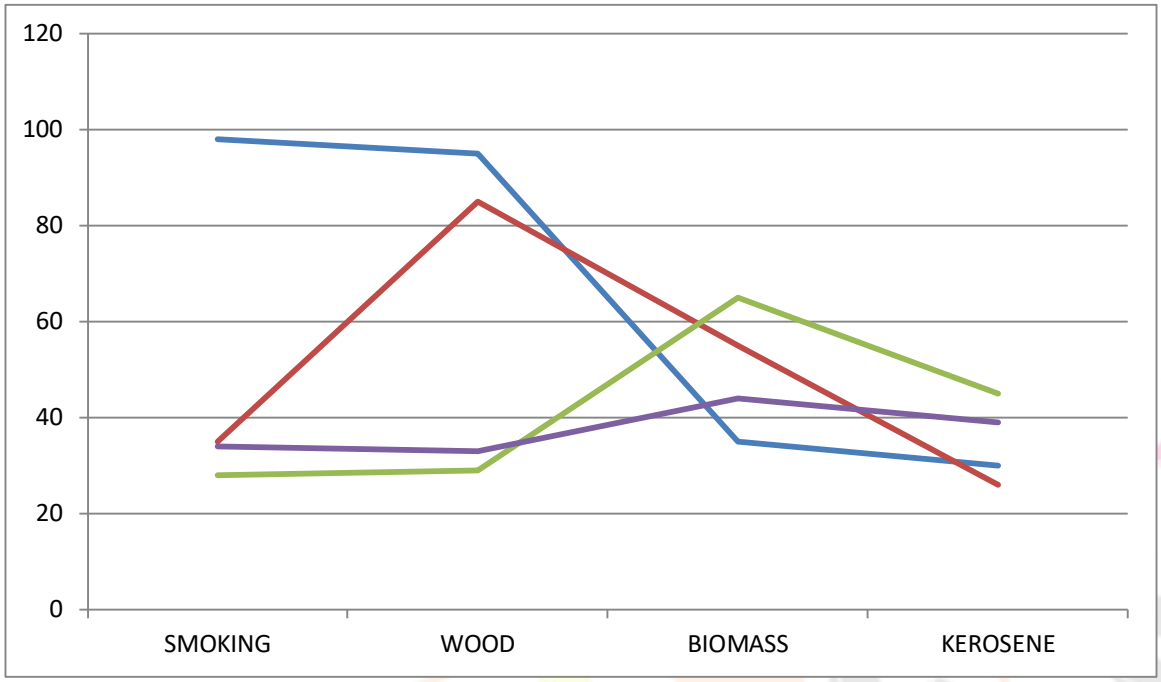
Live stock at home

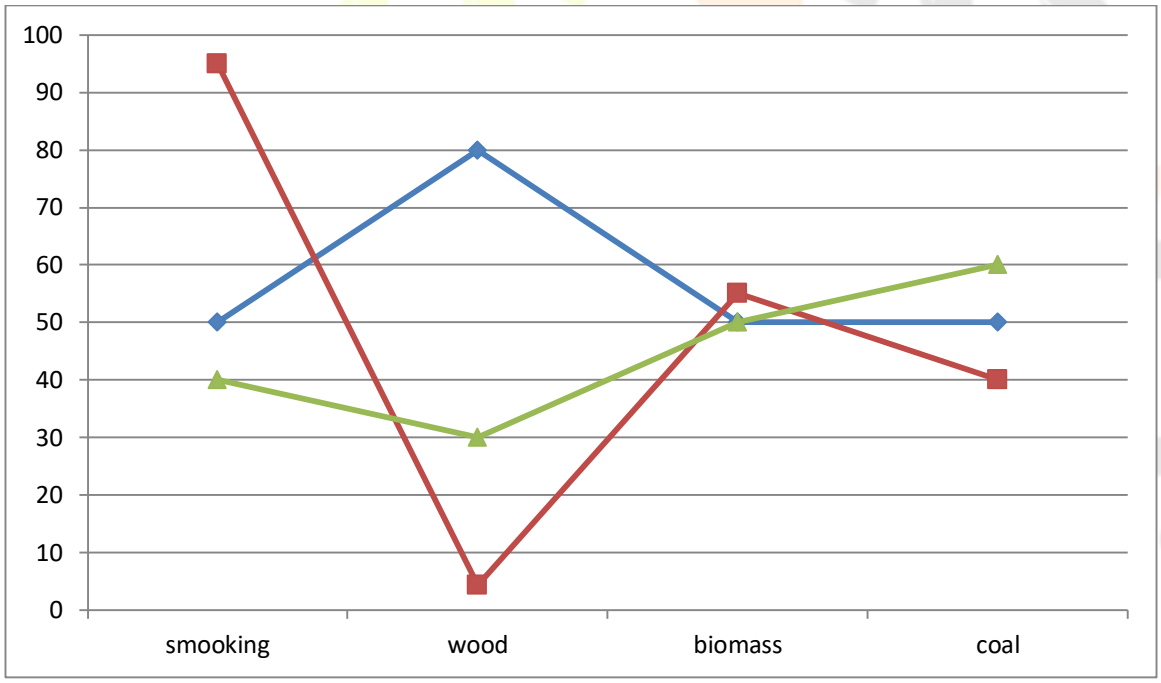
Smoking

[Kausar et al 2021],

RESULTS

Indoor air quality in Pakistan is not satisfactory. The results of this research show various kinds of particles in air which are high risk for human health. The presence of CO2 in air is converting indoor gas in CO reducing oxygen and create respiratory problems. The Pb in indoor air attack nervous system and red blood cells reduce in cognitive development and intellectual performance. Death among children. In cold areas PM CO, SO2, NO2 and Pb were major indoor pollutants. Air pollutants in cities, urban and rural areas are higher than WHO standards. The chemical gases, elements and vapors in indoor environment and workplaces create mental discomfort, respiratory and skin complications and health risk. The WHO safe standards are 150-200 Ug/m3. The indoor concentration of PM2.5 and PM10 should remain 25 Ug/m3 and 50 Ug/m3. In Pakistan [IAQ] in rural areas and big cities indoor air pollution is VERY HIGH.





Hig Except Bangladesh.

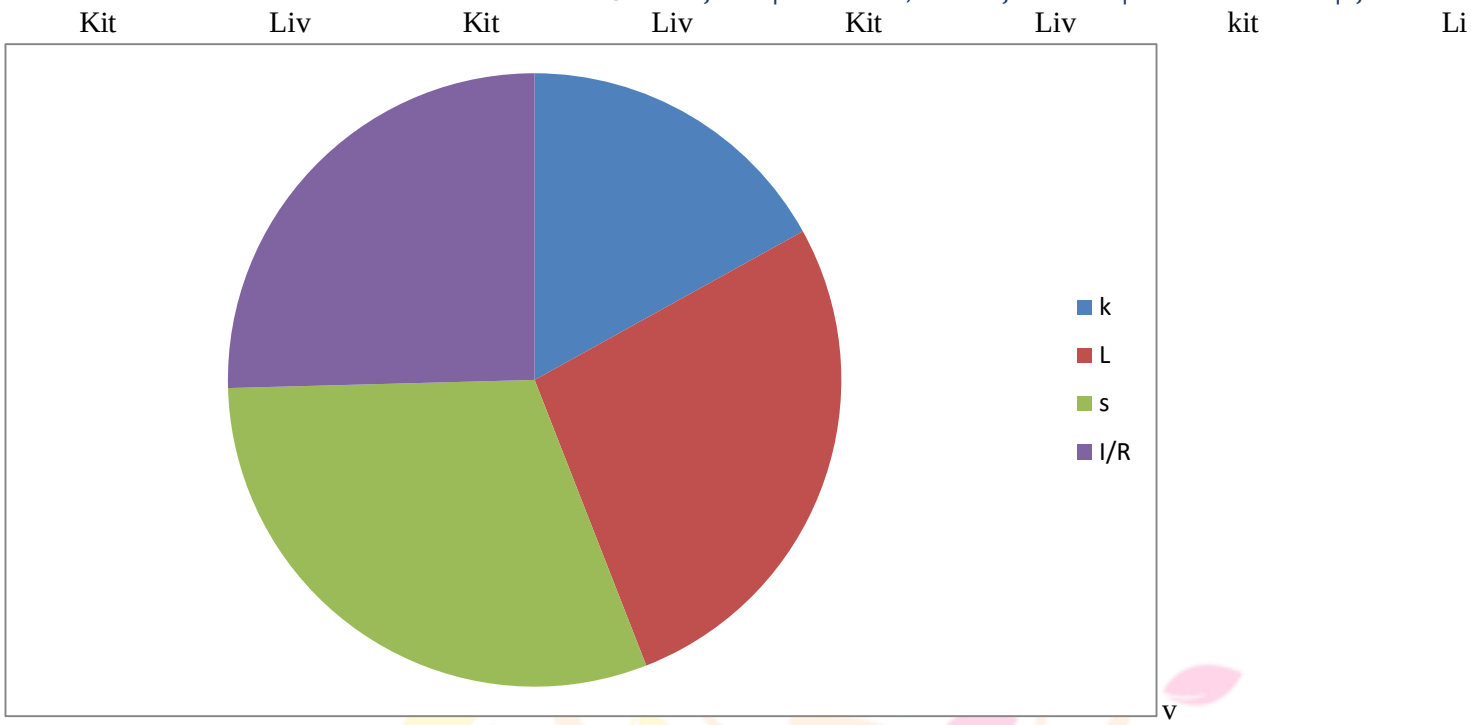


Fig.5. show frequency of pollutants in kitchen and living rooms.

The micro organisms/ microflora which is the major source of toxins in the indoor environment

PM2.5 were measured using [DUST TRACK M-8520]. Temperature and humidity along with CO2, NO2, SO2 were recorded using gas prob IAQ [BW Techniques]. The temperature was 10- 20 C0 in kitchin and in living room the temperature was 8-12C0. Humidity was 15-60%. Using the methodology of RR Research Repository the dominant bacterial species 375-35.4% have been recorded in kitchen and living rooms [RR, 2021][Fig. 5, Table-4]. The classification by RR is as follows.

Table-4. Classification of Pollution level by RR Globally and ranking of countries by pollution level.

Small *	*<	** = Medium		***=large	
	126.5 m2	> 126.5 m2	To 253 m2	>253 m2	Source RR 2021
Indoor Air Pollutants	CO	CO2	SO2	NO2	NO3
	O3	VOC	SMOKE	PM COX	DUST
IAQ	GOOD HEALTH	NO DUST	GOOD HEALTH		

RR [2021]. Bioaerosols and Microflora major sources of indoor pollution,

IAP a convenient sampling technique has been used and for sample selection Yamane,s Formula was used. N = N/1+Ne2 where n = sample size. N =population size. E = level of precession set at 0.05. Total no. of population n = 1000 household were considered and data was collected using questionnaire, covering household economic and environmental conditions . AIR QUALITY METER WAS USED FOR COLLECTING DATA. Using PM2.5 level goes to 35 Ug/m3 for two hour the air quality was found to be unhealthy can cause health issue. < 35 was considered neutral. Environmental awareness was measured using 5 point Likert scale that contain 5 items as used by Noordin and Sulaiman 2021. Ronbach,s Alpha has been used to measure reliability of data on environmental awareness. Cronbach,s alpha value > 0.70. Value of EC FOUND TO BE 0.703 and EA = 0.737 using derivation of Lagistic Model [Deda et al, Abdel Salam, 2021].

Using Pictorial representation of Binary Lagestic regression results it was found that if EC increase IPA will decrease. EA increase IAP decrease. The Indoor Air Quality Guidelines by WHO were adopted for this research.

Table -5. Show WHO and USEPA Guidelines for indoor/ outdoor pollution level for living and the use of healthy fuel. It also indicate living time in different environments.

Pollutants	Concentration Level mg/m3	Exposure Time	Organization
CO	100	15 MIN	WHO
	60	30min	
	30	1h	
	10	8h	
	29	1h	USEPA
	10	8h	USEPA
CO2	1800	1h	WHO
NO2	0.4 0.15	1h 24h	WHO
	0.1	1year	USEPA
PM	0.15]0.05	24h 1year	USEPA
O3	0.15-0.2 0.1-0.12	1h 8h	WHO
	0.235	1h	USEPA
SO2	0.5 0.35	10m 1h	WHO
Pb Xylene	0.005-0.001 0.0015 8	1y 3 months 24h	WHO USEPA WHO
Formalhydde	0.1	30min	WHO
Radon	100 Bq/m3	1year	WHO

Indoor Air Quality Guidelines for chemicals, gases, and carcinogen by WHO and USEPA 2024

OXIDATIVE CAPACITY OF INDOOR ENVIRONMENT

The oxidative capacity less explored in indoor environment. Recent studies confidently explored indoor oxidants . It was supposed that O3 the hydroxal [`Vinh Van Tran, Duckshin Park and Young -Chu Lee, 2020]. Envir. Res. Public Health. International, Jour.PP-27]. The comparative study indicates that Pakistan and South East Asian Countries [India, Nepal Siri-Lanka, Bhutan], the CO2, NO2, SO2, O3, Pb, PM and PM2.5 pollutants Pakistan was found > WHO Guidelines as compared to Bangladesh, Siri-Lanka, Bhutan. In Pakistan PM2.5 Exposure was 58.3 Ug/m3 in 2017. The mean annual exposure to PM2.5 Pakistan is on top. Building material hap-hazardly excavation is the major source and is > WHO. The material generated from brick stones , concrete, asbestos , paints, dyes, carpet, cleaner, floor board, sticking panels and sources for cancer risk. The wall, floor, roof coatings, paints, the VOC level is 50-100% in Azad Kashmir. Radon from soil, gravel, sands, bricks is in the range of 171-649 m BQ /m2h. Toxicologically, Pakistani environment is bacterial, fungel, and algal in exterior and interior of buildings. Humidity and temperature were recorded also using gas probe IAQ 4158 [BW] technologies LTD. Mississauga Canada. Indoor temperature was 20-30 C0 and humidity was 55-70%. Bacteria was recorded as 16780 Cfu /m3. The size range 60-90%. The cooking, smoking, cleaning, and outdoor polluted air the indoor bacteria concentration increases. Biosole and PM were recorded in kitchen and living rooms. Ventilation was consisted for IAQ in interior and exterior. It was noted that bioaerosol and PM2.5 were high in Rawalpindi, Lahore, Karachi and Azad Kashmir in winter season [Table-5].

It was noted in all Pakistan that in residential areas bioaerosol airborne micro- organisms, and diseases were high in residential area and outside environment. Indoor pollution is the result of building material, furniture, indoor inhabitants, air

from outside, indoor animals/pets, produce large amount of bacteria, bio-aerosol, [Fungi] hidden killer mostly in Pakistan [Mukhtar et al, 2020]. The genus Aspergillus of Fungi was predominant contaminent that caused serious health effects [Mukhtar et al, 2020]. The bio-aerosol were recorded in side houses, café, hospitals, laboratories, water courses, the places where sunrays are nor approachable, dark rooms, installations, locked rooms. ANDERSON VIABLE IMPACTOR was also used for indoor and outdoor recording bio-aerosol. The impactor was designed for study particles of various sizes. CO2 concentration was recorded Gas-probe. Temperature was considered important in this case. It was observed that Bio-aerosol and micro-flora are main source of indoor air pollution.

DISCUSSION AND CONCLUSION

The indoor air pollution is a hidden killer in rural and urban areas of Pakistan. In Lahore indoor pollution is > WHO and EPA. The use of wood, biomass, cooking, smoking, furniture, paints are contributing to indoor air pollution. In Azad Kashmir 95% peoples burn wood, biomass. Only 5% use kerosene or electricity. This is possible only for those living in cities and can afford burden of kerosene. Burning the wood add biomass increase CO,O3, CO2, NO2, SO2. The roasting bread, use of cooking oil, increase chemical in indoor air. Micro-flora , the major source of toxins in the indoor environment. PM2.5 were measured using [DUST TRAK M-8520], temperature, Humidity, and CO2 were measured. During burning and cooking the temperature was high in kitchen but in living rooms it was comparatively low. In the corners fungi was observed and recorded in living rooms. Percentage of bacterial species was high in living but > WHO in kitchen. The [RR] classify bio-aerosol and bacteria as: *small < 126.5 m2, ** Medium > 126.5 m2-253 m2, *** large > 253 m2 [Research Repository, 2020]. In cold regions like Rawalakot, Muzaffarabad, Bagh Plandri and Kahuta PM CO, SO2, NO2, VOC, O3, Pb, were major indoor pollutants. Pollutants are higher than WHO Guidelines. It was noted in cold areas of Pakistan and Azad Kashmir mental disorder, respiratory, skin complications, low workability, asthma, nose irritation, eye infactions pain in knees, foot pain and lungs infactions were common. These are great health risk for human. WHO Guide lines are: Safe concentration 150-200Ug/m3. Indoor concentration : PM2.5, PM10, 25 Ug/m3, 50 Ug/m3. In Rural and Urban areas of Pakistan the main sources of indoor pollution in residential buildings, educational and work places, directly effect human health [IAQ, 2023]. According to WHO indoor air pollution may effect 4-5 million people per year world wide[WHO, IAQ, EPA, 2023]. The people in rural and urban cities pass their time 90% indoor. The home activity, construction material, out door activities and air pollution are major source of indoor pollution. The pollutants identified as PMNOXIOUS, gases, bacteria, Fungi, insects, in kitchens, living rooms and work places [WHO, IAQ, EPA, 2023]. Major gases are CO, CO2, NO2, NO3, SO2, Pb, Radon, volatile organic matter, carbonaceous aerosol, bacterial aerosol, micro-flora, [bacteria, virus, Fungi], and pesticides, bleach, bath cleaner, insects killer, processed foods, meats, and kitchen kept are common health effect sources observed indoor. These pollutants disturb respiratory system, allergic diseases, lung cancer, nervous system damage, kidney cancer And cardiovascular diseases.

The indoor air quality depend on indoor air pollutants. The classification by IAQ monitoring committee, WHO, EPA, 2024 and other researchers is as under:

INDOOR AIR POLLUTION	INDOOR AIR QUALITY [IAQ]
CO, CO2, SO2, NO2, NO3	GOOD HEALTH
O3, VOC, SMOOK, PMCOX	NO DUST
DUST	GOOD HEALTH

The PM2.5 and PM10 are contaminant are indoor air pollutants. In Lahore city area the PM2.5 HIGH accumulation in outdoor air contaminate indoor air WHO, 2019, 2020]. WHO standards PM2.5 are 25 ug/m3. The industrial growth, traffic, seasonal changes rise indoor pollution. PM pollution rise in air is also due to excessive burning of plant residues [Nafees et al 2020] investigated the rise of PM2.5 level n restaurants, cafes, clubs in Karachi. PM2.5 range was 25-390 Ug/m3. Smoking, in public gathering, use of biomass fuel in kitchen in rural and semi urban areas increase health risk [Colbeck et al 2020]. The use of biomass in kitchen increase the concentration of PM10, PM2.5, PM1 as 3.80-4.36, 4.11. Using GRIMM Spectrometer Model 1.108+1.101 [GRIMM], aerosol Technik Gmbh, Ain ring Germany] +_ 2.1. It was noted that high concentration level was 4000-8555 Ug/m3. [PM WHO Standards are PM10 50 Ug/m3, PM2.5 25 Ug/m3]. The Youngteng

Yt-hpc 3000a handle particulate counter was used to measure PM2.5, PM10. Sensors were installed in these devices automatically detected PM level. Permissible limits are phosphate and triphenylPM2.5, PM10 35 Ug/m3 and 150 Ug/m3 [EPA, 2024]. The average concentration 23.7-126 Ug/m3. PM10 39.0-166.9 Ug/m3 [EPA, WHO, Colbec et al, 2020]. The number of patients in hospitals were counted for each disease. Asthama patients in Lahore 64% in 2020 EPA, WHO, 2020] and 75 % in Sindh, EPA, WHO, 2024 Khan et al 2024]. The patients were mostly femail those working indoor. Jiao et al studied PM1, PM10, PM2.5 and the values were 3377, 2305, 3567.35 Ug/m3 > EPA causing great health risk. Adult dust ingestion level was ~ 0.65-15.2 mg/kg/day[Khalid et al, 2020]. Khalid et al found polychlorinated biphenyl tri [2 butoxy-ethyl] phosphate and tri-phenyl phosphate in indoor dust as main organic pollutants in the dust in Lahore, Fasilabad, and Bahawalpur. The estimated amount was 34.39, 9.94, 8.79 ng/g in Lahore,Faisalabad and Bahawalpur [Khalid et al 2020]. But in recent study it raised to 38.21, 11.86, and 12.36 ng/g in Lahore, Faisalabad and Bahawalpur. The dust ingestion caused skin damage, liver damage, gastrointestinal diseases, immune and nervous system damage and cancer risk increase in inhabitants of the area.

The indoor pollution cause the following:

*74 million deaths /year, including 2 million deaths of children [under 5 year].

* > 6 million premature deaths per annaum.

*create diseases like pulmonary infections, lung cancer, strokes, heart diseases, chronic lungs diseases.

*Women and children effected by indoor cooling which caused great health effects.

*EPA refers IAQ within and around buildings. According to EPA the indoor pollution can cause major environmental risk to public health. The common indoor pollutants are CO, Radon, Pests, Dust, Lead, Smoke, Bacteria, Bio-aerosol, Humidity, precipitation.

*Caused eye irritation, nasal itching, throat rashing, headaches, fatigue, dizziness and asthma [short term].

*Long term chronic heart diseases cause cancer.

*Unhealthy fuel usage can create ~ 6% lung cancer[EPA, WHO, 2024].

*Attach kitchens with living rooms effect adults and child deaths about 145 deaths/1000 live briths

*80 deaths / 1000 women due to indoor kitchen fuels.

CONCLUSIONS

1-Unhealthy fuels are very risky for human and children health

2-Kitchen attached with living rooms are very dangerous for health

3-In Azad Kashmir 98% peoples use wood which cause cancer

4-Biomass is mostly used in villages like Sindh, Punjab, and Karachi which is a cause of cancer.

5-kerosene is little used in Azad Kashmir because of its high price but any where used was a risk for health.

It is concluded that indoor and outdoor pollution be reduced by using healthy fuels. The poor peoples should be helped by govt. providing 100% healthy fuel. Govt. should reduce fuel prices for all Pakistan. In the poor country where people can not afford their living the Govt. should provide facilities to the peoples to reduce diseases.

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