IMPACT OF BRICK KILN EMISSIONS ON CHILDREN'S COGNITIVE ABILITIES

A CASE STUDY OF DISTRICT PESHAWAR

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CERTIFICATE

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List of Abbreviations

AD	Alzheimer ’s disease
BTK	Bull Trench kiln
CA	Cognitive Ability
CO_2	Carbon Dioxide
CO	Carbon Monoxide
EPA	Environmental Protection Agency
EPAM	Environmental Particulate Air Monitoring
GHG	Green House Gas
HEAL	Health and Environmental Alliance
NO_X	Nitrogen Oxide
NO_2	Nitrogen Dioxide
O_3	Ozone
OLS	Ordinary Least Square
PM	Particulate Matter
PCSIR	Pakistan Council of Scientific and Industrial Research
Pb	Lead
SPM	Suspended Particulate Matter
SO_X	Sulphur Oxide
SO_2	Sulphur Dioxide
SLR	Sri Lankan Rupee
TSPM	Total Suspended Particulate Matter
USD	Dollar of United States
WHO	World Health Organization
$\mu g/m^3$	Microgram per cubic meter

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ABSTRACT

Air pollution from different sources has many consequences on the society especially in the developing countries. One of these consequences is the adverse impact on physical health of the people in the form of different diseases borne due to emissions from these sources which imposes both direct cost i.e. monetary cost as well as indirect cost (by reducing productivity in the future). These emissions not only affect physical health but also cognitive abilities of children living in polluted areas. This study estimates the impact of PM_{10} emitted from brick kiln on the children's cognitive abilities. Results showed that the level of PM_{10} was higher i.e 247 $\mu g/m_3$ in the brick kiln area (within 3 km radius) compared to 63 $\mu g/m_3$ in the unaffected area (away from 3 km). Using Raven-test scores to measure the cognitive skills of children aged 5-12 year, this study examines the impact of distance from brick kilns, treatment area and PM_{10} on cognitive abilities of children. Results show that the cognitive ability of children living in treatment (affected area) was significantly lower by 0.93 SD compared to unaffected children. Similarly, an increase of one µg/m3 in the value of PM_{10} reduces the cognitive ability by 0.006 SD. Consequently, using back of envelope calculation, we find that these children in the affected areas are likely to experience a reduction of around 20 percent in future wages due the detrimental effect of brick kiln pollution on their cognitive development.

Keywords: Air Pollution, Brick kilns, Particulate Matter, Cognitive Ability

Chapter 1
INTRODUCTION

1.1 BACKGROUND

Air pollution is a rapidly growing environmental issue and its impacts on health have been discussed in vast literature. The main causes of air pollution are the rapid increase in the demand of energy resources, increase in urbanization which has led to increase in the number of vehicle population, and most importantly increase in industrialization without any proper emission treatment. Burning of plastic in open environment and deforestation are the other most cited causes of air pollution. Due to these activities, the amount of CO_2, Suspended Particulate Matters (SPM) including particulate matters having a diameter of 10 microns or less ($\leq PM_{10}$) and particulate matter having a diameter of 2.5 microns or less ($\leq PM_{2.5}$) and other pollutants like sulphur dioxide (SO_2), nitrogen dioxide (NO_2), Ozone (O_3), Lead (Pb) etc. have been increased in the atmosphere which adversely affects human health and the whole ecosystem. Air pollution is also a negative externality as it adversely affects human health and bears monetary loss to the society in the form of medical treatment cost (i.e. Direct health cost) and also results in loss of productivity (i.e. Indirect health cost).

Brick kilns are one of the main causes of air pollution. Countries that have high concentration in bricks production are China with (54%), Pakistan, (8%), India (11%) and Bangladesh with (4%) while global production of bricks is about (75%) according to Baum (2010). This high concentration in bricks production contribute about 60% in GHG emissions, and about 28% in particular matters (Lee et.al, 2014). In China, modern

technology is used in brick kilns due to which their emissions are lower as compared to India which is on the second number in ranking of the world's highest bricks producing countries. In most of the major cities of Pakistan, the level of air pollution has crossed the threshold level as set by the national standards. According to the World Health Organization (WHO, 2014) report on ambient air quality in major districts of Pakistan, Quetta and Peshawar were considered in the top ten polluted cities of the world.

Peshawar is being one of the major cities of Pakistan in terms of air pollution. There are several reasons for pollution in the city but the major causes are vehicular emissions due to the rapid increase in the number of vehicles and industrial emissions especially from brick kilns. In Peshawar, there are approximately 450 brick kilns working in and around the city. About 7500 bricks are produced by each brick kiln each day. Wood, coal and rubber are extensively used in these kilns in which the consumption of coal ranges from 90 to 180 tons, wood from 10 to 15 tons and rubber from 4 to 6 tons per month according to the size and production per kiln (Sardar & Jan, 2000). Bricks production has also a significant impact on deforestation because wood is also used as a source of energy in the process of firing the bricks. This excessive use of energy resources in bricks production not only contaminates the environment but it leads to high economic costs. If the brick kilns are properly upgraded and new technologies are used, these emissions can be controlled by reducing the fuel use which is the main cause of these emissions. On global level, there are 10% brick kilns which are operated through modern technology (Baum, 2010) but in developing countries there is lack of access of brick kiln operators to use modern technologies.

The level of pollution is different based on the type of kilns and the fuels used in each type of kiln which makes it difficult to estimate the exact level of emissions coming

out from these kilns. In most of the developing countries including Pakistan, ordinary Bull's Trench Kilns (BTK's) are very common type of brick kilns. There is no proper tax system or any government regulations on these kilns to reduce their emissions or the tax rate is not that much higher on brick kiln owners to reduce the emissions. Similarly, most of the brick kilns in the developing countries are working without permits (Environmental Health Perspectives, 2013).

1.2 STATEMENT OF THE PROBLEM

Brick kilns emit huge amount of pollutants in the form of Sulphur dioxide (SO_2), Nitrogen dioxide (NO_2), Carbon dioxide (CO_2) and other pollutants which are harmful for human and other atmospheric ecosystem. Air pollution has a direct impact on human health such as asthma, bronchitis, cough, heart attacks and deaths especially in extreme cases of children. Similarly, the emissions of brick kilns not only harm the human health but may also affect the cognitive abilities of the people especially the children living and working near these brick kilns. Hence, these emissions can have a direct monetary cost to the people in the form of mitigation cost as well as an indirect cost by reducing productivity in the future, which may then translate into lower wages & adverse labour market outcomes. While the direct impact of air pollution on human health is extensively studied. There is a dearth of studies to examine the impact of air pollution on cognitive abilities.

1.3 RESEARCH QUESTION

Does exposure to air pollution created by brick kilns reduce children's long term welfare by having a negative impact on their cognitive abilities?

1.4 OBJECTIVES OF THE STUDY

The objectives of this study are:

1. To analyze the impact of brick kiln emissions on children cognitive performance

by comparing children who are exposed (living within 3 kilometers of the brick kilns) with those children who are unexposed (living away from brick kilns).

2. To estimate the cost in terms of reduction in future wage due to exposure to brick kiln pollution.

1.5 SIGNIFICANCE OF THE STUDY

The study will address the impacts of brick kiln emissions on children cognitive performance. Many studies conducted on both national and international level have been done by focusing on the health impacts of air pollution by different sources but in Pakistan, no study has been done on cognitive performance of children being affected by air pollution. Hence, an important contribution will be focusing on the impacts of emissions on cognitive performance of children living near the brick kilns. Consequently, this study will highlight the unobserved cost of air pollution which could have long term welfare consequences.

1.6 ORGANIZATION OF THE STUDY

In this study, the first chapter will be about introduction of the topic, research question, objectives of the study, research problem and significance of the study. The second chapter will include the literature review on studies done related to both the health and cognitive abilities affected due to ambient air quality. Third chapter will discuss the theoretical channels. Fourth chapter will discuss Data & Variables and the Econometric Methodology used for empirical analysis. Chapter 5 will show the results while chapter 6 will conclude the study.

Chapter 2

LITERATURE REVIEW

Air pollution is the presence of various pollutants in the atmosphere such as nitrogen oxides (NO_x), Sulphur oxides (SO_x), Ozone (O_3) and particulate matters (PM). These pollutants in the atmosphere are the result of various human activities like burning of wood, industrial emissions, emissions of vehicles which are increasing with the increase in population. Bricks industry is one of the major causes of air pollution working mostly the developing countries like India, Bangladesh, Nepal and Pakistan. The emission of these sources adversely affects the health and the whole ecosystem. With the increasing rate of urbanization and economic growth, the demand for housing has been increasing which has resulted in increasing demand for bricks (Pariyar, 2013).

2.1 AIR POLLUTION AND PHYSICAL HEALTH

There is vast literature on air pollution and its impacts on human health showing a significant impact of air pollution on human health. Exposure to air quality in the form of particulate matters including PM_{10} and $PM_{2.5}$, Nitrogen oxide, Sulphur oxide, Ozone, especially the total suspended particulate matter (TSM) remains in the atmosphere which can adversely affect human health. The impact of these pollutants depend on their size, mixture of pollutants and their concentration in the air (HEAL, 2002)[1]. These pollutants have adverse health impacts including heart attack, asthma, bronchitis, eye irritation, and other respiratory problems (Joshi & Dudani,2008; pariyar,2013). Pariyar et.al.(2013)

[1] Heal (Health and Environmental Alliance) works under the collaboration with EU-wide research project 'European Study of Cohorts for Air Pollution Effects' (ESCAPE) which shares latest reports about raising awareness about the effects of exposures on health.

showed that due to emissions of PM_{10} from brick kilns, majority of the respondents were affected having breathing problem, nasal problem, eye irritation and others diseases. Gupta (2008) identified the prevalence of various symptoms like blood pressure, asthma, heart attack, tuberculosis etc. due to the textile industries, heavy engineering and leather industries in Kanpur. Similarly, Yelda & Mustafa (2006) estimated PM_{10} and SO_2 for winter and summer. The concentration was higher in winter and it was found that in Trabzon, the air pollution had caused serious health symptoms like acute tonsillitis, acute bronchitis, and acute pharyngitis in winter. In another study, Cancado et.al, (2010) estimated that due to burning of sugarcane emissions, the respiratory problems to children and elders was increased by 21.4% and 31.03% respectively and about 50% of the respondents were facing the breath problem. Similarly, Khan et.al.**(**2015) estimated that the number of individuals having asthma was higher during the operating season in sugar mills and brick kilns as compared to no operating season.

Among the other pollutants, total suspended particulate matter (TSPM) and Ozone have been considered as more dangerous because at the time of inhalation, it penetrates deep into the respiratory path and results in respiratory illness and mortality as well (Gupta, 2006). Ozone can damage the sensitive tissues in the deep lung. This effect of ozone on human lungs was identified by testing the lungs of rats because the lungs of rats are similar to human lungs (Klienman, 2000). Ozone when inhaled through oxygen affects the hemoglobin in the blood which reduces the blood carrying capacity of providing clean oxygen to the lungs that causes lung cancer (Brook et.al. 2004; Pope and Dockery, 2006; Bascom et.al. 1996). Ozone (O_3) is also considered as one of the most dangerous pollutant that causes asthma and respiratory problem most probably in children who spend most of

the time outside as compared to elders (Schwartz, 2004). In a study, Marcer et.al.(2000) found that the number of hospitalization of children was increased due to SO_2, NO_x and Ozone concentrations. In another study, Neidell (2001) showed that CO resulted in hospitalization for asthma among children was under age 1 to 12. In another study, Joel.S (2003) showed that a total of 468 emergency room visits were noted in which 139 children were suffering from respiratory problems. Similarly, White et.al. (1994) examined the effect of ozone on number of hospital days for child asthma. Results showed that the ozone level exceeded to 0.11 ppm on 6 days. Similarly, there was 37% increase in the number of visits for asthma after those 6 days.

2.1.1 Health cost due to Air Pollution

The impact of air pollution on health bears a monetary loss to the society in the form of health cost to mitigate the effects of pollution on their health as well as loss in the work days that could be spent to earn income. Similarly, children may also miss their school days because of illness due to pollution. Most of the studies have used dose response function to observe the link between the pollution and health impacts and measured the health cost which is also known as demand function that includes measuring the cost of mitigation and work days lost showing the impact showing a significant impact of air pollution on health cost.

This study aims to estimate the health cost of the children affected due to air pollution. Various studies relevant to this objective have been done identifying that there is a strong association between the pollution level and the health benefits to the individuals in the form of reduction in cost of health. By reducing the pollution level from different sources including various industrial emissions, vehicular emissions, and from other sources

to safe level can result in reducing to cost of health in the form of monetary benefit. Gupta (2006) estimated the monetary benefits to the individuals due to a decrease in the level of pollution from the urban industrial city of Kanpur, India. He estimated that if the level of pollution is reduced to a safe level, then the average monetary benefit to the individual would be Rs.165. similarly, the annual benefit to the entire population was estimated to be Rs. 213 million. In another study, Murti et.al, (2003) measured the monetary benefit of the reduction in air pollution for two cities of India and estimated the annual benefit to both the cities by a reduction in air pollution to be Rs. 2999.7 million for Kolkata and Rs.4896.6 million for Delhi showing a negative impact of air pollution on monetary benefits. Similarly, the emissions of vehicles can also affect the health. Due to increase in population the number of vehicles is also going up. These vehicles especially the diesel vehicles emits various pollutants including Particulate matters (PM_{10} and $PM_{2.5}$), carbon monoxide (CO), Nitrogen dioxide (NO_2), Sulphur dioxide (SO_2), Lead (Pb) and black smoke emitted from especially the diesel vehicles causing different health problems like cancer, heart attack and increases the mortality risk (Pope, 2007). Children are more exposed to these pollutants especially those who live in urban areas where there is a huge rush of vehicles and they go to their schools passing through the main road where there is traffic pollution. Janice et.al.(2004) analyzed the impact of traffic pollutants on respiratory illness. The data on different pollutants like particulate matter, black carbon and nitrogen oxides was collected at 10 school sites during several seasons. Results showed that the rate of asthma due to NO_x was 1.07. Similarly the rate of concentration was different between the schools nearby versus the schools at a distance from major roads. The results showed a significantly positive impact of traffic pollution on respiratory symptoms.

Emissions from these sources have negative impact on society in the form of economic loss attributed to the individual or society in the form of work days lost due to acute illness. Chowdhury et.al.(2010) estimated the health cost attributed to the vehicle emissions in Dhaka, Bangladesh using the cost of illness approach. Random effect zero inflated poisson regression model was used for measuring the loss in earnings while for mitigation cost, random effect tobit regression was used. The results showed that by reducing pollution to safe level, the annual monetary benefit per person was Taka 131.37(USD 1.88). Another interesting study done on air quality due to cement production by Herath et.al.(2008) estimated that the welfare gain was SLR 699(US$7) if the pollution level is reduced to 50%. Similarly Kunzli et.al.(2000) estimated the health cost due to traffic related accidents based on particulate matter PM_{10} and used exposure response function for measuring different health outcomes.

2.1.2 Air pollution and Cognitive Performance

Air pollution not only affects health but also cognitive performance because these emissions after inhalation also affect the brain. Children are most affected due to air pollution because they spend most of their time outside as compared to adults. Children are sensitive to high exposure of air pollutants because at the time of their growth, their lungs, immune system, cardiovascular system and their brain also develops (HEAL, 2002). They inhale high exposure to air pollution which affects their brain. High exposure to air pollution can reduce children's learning abilities by increasing their respiratory illness, and their absentees from school (Miller, 2013). These ambient air pollutants cause high risk of

vascular dementia and Alzheimer's disease[2]. Studies have been done identifying that at the time of inhalation, polluted air is taken through lungs into the bloodstream which reacts with haemoglobin molecules in the blood due to which the blood's capacity to carry oxygen to all body parts reduces and affects the heart and brain (Pope and Dockery, 2006; Bascom et al, 1996;) which affects the performance of the brain and cognitive abilities resulting in lowering the academic performance of children during education as well. In a study, Evol,(2009) investigated the impact of air pollution on standardized state test scores of California public school children. He found that a 10% decrease in outdoor pollutant PM_{10}, $PM_{2.5}$ and NO_2 increased the test score of the children by 0.15%, 0.34%, and 0.18% while the reading score of the children was increased by 0.21%.

Another study by Roth (2013) analyzed the impact of PM_{10} on test scores of a university examination at British institution. The impact of the pollutant was higher in males and the level of pollution was higher than the standard level. Carbon monoxide (CO) and $PM_{2.5}$ have been considered as the most dangerous pollutants affecting the cognitive performance of children. In a study of Levy & Roth (2014), they analyzed the impact of CO and $PM_{2.5}$ on the test scores of the children in Israeli high school test from 2000 to 2002. The results showed a significant impact of these two pollutants on test scores of the children. Similarly, it was found that exposure to these pollutants had a significant impact of not receiving a Bagrut certificate required for college entrance in Israel. Results concluded that air pollution affects the cognitive performance which results in decreasing productivity in future.

[2] Alzheimer's is a brain disease that causes a slow decline in memory, thinking and reasoning skills.

Air pollution from huge traffic also affects the cognitive performance of the children especially those living in urban areas near the main road. Emissions of the vehicles can adversely affect children as they are less aware of the effects of these pollutants. Studies show that air pollution of vehicles have long term respiratory and cardiovascular effects as well as affecting the children's cognitive performance. In a study, Freire et.al.(2009) investigated the impact of Nitrogen dioxide (NO_2) on children's cognitive performance. The exposure of NO_2 was recorded to be (>24.75 mg/m^3) which reduced the general cognitive score by 4.19 points. Results showed that the impact was not statistically significant but the association between traffic related air pollution and general cognitive performance suggested that traffic pollution had an adverse impact on neurodevelopment of the children even at low pollution level.

After discussing all these studies, it is clear that air pollution from different sources can have a significantly negative impact on not only physical health but also on cognitive ability of children. This type of unobservable impact in the form of cognitive impairment can affect the child's career in future in the form of job availability and further affects the labor productivity in future which is an important factor for economic growth and development. So it is concluded that not only the observable cost (cost on physical health) but also the unobservable cost in the form of mental disability and weakness should also be addressed and needs some more research in this regard.

2.2 RESEARCH GAP

This study aims to analyze the impact of air pollution on children cognitive performance. The important gap after studying these literature is that the effects of air pollution on health has been discussed in vast literature done on both national and international level but the

impact of air pollution which also affects the cognition has not been understudied in general and no study has been found on this issue in Pakistan in particular. As such the impact of air pollution on health is underestimated. Therefore this study will contribute to the literature on long term welfare cost of environmental degradation by analyzing the effect of exposure to brick kiln pollution on cognitive abilities of children.

Chapter 3

AIR POLLUTION AND BRAIN DEVELOPMENT: THE CHANNELS

Many epidemiological studies have shown that air pollution has an adverse impact on human health causing various diseases mentioned earlier but its impact on brain development is not addressed that much. Studies have linked the air pollution with health by addressing different symptoms like cardiovascular diseases and respiratory problems but there is a need of more research to address the impact of air pollution on brain development especially of children. As children are more affected due to air pollution because they spend most of their time outdoor i.e. their schools which are most often near to roads with huge traffic rush which affects their health as well as their brain development. Exposure to air pollution affects the neuropsychological or cognitive development of children but it is less clear that reduction in exposure or the earlier exposure will have long-lasting effects on brain's cognitive functioning (Peter et.al, 1992). Similarly, child's birth weight is affected when mother at the time of pregnancy is exposed to pollution. According to Curry et.al (2009) and Neidell (2011), air pollutants especially carbon monoxide affects child's birth weight because mother at the time of pregnancy is exposed to CO. children long term development is also indicated by their birth weight.

Besides CO, Mercury is also a type of neurotoxin that can affect early childhood brain development and the nervous system. Air pollution occurs from various sources like power plants, kilns, industries etc. mercury is emitted in atmosphere from these sources and remains in the atmosphere and then comes to the ground by rain. After

entering to the lakes, this mercury is converted into methylmercury[3] after adding up with bacteria. Humans after consuming these fishes as their food are exposed to methylmercury (PSR, 2009[4]). The cognitive development of children and their nervous system is affected during their birth when this contaminated food is consumed by women during their pregnancy, affecting their child's thinking abilities and other natural abilities like memory, attention, and other skills during his growing stages. Children are more vulnerable to air pollution as the brain develops gradually at the age of 6 to 12 (Jordi et.al, 2015). As this stage, they are in the learning process for which their proper cognitive functioning is very important. The impact of air pollution on brain is less clear however, which needs to be focused.

3.1 HOW AIR POLLUTION AFFECTS BRAIN FUNCTION?

There are multiple pathways through which the air pollutants affect the central nervous system and affecting the brain but still it is less understood and many studies are still unable to identify how these pollutants affect the brain function. The air pollution affects the brain as they are linked through the cardiovascular system. Air pollution affects the central nervous system by affecting the cardiovascular system. This is because at the time of inhalation, the ultrafine particles directly enter into the lungs by crossing the alveolar-capillary barrier to all parts of the body including brain (Sermin,et.al;2011). These pollutants can be easily inhaled because of the small size of the particles.

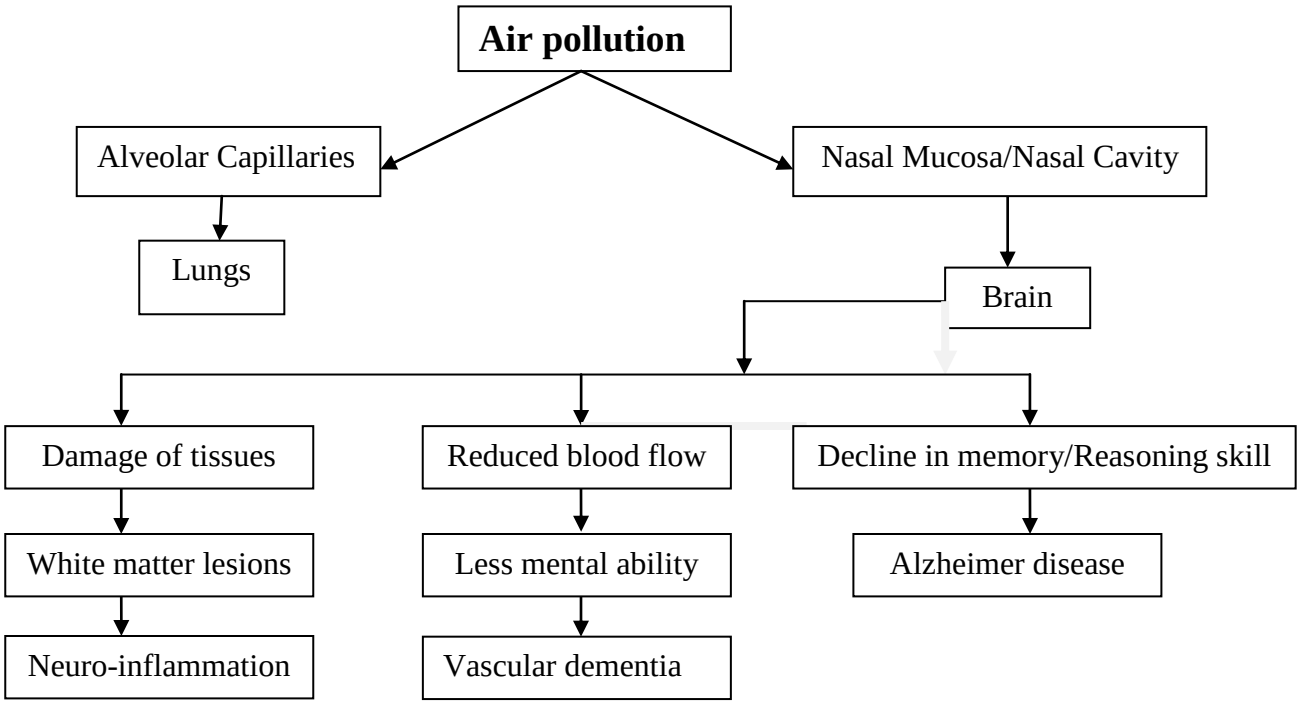
These pollutants are inhaled through the nasal mucosa passing through the olfactory neurons. Once these pollutants reach to the olfactory neurons, they passes

[3] An organic type of mercury that is hazardous for living health. This toxic is absorbed by tissues of aquatic organisms like fishes and other organisms used as a food.

[4] PSR: Physicians for social responsibility: It is a largest organization in United states mainly focusing on the protection of the public for environmental hazards, climate change and nuclear war.

through the olfactory bulb and then further reach to the central nervous system and affect the brain (Erin.O,2012). These olfactory neurons serve as a pathway which connects nose with the brain. These pollutants affect the brain tissues that contain millions of nerve cells. These tissues are damaged because at the time of inhalation, the arteries that carry blood to the brain are blocked due to which brain does not get efficient amount of blood for its proper functioning. Neuro-inflammation occurs due to these damaged tissues causing brain strokes which results in brain white matter lesions.

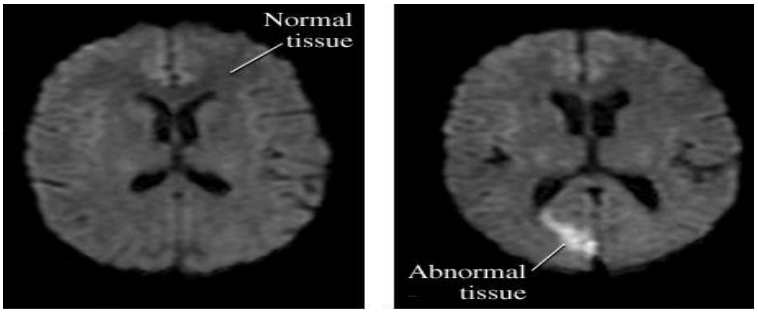
Figure 3.1.1 Air Pollution and Brain Development



Erin (2012) investigated the impact of particulate matter (PM_{10}) and NO_2 on cognitive decline, dementia risk and brain white matter. Results showed that a 10µg/ m^3 increase in PM_{10} caused a 2.45 increase in vascular dementia with (95% CI: 1.23, 4.86) while decreased white matter grade to 0.14 units with (95% CI: 0.01, 0.27) while due to a 10 ppb increase in NO_2 resulted in a 0.37 units decrease in white matter grade with (95%

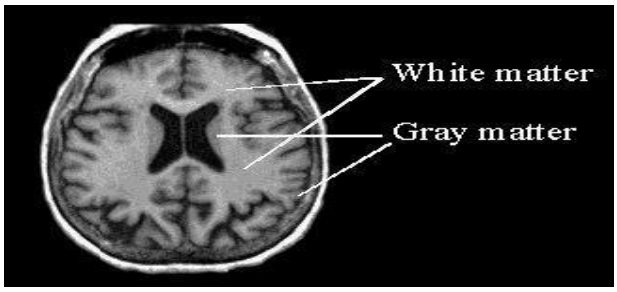
CI: 0.41, 0.61). Vascular dementia which is a form of dementia is caused due to reduced blood flow to the brain which results in less mental abilities and reducing IQ level especially in children and adults. Alzheimer's disease (AD) which is another type of dementia according to Erin.O,(2012), Michelle.L, et.al.(2010) causes a slow decline in memory, thinking and reasoning skills.

Figure: 3.1.2: An MRI picture showing a normal and abnormal brain tissue



Brain contains two types of tissues. The tissue on its upper side is known as the grey matter while the tissue in inner part is known as white matter. This white matter is composed of millions of nerve cells also called (axons). It is whitish in color because the nerve fibers are covered with myelin and it passes nerve signals in the whole brain very quickly (Leslie, 2015) while the grey matter is composed of neurons. The white matter carries nerve impulses to these neurons present in grey matter.

Figure 3.1.3: A picture showing a white and gray matter inside a human brain



The neurotoxic pollutants affects these nerves and tiny strokes are produced in white matter which results in increasing the white matter lesion causing reduction in memory and thinking abilities in children and elders (Lavy, 2014). Very few studies have identified this linkage between the air pollution and its impacts on cognitive performance but from the above discussion it is clear that air pollution not only affects the cardiovascular system but also the central nervous system.

Chapter 4

DATA COLLECTION AND METHODOLOGY

The focus of this study is on the adverse impacts of air pollution from brick kilns on cognitive abilities of children as they are more exposed to these emissions.

4.1 STUDY AREA

The study area selected for the research was district Peshawar. Peshawar is derived from the name of a Sanskrit word 'Pushpapura' which means the city of flowers. Peshawar lies between 33° 44′ and 34° 15′ north latitude and 71° 22′ and 71° 42′ east longitude. Peshawar is the capital of Khyber Pakhtunkhwa. Peshawar is situated near the eastern end of Khyber Pass. The total population of Peshawar according to 1998 census was about 2019118 (2.019 million) while the total area of district Peshawar is 1257 square km. Peshawar is enriched with a large number of brick kilns. About 450 brick kilns are working in the district at different places. Pollution is emitted through 15 meters high chimneys due to which the air quality is very bad within 3 kilometers of the brick kilns. According to WHO Report (2016), Peshawar is ranked as the second most polluted city with a PM_{10} concentration of 540 $\mu g/m^3$ (annual mean).

4.2 SAMPLE SIZE AND DATA COLLECTION

In district Peshawar, Pandu was selected as a study area. According to district health report (2009), the total population of Pandu is 24572. So according to this population, the sample size of the respondents was 264 with 95% C.I. In the study area, the treatment group (Brick kilns area) was Sorizai while the controll group was Chamkani which is 4 kilometers away from the kiln area. The sample size was divided into 132 samples from

each group. The total area of the treatment group selected was within 3 kilometers radius from the brick kilns while the controlled group selected was 3 kilometers away from the brick kilns. Data from households was collected through household survey using questionnaire. Similarly, data on cognitive abilities of children of age 5 to 12 years was collected using Raven Test-scores. While, through Pakistan Council of Scientific and Industrial Research (PCSIR), data on PM_{10} was measured at two spots in both the controlled and treatment sites at the study area to compare the quality of air at both the sites. In order to measure the level of PM_{10} at both spots, HAZ Dust Environmental Particulate Air Monitoring Equipment with Model (EPAM-2000) was used for the analysis. Results showed that the level of PM_{10} in the Brick kiln area was 247$\mu g/m^3$, which was higher than the standard level of 150$\mu g/m^3$ set by the Environmental Protection Agency (EPA). On the other hand, at controlled area the level of PM_{10} was 63 $\mu g/m^3$ which was lower than the standard level. Table 4.2.1 shows the level of PM_{10} at both the areas. The report by PCSIR for this data is attached in appendix.

Table 4.2.1: Test of Air Pollution

Parameter	**Result**			**Standards of Pak EPA**
	Unit	**Spot:1** Kiln Area	**Spot:2** Control Area	
Particulate Matter (PM_{10})	$\mu g/m^3$	247.00	63.00	150.00 for 24 hours

4.3 ECONOMETRIC SPECIFICATION OF THE MODEL

In order to analyse the impact of Brick kiln emissions on children's cognitive ability, we estimated three models using OLS. In the first model, we analysed the impact of distance from brick kiln on the child's cognitive ability. For this purpose, we used the following regression model.

$$CA_{ij} = \alpha_0 + \alpha_1 DBK_j + \alpha_2 AGE_i + \alpha_3 GEND_i + \alpha_4 HT_i + \alpha_5 AS_i + \alpha_6 GD_i + \alpha_7 PE_j + \alpha_8 TM\_E_j + \alpha_9 HHI_j + \alpha_{10} HHS_j + \alpha_{11} PQ_j + \alpha_{12} D\_MR_j + \alpha_{13} TOH_j + \alpha_{14} TS_j + \alpha_{15} U\_SM_i + \alpha_{16} PS_j + \mu \ldots\ldots\ldots\ldots\ldots\ldots 1$$

In second model, we analyzed the impact of treated area on child's cognitive ability.

$$CA_{ij} = \beta_0 + \beta_1 TA_j + \beta_2 AGE_i + \beta_3 GEND_i + \beta_4 HT_i + \beta_5 AS_i + \beta_6 GD_i + \beta_7 PE_j + \beta_8 TM\_E_j + \beta_9 HHI_j + \beta_{10} HHS_j + \beta_{11} PQ_j + \beta_{12} D\_MR_j + \beta_{13} TOH_j + \beta_{14} TS_j + \beta_{15} U\_SM_i + \beta_{16} PS_j + \mu \ldots\ldots\ldots\ldots\ldots\ldots 2$$

In third model, we analyzed the impact of PM_{10} on child's cognitive ability.

$$CA_{ij} = \gamma_0 + \gamma_1 PM10_j + \gamma_2 AGE_i + \gamma_3 GEND_i + \gamma_4 HT_i + \gamma_5 AS_i + \gamma_6 GD_i + \gamma_7 PE_j + \gamma_8 TM\_E_j + \gamma_9 HHI_j + \gamma_{10} HHS_j + \gamma_{11} PQ_j + \gamma_{12} D\_MR_j + \gamma_{13} TOH_j + \gamma_{14} TS_j + \gamma_{15} U\_SM_i + \gamma_{16} PS_j + \mu \ldots\ldots\ldots\ldots\ldots\ldots 3$$

4.4 DESCRIPTION OF VARIABLES

In the above models, **CA** is the cognitive ability of the children aged (5-12) years. This was measured by using Raven-test score. The children with age limit (5-12) years were asked 18 questions. For each correct answer, 1 mark was given. There correct answers were then summed up and standardized (with mean 0 and standard deviation 1) for age

and gender.

DBK: This shows the distance from brick kilns in kilometers. This shows at how much distance a child is living away from the brick kiln. Distance from Brick kiln has a significant impact on child's cognitive development. The more a child is distant from the brick kiln, the higher will be his cognitive ability.

TA: It shows the treatment group (or children living in the treated area). A child living within 3 kilometers radius of the brick kilns was considered in the treated group and was given the value 1 while 0 for children living in controlled area. Child living within three kilometers of the Brick kiln has lower cognitive ability as compared to the child living in the controlled group. This variable has a significant impact on child's cognitive ability.

PM_{10}*:* This is the air quality parameter with a diameter less than or equal to 10 microns. The level of PM_{10} has a significant impact on cognitive ability. If the level of PM_{10} is higher, it will negatively affect the cognitive ability of a child.

AGE: This shows age of the child in years. (Age limit from 5 to 12). Age is expected to have a significant impact on the child's cognitive ability. Cognitive ability improves as the age of the child increases. Age has a significantly positive impact on cognitive ability of child.

GEND: This is the gender of the child; 1 for male while 0 for female. Male children's cognitive ability is expected to be more negatively impacted by pollution than female children. Male children spend more time playing outside as compared to female children. Male children are more exposed to brick kiln emissions as compared to female children. However by playing outside, male children interact with other children which may positively affect their cognitive abilities. A positive impact also comes from the fact the

male children get more attention in the house (gender discrimination). Hence, the theoretical sign of this variable is ambiguous.

HT: This indicates the height of the child in centimeters (cm). If the height of the child is normal it shows that the nutrition of the child is good and the child has better cognitive ability as compared to the child with malnutrition which also affects his/her cognitive ability. It is expected that children with good nutrition and normal height have better cognitive ability showing a significantly positive impact of height on cognitive ability of the child.

AS: This shows the child attending school. The Raven Test score measures the natural cognitive ability of every child and does not depend upon on whether or not he/she attends school. This variable takes the value 1 if the child attends the school and 0 otherwise.

GD: This measures the grade of child in school. That is, grade shows class of the child in school. Hence, a child who does not attend school will get the value 0. A child attending school may have better cognitive ability as compared to children not attending the school. Hence, we expect a positive impact of grade/school attendance of child on his/her cognitive ability.

PE: It shows parental education. Parental education has important role in child's cognitive performance. Educated parents better know the importance of education for their children and have an important role in their cognitive development. This variable is expected to positively affect the children's cognitive ability.

TM_E: This is the total members employed of a single household. No of members employed also affects the child's cognitive ability. If both father and mother are employed then they will not get much time to spend with their child. More members employed would negatively affect the child's cognitive development.

HHI: It shows the monthly income of the household members. A family with high income would provide better environment, better nutrition and education facilities to their children which also has a positive impact on their cognitive abilities. Higher income of household has a significantly positive impact on child's cognitive development.

HHS: This shows household size of the family. A large family size has a significant impact on child's cognitive ability. Increase in the number of children in a family requires more time to be given by the parents.

PQ: It shows parental quality. It is measured by the average number of hours parents spend with children per day. Educated parents are expected to spend more time with their children in their homework. The more time the parents spend with their children in homework, the more the cognitive ability of the child will improve and shows a positive sign.

D_MR: This shows distance from main road to the house of the child. If the main road is near to the child's house, the dust of the main road and vehicular emissions can also affect the child's cognitive functioning. The more the child is distant from the main road, the more will be the child's cognitive development. Distance from main road to the child's house has a significant impact on child's cognitive ability.

TOH: This shows the type of house the family of the child lives in. If the family is living in own home, their accumulation of wealth will grow and they will enjoy better living conditions. Growing up in a homeowner family has a positive impact on child's cognitive development.

TS: This variable shows the time spent by the family in the Brick kilns area i.e (affected area). More time spent by a family will have a significantly negative impact on their children's cognitive performance.

*U*_SM: This shows the use of safety measures i.e use of mask, handkerchief etc; by the child while going to school or anywhere else. Child using the safety measures is given the value 1 while 0 is given for child not using the safety measures. Use of safety measure by a child is expected to have a significant impact on his/her cognitive ability.

PS: It shows parental smoking; 1 for smoking while 0 for no smoking. Parental smoking has a significant impact on child's cognitive ability. Parents especially fathers who smoke in front of their children have a negative impact on their children's cognitive development.

Chapter 5

RESULTS AND DISCUSSION

This chapter will discuss the results of the regression model used for the analysis of impact of Brick kiln emission on cognitive ability of children. For this purpose, we first examine the descriptive statistics of dependent and independent variables. In Table 5.1, the descriptive statistics of these variables in both the treated and controlled groups are provided.

Table 5.1: Descriptive Statistics of Variables for Treatment and Controlled Areas

Variables	Treatment	Controlled	Difference
Cognitive Ability	-0.544 (0.064)	0.544 (0.081)	-1.088*** (0.103)
PM10	247.00 (0.000)	63.00 (0.000)	184.00*** (0.000)
Age	8.704 (0.192)	8.666 (0.173)	0.037 (0.258)
Gender	0.545 (0.043)	0.598 (0.042)	-0.053 (0.061)
Height (cm)	123.24 (1.256)	130.84 (1.131)	-7.593*** (1.690)
School attended (Y/S)	0.946 (0.019)	0.916 (0.024)	0.030 (0.031)
Grade (class)	2.234 (0.148)	1.931 (0.141)	0.303 (0.205)
Father Education (years)	3.386 (0.180)	4.128 (0.181)	-0.742*** (0.255)
Mother Education (years)	1.037 (0.128)	0.954 (0.106)	0.083 (0.167)

Total members Employed	1.227 (0.043)	1.083 (0.026)	0.143 (0.051)***
Household Income	27312.88 (891.50)	30949.24 (1125.98)	-3636.36** (1436.18)
Household Size	5.75 (0.151)	6.030 (0.165)	-0.280 (0.223)
Time Spent with Child (Y/N)	0.454 (0.043)	0.500 (0.043)	-0.045 (0.061)
Time spent per day (Hours)	0.530 (0.055)	0.598 (0.057)	0.068 (0.079)
Type of House (O/R)	0.863 (0.029)	0.712 (0.039)	0.151*** (0.049)
Time spent (years)	20.67 (1.073)	10.09 (0.724)	10.58*** (1.295)
Distance from Brick kiln (km)	1203.18 (53.36)	4360.22 (19.39)	-3157.04*** (56.78)
Distance from main road (km)	187.95 (5.543)	249.09 (7.349)	-61.13*** (9.205)
Use of Safety measure (Y/N)	0.386 (0.042)	0.393 (0.042)	-0.007 (0.060)
Parental Smoking	0.386 (0.042)	0.424 (0.043)	-0.037 (0.060)

Note: Standard Errors are in parenthesis.*** shows significance at 10% significance level,** shows significance at 5% significance level.

The above table shows the descriptive statistics of dependent variable (CA) and the independent variables like age, gender, height, and other variables of treatment and controlled areas. In this table, we compare the difference of the variables between the two areas. This table shows that the cognitive abilities of children living in the treatment area is significantly reduced by 1.08 than the children living in the controlled with 0.10 standard deviation. Similarly, the level of PM_{10} is much higher in treatment area as

compared to the controlled area. The table shows that the difference in level of PM_{10} in the two areas is highly significant with 184μg/m^3. Other demographic variables like age, gender, school attendance, grade, mother education, time spent by parents with child, use of safety measures and parental smoking were statistically insignificant. However, height of the children living in treatment group was significantly lower by 7.6 cm. Similarly, father education in treated area was less by 0.74 years and their difference was highly statistically significant. Household income was lower in treated area as compared to the controlled area and is reduced by 3636.36 rupees showing a highly significant difference between the incomes of both the groups. Likewise, the time spent was higher in the treated area as compared to the controlled area and was highly significant with 10.58 years. Distance from brick kiln was lower in treated area with a highly significant difference of 3157.04 meters. Similarly, the distance from main road is 61.13 meters less than the controlled area.

5.2 IMPACT OF POLLUTION ON COGNITIVE ABILITY

In order to analyse the impact of Brick kilns emissions on children's cognitive ability, we estimated the effect of three variables on cognitive ability. These variables are distance from brick kiln, treatment area (Pollution affected area) where the child lives, and the impact of level of PM_{10} in that area. These variables have a highly significant impact on child's cognitive ability. For analysis of this impact we estimated three regression models for each variable to estimate the true effect of these variables on cognitive ability.

5.2.1 Impact of Distance from Brick kilns on Cognitive Ability

First we analyzed the impact of distance of cognitive abilities. Distance from brick kiln has a significant impact on cognitive ability. This is shown in Table 5.2.1. If a child is

more distant from the brick kiln, his cognitive ability will be much higher as compared to the child living near to the brick kilns. In the above table, Model 1 shows that an increase in the distance from brick kiln by one kilometre increases the cognitive ability of the child by 0.32 standard deviation shows a highly significant impact of distance on cognitive ability. However, Model 1 does not control for other variables and therefore, the effect might have be biased (most probably) overestimating.

Table 5.2.1: Impact of Distance from Brick kilns on Cognitive Ability

Variable	Model 1	Model 2
Distance from Brick Kiln	0.321***	0.273***
	(0.031)	(0.031)
R-Squared	0.280	0.712
No of Observations	264	264

Note: Robust standard errors are in parenthesis. *** shows significance level at 10%. Model 2 controls for age and gender, and height of the child; whether or not the child is going to school; grade in which the child is currently studying; parental education, household size and income, type of house, duration of residence, distance from main road and use of safety measures and parental smoking.

Hence, Model 2 shows that if we control the effect of other variables on cognitive ability, then the result shows that an increase in the distance from brick kiln by one kilometre increases the cognitive ability of the child by 0.27 SD. This result shows the true effect of distance on cognitive ability of the child showing a highly significant impact of distance on cognitive ability.

5.2.2 Impact of Treatment Area on Cognitive Ability

Secondly, we estimated the impact of treated area on child's cognitive ability. A child living in treated (affected area) will be more affected as compared to the child living away from the brick kiln area. To analyse this impact, we estimated a regression model to examine the impact of treated area on child's cognitive ability. This is given in Table

5.2.2. The table shows the impact of treatment (Pollution affected) area on cognitive Ability. We define the treatment area as the area within three kilometres of the brick kilns while the controlled area as three kilometres away from the brick kilns. A child living in the treatment area will be affected more as compared to the child living in the controlled area. In this table, Model 1 shows that the cognitive ability of the child living in treated area is reduced by 1.088 standard deviation showing a highly significant impact of treated area on cognitive ability of the child. Negative sign shows the reduction in cognitive ability of the child.

Table 5.2.2: Impact of Treatment (Pollution affected) area on Cognitive Ability

Variable	Model 1	Model 2
Treated Area	-1.088***	-0.933***
	(0.103)	(0.101)
R-Squared	0.297	0.708
No of Observations	264	264

Note: Robust standard errors are in parenthesis. *** show significance at 10% level. Model 2 controls for age, gender and height of the child; and other variables.

Due to the effect of other variables, the result is over estimated and shows a biased result. To overcome the biasness, we control the effect of other variables. In Model 2, the result shows the true effect of treated area on cognitive ability by 0.93 standard deviation showing a statistically significant impact.

5.2.3 Impact of PM_{10} on Cognitive Ability

In treated area, the level of PM_{10} was very high. PM_{10} has a significant negative impact on cognitive ability. This is shown in Table 5.2.3. The table shows the impact of PM_{10} on cognitive ability. In this table, Model 1 shows that increase in one unit of PM_{10} reduces the cognitive ability of the child by 0.006 SD showing a highly significant impact. But

this value is not showing a true effect of PM10 on cognitive ability because the effect of other variables over estimates the result.

Table 5.2.3: Impact of pollution (PM_{10}) on cognitive ability

Variable	Model 1	Model 2
PM_{10}	-0.006***	-0.006***
	(0.000)	(0.000)
R-Squared	0.297	0.708
No of Observations	264	264

Note: Robust standard errors are in parenthesis. *** shows significance level at 10%. Model 2 controls the effect of other variables.

In Model 2, to overcome the impact of other variables, we control the impact of other variables on cognitive ability. Model 2 shows that an increase of one microgram per cubic meter in the value of PM_{10} reduces the cognitive ability by 0.006 SD. This shows the true impact of PM_{10} on cognitive ability showing a highly significant impact on cognitive ability. Hence, all these three measures of brick kiln pollution confirm that air pollution has a significant negative impact on child's cognitive development. This in term can affect the labour market outcomes of these children. Hence, studies that do not take into consideration the effect of air pollution on cognitive ability underestimate the true cost of this pollution.

The second objective of this study was to estimate the cost in terms of reduction in future wage due to exposure to brick kiln pollution. This can be done by quantifying the negative effect of brick kiln pollution on the future wages of the affected children. Alderman *et al*. (1996) concluded for Pakistan that one standard deviation increase in cognitive ability suggests an increase of 20 percent in wages. Making this study a bench mark and using back of envelope calculation, we found that these children in the affected areas are likely to experience a reduction of around 20 percent in wages

due the detrimental effect of brick kiln pollution on their cognitive development. This is a significantly higher cost on the welfare of our future generation. Ironically, however, it is not even recognized as a cost because it is not directly observable. Consequently, the cost of air pollution on children's health and productivity is underestimated.

Chapter 6

CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSION

Brick kilns are one of the main causes of air pollution. Emission of brick kilns causes various health impacts. But the black smoke coming out from these brick kilns is not only affecting physical health but also affects the cognitive development of the children living near these kilns. This emission bears a monetary cost to the people in the form of direct cost (health cost) as well as indirect (unobservable) cost by reducing productivity in future. This indirect cost may then have a negative impact in the form of lower wages and adverse labor market outcomes in the future. Therefore, more research is needed to highlight this issue as well.

The prime objective of this study was to analyze the impact of brick kiln on children's cognitive ability by comparing children living in treated and controlled areas. It is found in this study that the cognitive ability of the children living in the area within three kilometers of brick kiln was much lower as compared to the children living three kilometers away from the brick kilns. Similarly it was found that in treated area, the level of PM_{10} was higher than the standard level while in controlled area it was much lower than half of the standard level of PM_{10}. This clearly indicates that increase in the level of pollution has a significantly negative impact on cognitive ability. Study also found that the average height of children living in the treated area was lower than the height of the children in controlled area. This is true because increase in pollution affects the physical growth of the child which directly affects his mental abilities as well.

In this study, mostly fathers of the children were educated. Education of fathers was lower in treated area while mother education was lower in both the areas. Father education had a significant impact on cognitive ability while mother education had insignificant impact. Member employed per household was higher in treated area as compared to controlled area showing a significant difference between the two groups. The reason is that as the number of members employed increases, they will spend less time with their children which negatively affect their cognitive development. Moreover, the time spent by parents with their children was much lower in both the areas which showed an insignificant impact of parental quality on child's cognitive development. Similarly, parental income was higher in controlled area than the affected area and this difference is highly statistically significant. Parents with higher income level can provide better education facilities to their children to improve their cognitive development.

In this study, after analyzing the impact of brick kilns impact on children's cognitive ability, it is concluded that the emission of brick kilns has a significant impact on child's cognitive ability. Results showed that the cognitive ability of children living in the affected area was much lower than the children living in the controlled area. This is because of the high level of pollution which was measured by PM_{10} levels in both the areas. The level of PM_{10} was much higher in the treated area as compared to controlled areas which showed a significant impact of cognitive ability. This negative impact clearly indicates that compared to elders, children are more vulnerable to the pollution of brick kilns. Similarly, the height of the children living in affected area was lower than the children of controlled area.

Height is also an important indicator of child's cognitive development at early stages of growth. If the physical growth of a child is normal, his cognitive ability will also develop. In this study, it is clear from the results that the height of a child has a significant impact on his cognitive ability. Similarly parental education is expected to have a significant impact on cognitive ability. In this study, only father education was significantly different in the two areas. Mother education was lower in both the areas and their difference is statistically insignificant.

Therefore, main conclusion derived from this study is that the cognitive abilities of children living within three kilometers area which is considered as treated area is lower than the children living in the controlled area which is the prime objective of this study.

6.2 SUGGESTIONS AND POLICY RECOMMENDATIONS

Keeping in view the negative impact of brick kilns emissions on children's cognitive abilities, the important suggestions are as follows:

1. As children were more affected in the treated area, therefore it is suggested that government should ban living in the area within three kilometers of the brick kilns to overcome its impact on physical health and the growth especially of children.
2. Government should impose tax on the brick kiln owners to reduce the level of emission due to these kilns or push them to adopt new technology.
3. Rubber is extensively used in the brick production which causes emission of huge amount of hazardous gases in the atmosphere which affects health and cognition of

the children and elders. Therefore, use of rubber should be banned by the government to reduce the level of pollution.

4. Instead of yellow brick which is more expensive and causes air pollution, green bricks should be introduced as they are cheap and more environment friendly.
5. Brick kilns should be constructed in open areas where there is no population nearby.

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Appendix A

Table A: Complete Results for Models

VARIABLES	Model 1	Model 2	Model 3
Distance	0.273***		
	(0.0311)		
Treated Area		-0.934***	
		(0.101)	
PM_{10}			-0.00508***
			(0.000549)
Age	0.0464	0.0764	0.0764
	(0.0667)	(0.0646)	(0.0646)
Gender	-0.163**	-0.159**	-0.159**
	(0.0769)	(0.0766)	(0.0766)
Height	0.0166**	0.0117	0.0117
	(0.00815)	(0.00833)	(0.00833)
Attending school	0.408***	0.336**	0.336**
	(0.145)	(0.149)	(0.149)
Grade	0.0646	0.0659	0.0659
	(0.0639)	(0.0622)	(0.0622)
Father Education			
Primary	-0.0348	-0.0496	-0.0496
	(0.177)	(0.173)	(0.173)
Middle	-0.132	-0.135	-0.135
	(0.139)	(0.140)	(0.140)
Matric	-0.247*	-0.219*	-0.219*
	(0.127)	(0.126)	(0.126)
FA/FSc	-0.177	-0.101	-0.101
	(0.144)	(0.149)	(0.149)
BA/BSc/BCS	-0.124	-0.0822	-0.0822
	(0.149)	(0.154)	(0.154)
MA/MSc	-0.0324	0.00650	0.00650
	(0.168)	(0.175)	(0.175)
Mphil/PhD	-0.150	-0.0870	-0.0870
	(0.257)	(0.256)	(0.256)
Mother Education			
Primary	0.114	0.141	0.141
	(0.107)	(0.110)	(0.110)
Middle	0.237**	0.271**	0.271**
	(0.112)	(0.111)	(0.111)

Matric	0.129	0.140	0.140
	(0.134)	(0.137)	(0.137)
FA/F.Sc	0.477**	0.470**	0.470**
	(0.220)	(0.207)	(0.207)
BA/B.Sc/BCS	-0.0141	0.00456	0.00456
	(0.299)	(0.341)	(0.341)
Total members employed	-0.407***	-0.346***	-0.346***
	(0.0933)	(0.103)	(0.103)
Household income	7.25e-06	7.67e-06	7.67e-06
	(4.71e-06)	(4.88e-06)	(4.88e-06)
Household size	0.0155	0.00857	0.00857
	(0.0244)	(0.0251)	(0.0251)
Time spent/day	0.331***	0.303***	0.303***
	(0.0955)	(0.101)	(0.101)
Type of house	0.0497	0.0595	0.0595
	(0.109)	(0.111)	(0.111)
Time spent	-0.00268	-0.00166	-0.00166
	(0.00422)	(0.00438)	(0.00438)
Parental smoking	0.0268	0.0357	0.0357
	(0.0755)	(0.0755)	(0.0755)
Distance from main road	-0.000841*	-0.000788*	-0.000788*
	(0.000461)	(0.000465)	(0.000465)
Constant	-3.500***	-1.963***	-1.644**
	(0.659)	(0.740)	(0.760)
Observations	264	264	264
R-squared	0.713	0.709	0.709

Note: Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix 2 **Questionnaire**

PAKISTAN INSTITUTE OF DEVELOPMENT ECONOMICS ISLAMABAD

Household survey on

IMPACT OF BRICK KILN EMISSIONS ON CHILDREN'S COGNITIVE PERFORMANCE

This research is conducted on the impacts of brick kiln emissions on children's cognitive performance in this area and we require conducting interviews with households with a special focus on their children to analyze their cognitive skills affected due to brick kiln emissions. This research is only for academic purpose and the responses given will be kept confidential. It will be very helpful if you cooperate with us and give your time to answer a set of questions we have. I thank you for your time and I hope for your cooperation.

S.No: _____ Date of interview: _____

Time started: _____ Time finished: _____

A. HOUSEHOLD DETAILS:

1. **Are you the head of the household?**1. YES ☐ 2. NO ☐
2. **If yes, name of the household head**:_____
3. **Gender of the household head**: M…..1☐ F……0 ☐
4. **Education of household head if both (father & mother):**
   1. Only father educated ☐ 2. Only mother educated☐ 3. Both literate☐ 4. both Illiterate☐
5. **If both educated, then level of education of each: Father_____ Mother_____**

   1. Primary 2.Middle 3.Matric 4.FA/FSc 5. BA/ BSc /BCS

   6. M.A/ MSc 7.Mphil/PhD 8.Diploma/courses9. Any other

6. Is any member of the household employed? YES…….1 ☐ NO……..0 ☐

If yes, (cont. to Q.10)

1. Total members of household who are employed: _____

2. Which members of the household are employed?

1. Only father employed ☐ 2. Only mother employed ☐ 3. Both father & mother employed ☐ 4. Any other_____

3 Employment status of the household who are employed:

1. Father_____2. Mother_____3. Any Other_____

a. Government employee ☐ b. Private employee ☐ c. Own business ☐ d. Servant ☐ e. Other ☐

10. Average monthly income of the household members who are employed:

1. Father_____ 2. Mother_____3. Other_____

11. Total members of the household: _____

12. Number of children:_____

Child No (5-12 years)	Age (years)	Gender Male=1 Female=0	Height (cm)	Attended school Yes=1, No=0	Class (grade)
1.					
2.					
3.					
4.					
5.					

13. Do you get much time from your occupation to spend time with your children in doing their homework?

1. YES.....1 ☐ 2. NO.....0 ☐

14. If yes, how much time per day do you spend with them?

a. 1-2hours ☐ b. 3-4 hours ☐ c. More than 4 hours ☐

B. **LOCATION AND AIR QUALITY:**

15. What type of house do you live in?

1. Own house ☐ 2. Rented house ☐ (If own house, move to Q.17)

16. If rented, how much rent do you pay every month? _____

17. For how long you are being living in this house? _____

18. Is the air quality good in your area? 1. YES 2. NO

19. If no, then what do you think are the main causes of bad air quality in your area?

1. Emission of brick kilns ☐ 2.Road dust ☐ 3. Vehicle emissions ☐

4. All of the above ☐

20. Do you live near the main road? 1. YES……1 ☐ 2. NO……0 ☐

21. If yes, what is the approximate distance between your house and the main road (meters)? _____

22. What is the approximate distance between your house and the brick kilns (meters)?

_____

23. Are you aware that brick kiln emission causes illness? YES…..1☐ NO…..0 ☐

24. Do you use any safety measures while going outside? YES…..1☐ NO…..0 ☐

25. If yes, what type of safety measures?

1. Mask ☐ 2.Glasses ☐ 3.Handkerchief ☐ 4.Other☐

26. While going to school, do your children use these measures?

1. YES……..1 ☐ 2. NO……. 0 ☐

27. Do you have smoking habit? 1. YES……..1 ☐ 2. NO……..0 ☐

28. If yes, do you smoke in the presence of your children?

1. YES ☐ 2. NO ☐

29. For cooking, what type of fuel is used in your house?

1. Wood ☐ 2. LPG ☐ 3.Kerosine ☐

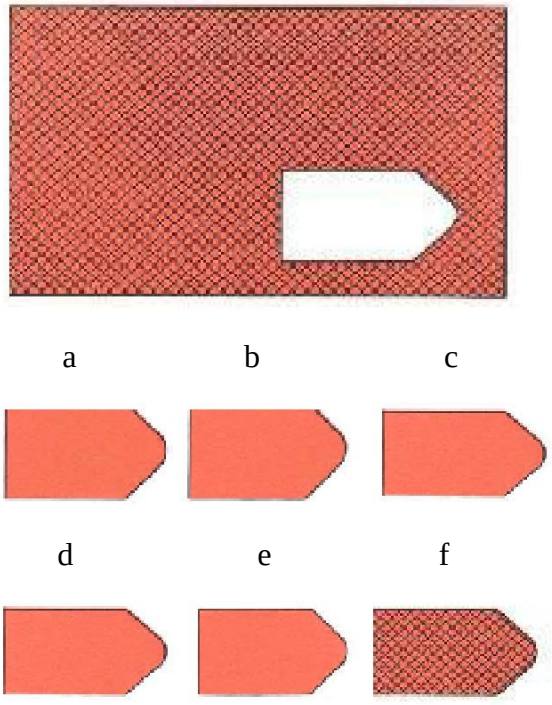
C. COGNITIVE ABILITIES: **(This part is to be filled by child)**

Time started: _____ **Time finished: _____**

In this part, some pictures are given and the child has to fill them by himself by choosing any one from the options given below at the end of each question. The child has to fill these questions in 12 minutes.

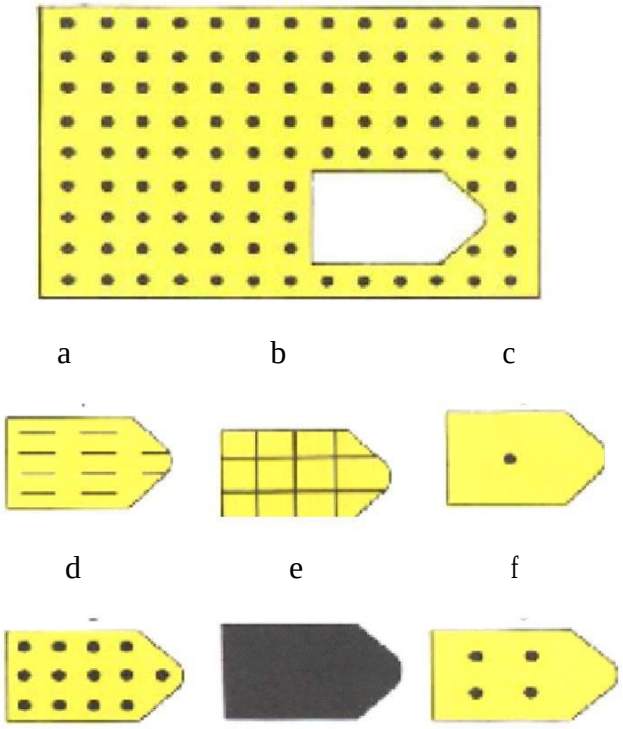
30. Choose the correct answer in each of the following diagrams.

Q: 1



Answer: _____

Q: 2



Answer: _____

Q: 3

a b c

d e f

Answer: _____

Q: 4

a b c

d e f

Answer: _____

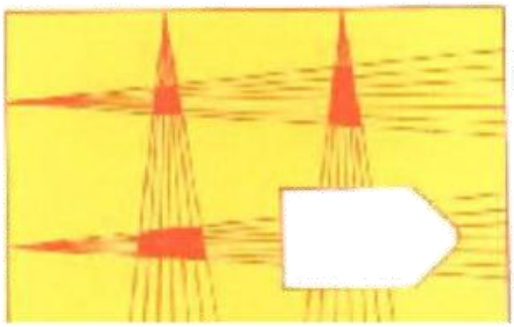
Q: 5

a b c

d e f

Answer: _____

Q: 6



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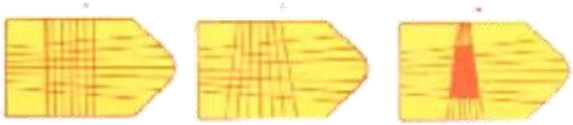
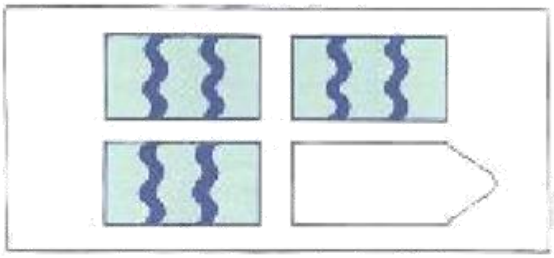


d e f

Answer: _____

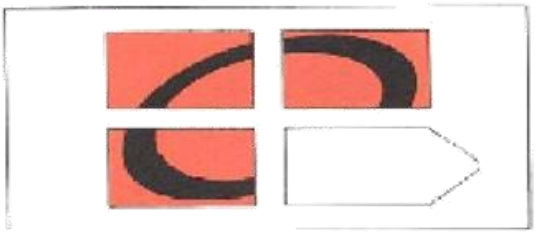
Q:7



a b c

d e f

Q:8

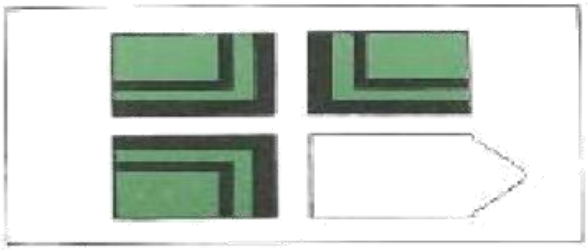


a b c

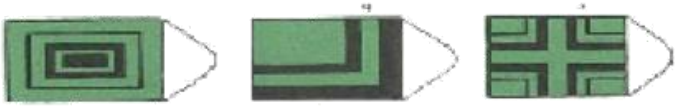
d e f

Answer: _____

Q: 9



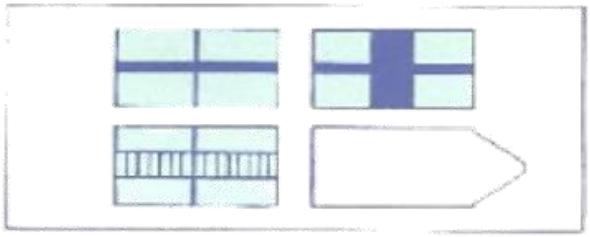
a b c



d e f

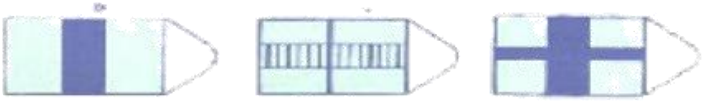
Answer: _____

Q:10



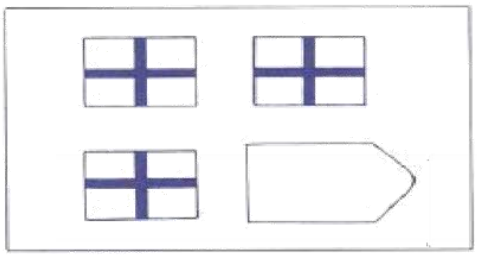
a b c

d e f

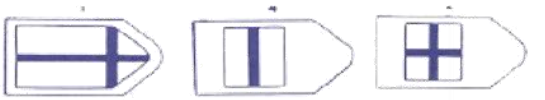


Answer: _____

Q:11



a b c



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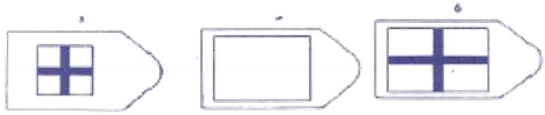
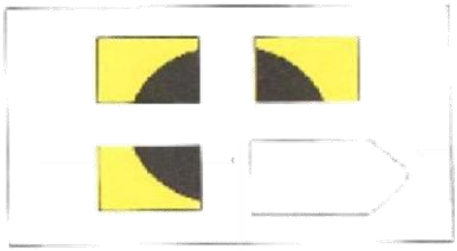


Answer _____

Q:12



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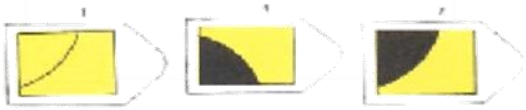
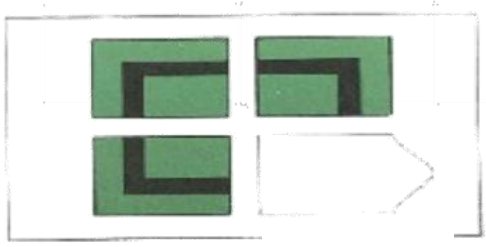


Answer _____

Q:13

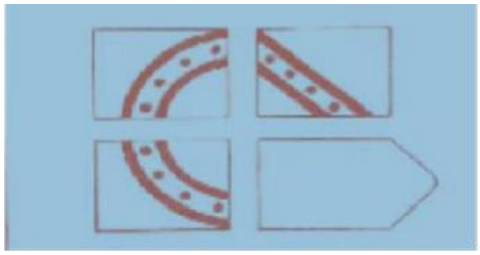


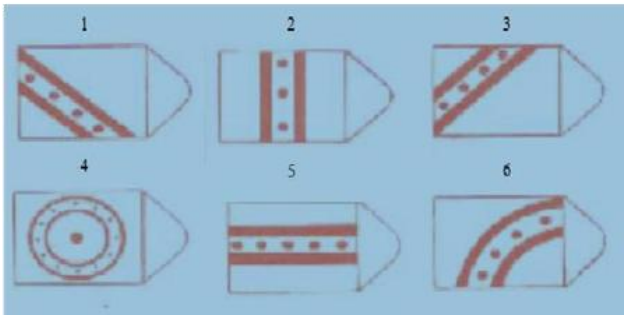
a b c

d e f

Answer _____

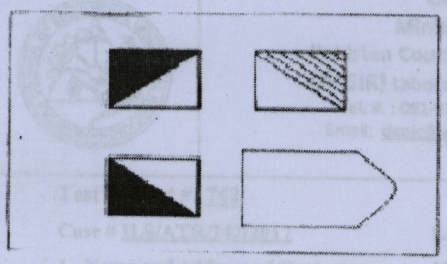
Q:14





Answer _____

Q: 15



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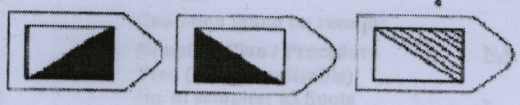

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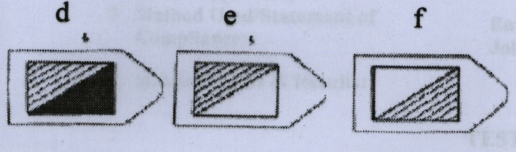
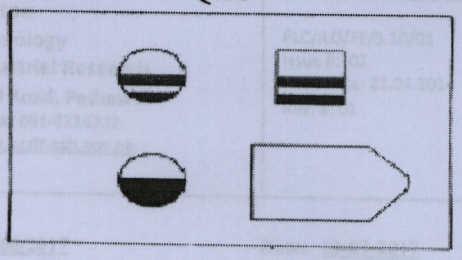


Answer: _____

Q:16



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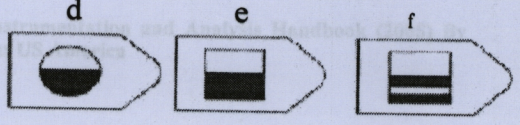
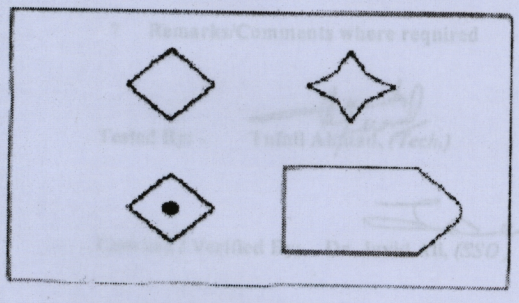


Answer: _____

Q:17



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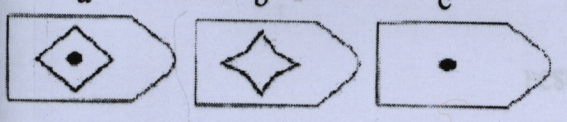

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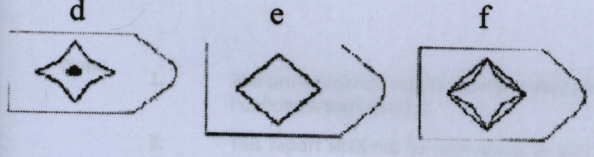
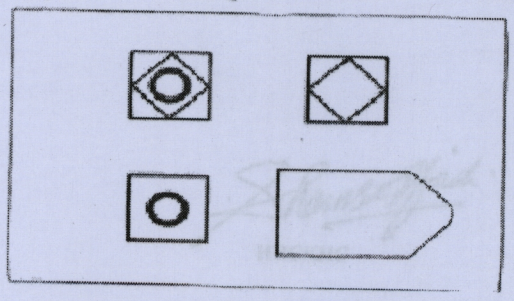


Answer: _____

Q:18



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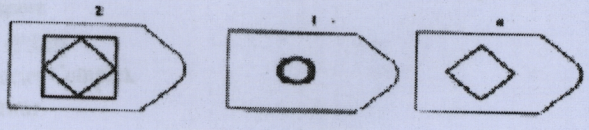

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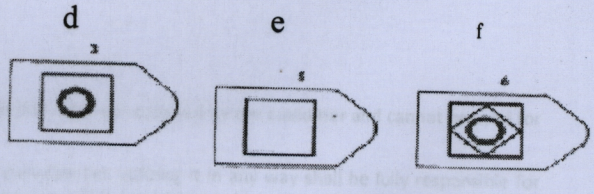

Answer: _____

Government of Pakistan
Ministry of Science & Technology
Pakistan Council of Scientific & Industrial Research
(PCSIR) Laboratories Complex Jamrud Road, Peshawar
Tel. #. : 091-9216240-2, 091-9218174, Fax 091-9216232
Email: dgplc@yahoo.com, Website: www.pcsir-psh.gov.pk

PLC/ILO/FF/5.10/01
Issue #: 02
Issue date: 21.04.2014
Rev. #: 01

TEST REPORT

Test Report #: 742

Case # ILS/ATR/742/2017 **Lab.Code # PLC/FTC/266/2017** **Date: 13-07-2017**

1. **Name and address of Customer:** Mr. Muhammad Adil from Peshawar

   Ref.No. (if any): Nil **Date: 12-07-2017** **Date of Receipt : 12-07-2017**

2. **Description of the Sample (s)Item:** Test of Air Pollution **Mark if any** -

   Condition found on receipt: **Packed in:** Onspot Analysis

3. **Sampling Plan / Procedure Used (where applicable)** NA

   No. of samples: 02 Spots -

4. **Environmental Conditions:** (Where applicable) **Temp:** - **Humidity** -

5. **Method Used/Statement of Compliance:** Environmental Instrumentation and Analysis Handbook (2005) By John Wiley & Sons US America

6. **Measurements & Results:**

TEST OF AIR POLLUTION

HAZ Dust Particulate Air Monitoring Equipment, Model: EPAM-5000, USA

Parameters	Result			Standards Pak EPA
	Unit	Spot #1 Kiln (Bricks)	Spot #2 Control Area	
Particulate Matter (PM_{10})	$\mu g/m^3$	247.00	63.00	150.00 for 24 hours

7 **Remarks/Comments where required** N.A

Tested By: - Tufail Ahmad, *(Tech.)*

Checked / Verified By: Dr. Javid Ali, *(SSO)*

HRC/OIC

13/7/2017
DIRECTOR (P&D)

End of Report

Director (P&D)
PCSIR Laboratories Complex
Peshawar

Note:

1. This analytical/test report is based solely on the particular sample(s) supplied by the customer and cannot be used for Publicity/Advertisement.
2. This report shall not be reproduced in part and the party/parties utilizing it in any way shall be fully responsible for ethical use and proper technical application of the report and all losses/claims, which may ensure there from PLC shall be held indemnified, harmless and free from any and all claims.
3. PLC shall assume and assure that the particular samples are truly representative of any batch or stock or lot or entire production only, when its representative would have performed the sampling.
4. While every possible precaution was exercised to ensure accuracy of the results, PLC does not assume any responsibility for the accuracy of the results beyond the limit and scope of the available methods employed and the validity of the results for the purpose (s) for which the results may be used.