Analysis and Detection of Heavy Metals (Chromium, Zinc, and Lead) in Dust Samples from Government Schools in Shalimar Town, Lahore, Pakistan.

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Abstract:

Clean Environment is a major component of life. Our environment is polluted day by day. Lahore, the city of gardens, is on the top list of polluted cities. Heavy metals are among the most harmful environmental pollutants due to their widespread use. They are one of the reasons of atmospheric pollution. In order to access the heavy metals detection, different government schools of Shalimar town, Lahore were selected. In this study, heavy metals (chromium, zinc, lead) were detected from dust samples collected from four Govt. schools of Shalimar town. Results shows that all school have higher conc. of zinc 334 mg/kg exceeding the NEQS standards. Lead shows slightly higher values 0.67mg/kg exceeding the NEQS standards. Chromium shows values 0.30 mg/kg. Chromium values are below the exceeding levels of NEQS. It is concluded that reason of zinc conc. was higher because of traffic related pollution and may be due to the improper disposal of wastes, manure sewage and sludge at school sites.

Introduction:

The atmosphere sets the standards for breathable air, which directly impacts the quality of life and human health. These standards must align with the conditions of breathable air and vary according to the environment's needs. Enclosed spaces like homes, schools, libraries, and workplaces require particular attention to air quality, as people spend most of their time in these settings. Nowadays, indoor air quality is as crucial as outdoor air quality. Various factors, both environmental and personal, can degrade the air quality in our surroundings, posing risks to human and animal life. The environmental consequences of globalization and rapid industrialization are increasingly burdensome for humanity. Heavy metals are generally defined as elements with a density exceeding 5 g per cubic centimeter. Many of these elements are highly water-soluble and known to be toxic and carcinogenic. Common heavy metals include copper, silver, zinc, cadmium, gold, mercury, lead, chromium, iron, nickel, tin, arsenic, selenium, molybdenum, cobalt, manganese, and aluminum. These heavy metals pose serious threats to both human populations and the fauna and flora in receiving water bodies. They can be absorbed and accumulate in the human body, leading to severe health effects such as cancer, organ damage, and nervous system disorders. In extreme cases, heavy metal exposure can even result in death. Additionally, heavy metals can hinder growth and development. Industrial processes across various sectors generate wastewater streams containing heavy metals. For instance, electroplating, electrolysis, conversion coating, anodizing, milling, and etching industries produce heavy metals like cadmium, zinc, lead, chromium, nickel, copper, vanadium, platinum, silver, and titanium. Furthermore, significant amounts of heavy metal waste, including tin, lead, and nickel, result from printed circuit board (PCB) manufacturing and wood processing industries.

Heavy metals are among the most harmful environmental pollutants due to their widespread use. Heavy metals are expressed as metals with a density greater than 5 g/cm^3. In medicine, heavy metals are defined as all metals with toxic properties, regardless of the atomic weight of the elements. Although more than sixty elements can be given as examples of heavy metals, the most common and well-known are mercury (Hg), manganese (Mn), iron (Fe), cobalt (Co), nickel (Ni), copper (Cu), zinc (Zn), cadmium (Cd), arsenic (As), chromium (Sn), lead (Pb), silver (Ag), and selenium (Se) . These elements, which can show high toxic effects even at low concentrations, can be taken into the human body in various ways, and their products can cause serious health problems. Lead (Pb) exposure in children and adults can cause a wide spectrum of health problems, ranging from small effects on metabolism and intelligence to convulsions, co coma, renal failure, and death. Chromium is an important element especially in metallurgical/steel or pigment industry. Both of its oxidation forms (+3 and +6) in the chemical are used primarily in pigments, metal finishing, and wood preservatives. The toxic form of Cr occurs in +6 oxidation state (Cr (VI)), and its compounds cause cancer of the lung and positive associations have also been observed between exposure to Cr (VI) compounds and cancer of the nose and nasal sinuses. Zinc is essential micronutrient and catalyzes enzyme activity, contributes to protein structure, and regulates gene expression. The adverse effects associated with chronic intake of supplemental Zn include acute gastrointestinal effects and headaches, impaired immune function, changes in lipoprotein and cholesterol levels, reduced copper status, and zinc-iron interactions (McConnell R *et al.,* 2003).

Heavy metals pollution via dust especially in the urban environment have focused largely on road deposited dust. Soil particle directly or indirectly transform into house dust and can be ingested by adults and children through unintentional hand-mouth contact, geophagia or dust inhalation. A study by conducted among children in Rochester (indicates that dust lead content explains most of the variance in blood lead levels. Dust makes a significant contribution to the pollution in the urban environment and consists of vehicle exhaust, sinking particles in air, house dust, soil dust and aerosols that are carried by air and water. Many studies on street dust have focused on elemental concentrations and source identification (Hoffmann *et al*, 2007).

On a daily basis, numerous human activities, including municipal, industrial, commercial and agricultural operations, release a variety of toxic and potentially toxic pollutants into the environment. Within the urban environment, where these activities are especially intense, emissions of both metal and organic pollutants are often vastly accelerated, inevitably rendering the urban environment particularly susceptible to environmental degradation and contamination. One of the crucial properties of the metals that differentiate them from other toxic pollutants is that they are non-biodegradable and also accumulate in the environment. Dust is the material that has largely been ignored as a significant source of trace metal contamination in the urban environment. Heavy metals have harmful effects on human health, and exposure to these metals has been increased by industrial and anthropogenic activities and modern industrialization. Contamination of water and air by toxic metals is an environmental concern (Gurjar of *et al.,* 2008).

MATERIALS AND METHODOLOGY:

Lahore is getting polluted day by day because of the heavy traffic loads and exhaust from automobiles, crop burning, and Industrial exhaust. Now Lahore is considered most polluted city worldwide Air quality of Lahore has declined over last two decades. However, pollution only came into account of the public's mind in early 2017, when Pakistan's first actionable air quality data was published. In the lack of government data, a network of citizen-operated sensors began heavy metals and reporting data in real time. This research has been done to analyze the detection of heavy metals from dust collected from schools.

Methodology:

3.1 Study Duration:

This investigation on zinc, chromium and lead measurement and analysis lasted for seven months (Dec 2023 to June 2024) and involved 12 samples.

3.2 Sampling Location:

The goal of this study was to analyze the heavy metal concentration in Schools of Shalimar town, Lahore. The sampling site for analyzing the concentration of heavy metals in school children.

Figure 3.1. Map showing location of Shalimar town

3.3 Sample Collection:

The analysis of heavy metals concentration in the schools at the Shalimar town. Samples were collected using a Filter paper (glass fiber filter 47mm). In each school, three samples were collected mainly collected from classroom and some from cafeteria and children playground. 12 samples were collected from 4 schools of Shalimar town.

3.4 Handling of samples:

The samples were brought to an environmental science research of Lahore College Women University and kept at room temperature in an air tight plastic bag until they were analyzed to obtain reliable findings, the samples were analyzed immediately.

3.5 Materials:

3.5.1 Apparatus:

Beakers, Sample holder, Whattman filter paper, conical flask, Funnel, Volumetric flask, Stirrer, Test tubes, Test tube stands, and gloves.

3.5.2 Reagents:

Nitric acid, Hydro chloric acid, Hydro fluoric acid and deionized water

3.5.3 Instruments:

Hot plate and Atomic absorption spectrometer

3.6.1 Pre-treatment Procedures:

3.6.2 Cleaning the Apparatus:

All the Apparatus including Beakers, Stirrer, funnels, test tubes, volumetric cylinders, and flask which were used during analysis were cleaned and steralized with deionized water and autoclaved.

3.6.3 Acid Digestion:

Chemical degradation of sample matrices in solution is used in wet digestion procedures for elemental analysis, commonly with a combination of acids to promote solubility. For wet digestion we added 5 ml of nitric acid, per chloric acid and hydrofluoric acid in each sample and mark each sample. The sample heated on hot plate for 1-2hours at 427°C in start until white fumes starts appear temperature slow down to 350°C. White fumes start appearing and almost digestion takes place. The digested solution was allowed to cool and then add 5 ml of nitric acid in it and then put on hot plate for 2-3 minutes. Complete digestion has been done. Now samples allowed to cool and filtered it. After filtration, now filter solution go for dilution. Take 10 ml of filtered solution and dilute it against 250 ml de ionized water. After dilution put that samples in test tubes. Now put theses test tubes in atomic absorption spectrophotometer.

3.6.4 Storage of samples:

The treated samples were stored in glass bottles and then kept at 25°C room temperature in the laboratory under keen observation.

3.6.5 Elemental Analysis of Samples:

The amount of lead, Zinc and chromium in the samples were measured using Atomic absorption spectrometer.

3.7 Analytical Procedure:

3.7.1 Atomic Absorption Spectrophotometer

The atomic absorption spectrophotometer was used to examine the air samples. The instrument's condition was manually altered. The device was calibrated at the start of the analysis to confirm that it was working properly. For calibration, a minimum of four standards were used. Prepared samples were introduced into the device using a tiny capillary after calibration. For the analysis, a separate source lamp containing lead, chromium and zinc.

3.7.2 Principle of AAS:

AAS is a technique anatomizing the concentration of specific elements in a sample. It is based on the fact that atoms and ions can absorb light at only one wavelength. The energy (light) is absorbed by the atom when this precise wavelength of light is delivered in the atom, electrons migrate from the ground state to the excited state. The amount of light absorbed is derived from the concentration of the element in the sample .Using hollow cathode lamps of lead chromium and zinc samples were examined on an atomic absorption spectrophotometer. The samples are then taken out and analyzed. The samples were inhaled into flame for 5 seconds using a capillary attached to the apparatus, and the cycle was completed by aspirating pure water. Standard solution, reference, absorbance, and concentration data were recorded.

3.8 Statistical Data Analysis:

The result of the lead, chromium and zinc concentration in 4 schools were collected. The mean concentration was used to statistically analyze the data. Bar graphs and tables were used to illustrate the data (statistic 8.1).

RESULTS:

The main purpose of this study to analyze the concentration of heavy metals such as chromium, lead, zinc in govt. schools of Shalimar town, LAHORE. Different samples were collected from schools. Schools chosen for analysis were

1. AL HADEED GRAMMAR SCHOOL.
2. ALLAMA IQBAL HIGH SCHOOL.
3. GOVT. ISLAMIA HIGH SCHOOL.
4. GOVT. MADRASA TUL BINAT HIGH SCHOOL.

12 samples were collected from four schools. All these samples after pre-treatment of acid digestion run on atomic absorption spectroscope.

4.1 General Observations:

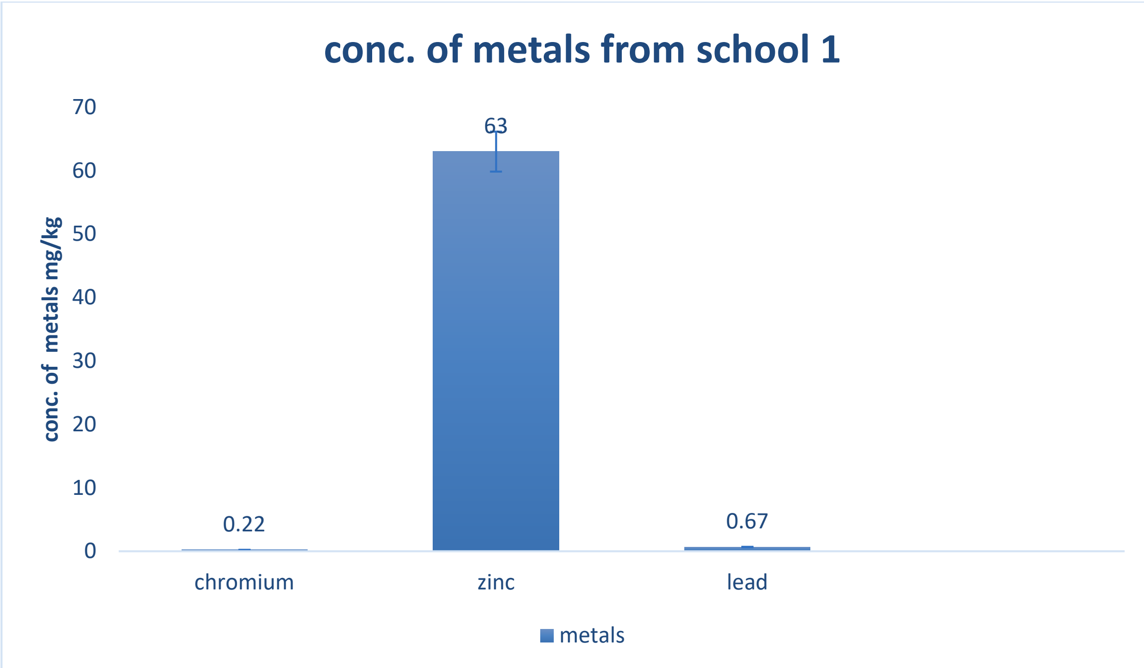
The study was done to analyze the heavy metals concentration among schools. Different spots were choose like cafeteria, playground and classrooms for sample collection. A brief comparison of these metals was also done through this research to analyze which metal concentration is higher. Variations among concentration of metals were seen.

4.1 Table Shows Metals Conc. (chromium, zinc, lead) From Different Schools

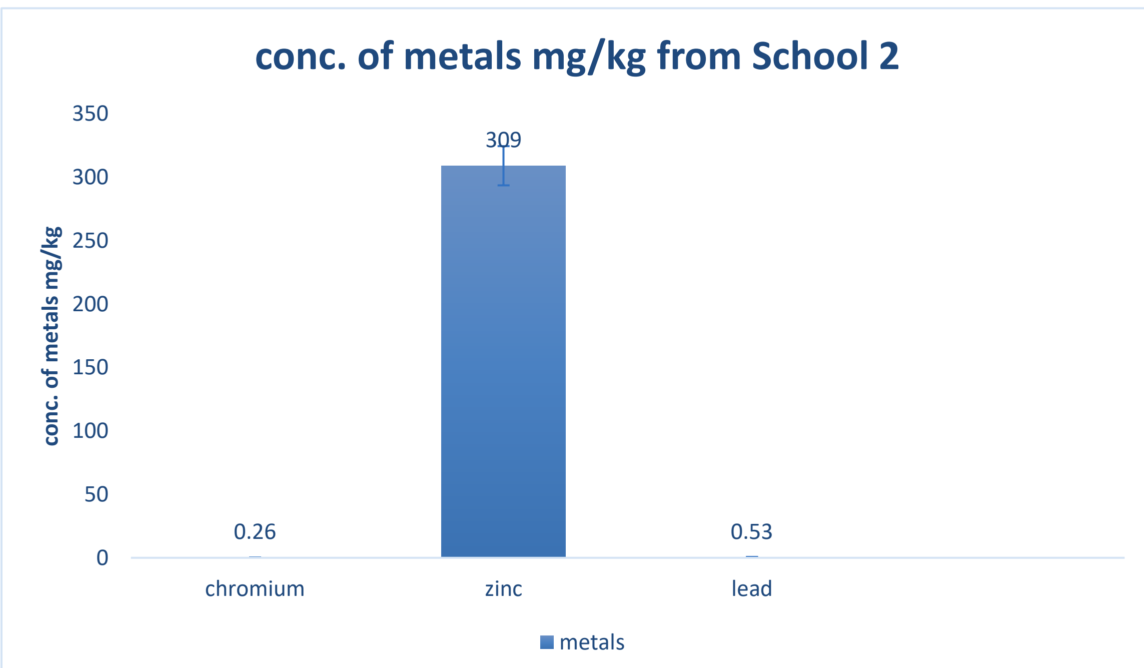
Schools	chromium(mg/kg)	Zinc(mg/kg)	lead(mg/kg)
Al Hadeed High School	0.22 mg/kg	63.0 mg/kg	0.67 mg/kg
Allama Iqbal High School	0.26 mg/kg	309 mg/kg	0.53 mg/kg
Govt. Islamia High School	0.30 mg/kg	330 mg/kg	0.41 mg/kg
Govt, Madrasa-tul -Binat High School	0.29 mg/kg	334 mg/kg	0.62 mg/kg

4.2 CONCENTRATION OF CHROMIUM, ZINC AND LEAD FROM GOVT. SCHOOLS:

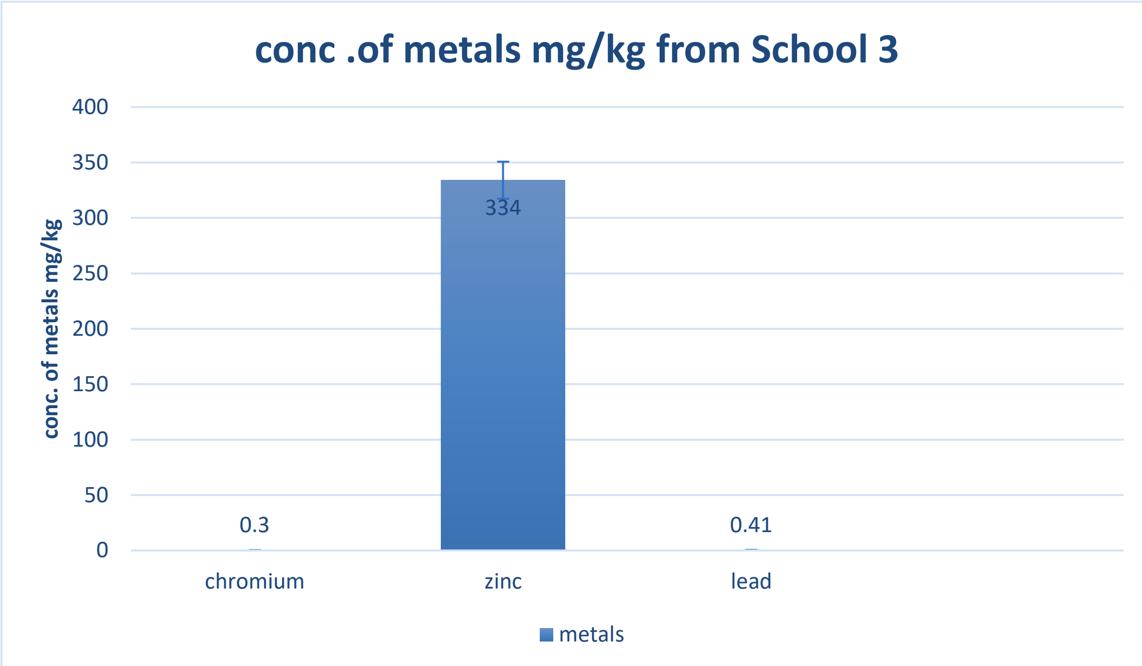
Analysis of heavy metals (lead, chromium, zinc) has been done from four Govt. schools of Shalimar town. Their results have been shown in bar graphs. The bar graph 4.1 showing the concentration of chromium, zinc, and lead from school 1(AL-hadeed high school) .Chromium shows conc. of 0.22mg/kg, zinc shows conc. of 63mg/kg and lead shows conc. of 0.67mg/kg. Among these metals zinc show highest concentration which is 63.0mg/kg, chromium shows lowest conc. 0.22mg/kg that is shown in figure 4.1. The Bar graph 4.2 showing the concentration of chromium, zinc, and lead from school 2 (Alama Iqbal high school).Chromium shows conc. of 0.26mg/kg, zinc shows conc. of 309mg/kg and lead shows conc. of 0.53mg/kg. Among these metals zinc show highest concentration which is 309mg/kg, chromium shows lowest conc. 0.26mg/kg that is shown in figure 4.2. The bar graph 4.3 below showing the concentration of chromium, zinc, lead from school 3(Govt. Islamia high school) .Chromium shows conc. of 0.30mg/kg, zinc shows conc. of 334mg/kg and lead shows conc. of 0.41mg/kg. Among these metals zinc show highest concentration which is 334mg/kg, chromium shows lowest conc. 0.30mg/kg that is shown in figure 4.3. The bar graph 4.4 below showing the concentration of chromium, zinc, lead from school 4 (Govt madrasa- tul-binat high school .Chromium shows conc. of 0.29 shows conc. of 63mg/kg and lead shows conc. of 0.67mg/kg. Among these metals zinc show highest concentration which is 334.0mg/kg, chromium shows lowest conc. 0.62mg/kg that is shown in figure 4.4.



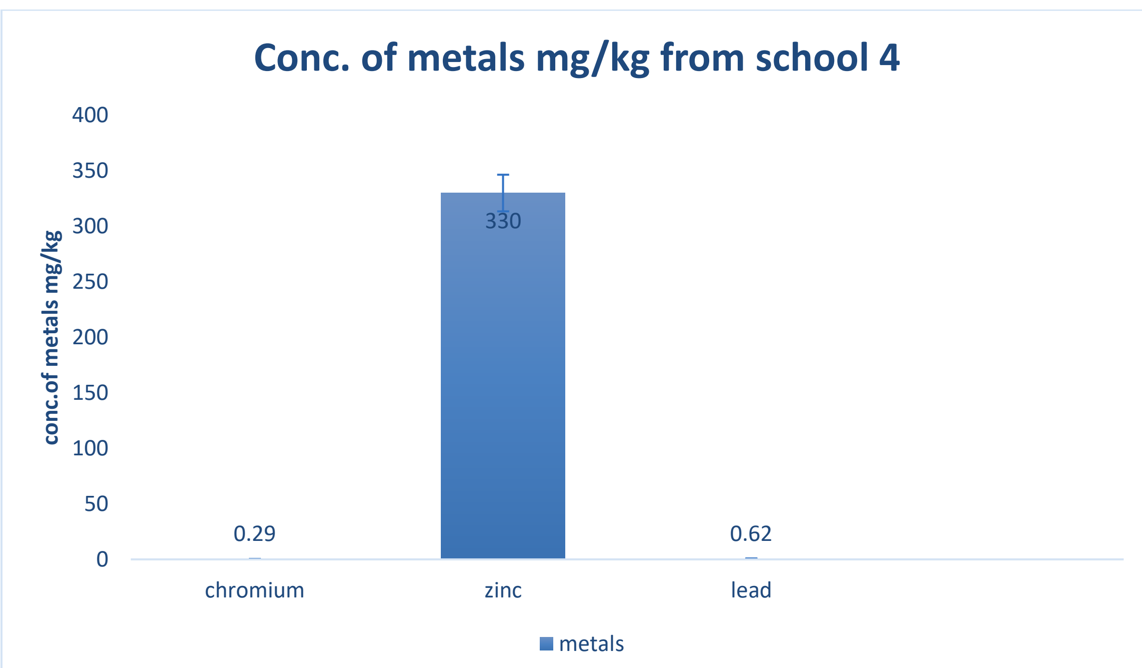
4.1 Graph showing concentration of chromium, zinc and lead mg/kg from school 1



4.2 Graph showing concentration of chromium, zinc and lead mg/kg from school 2



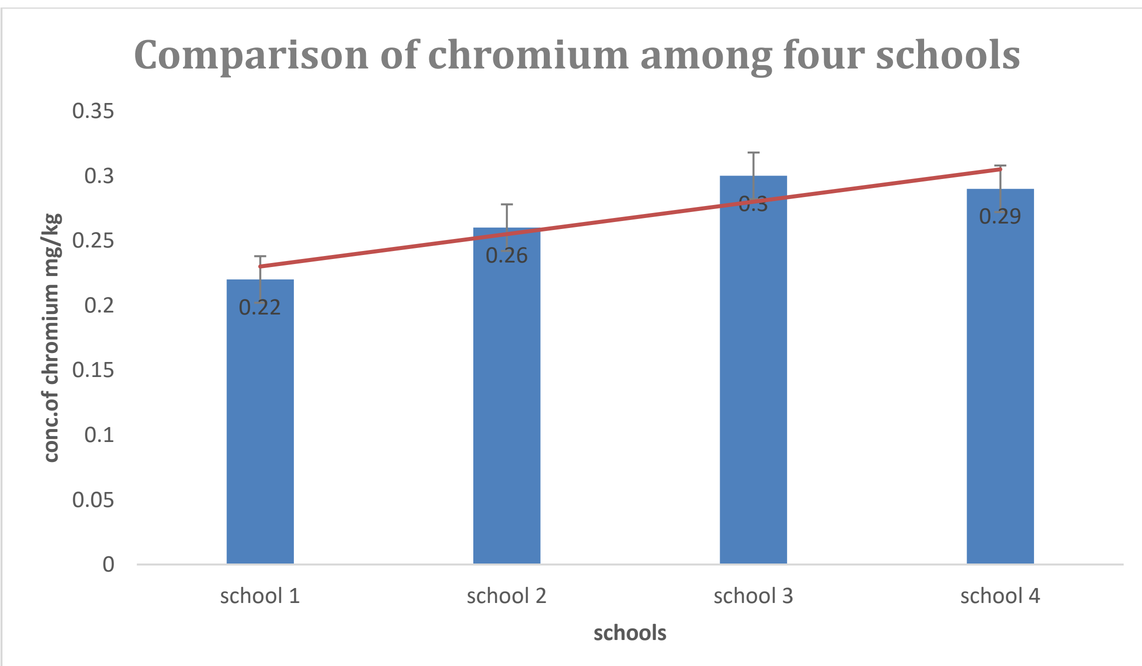
4.3 Graph showing concentration of chromium, zinc and lead mg/kg from school 3



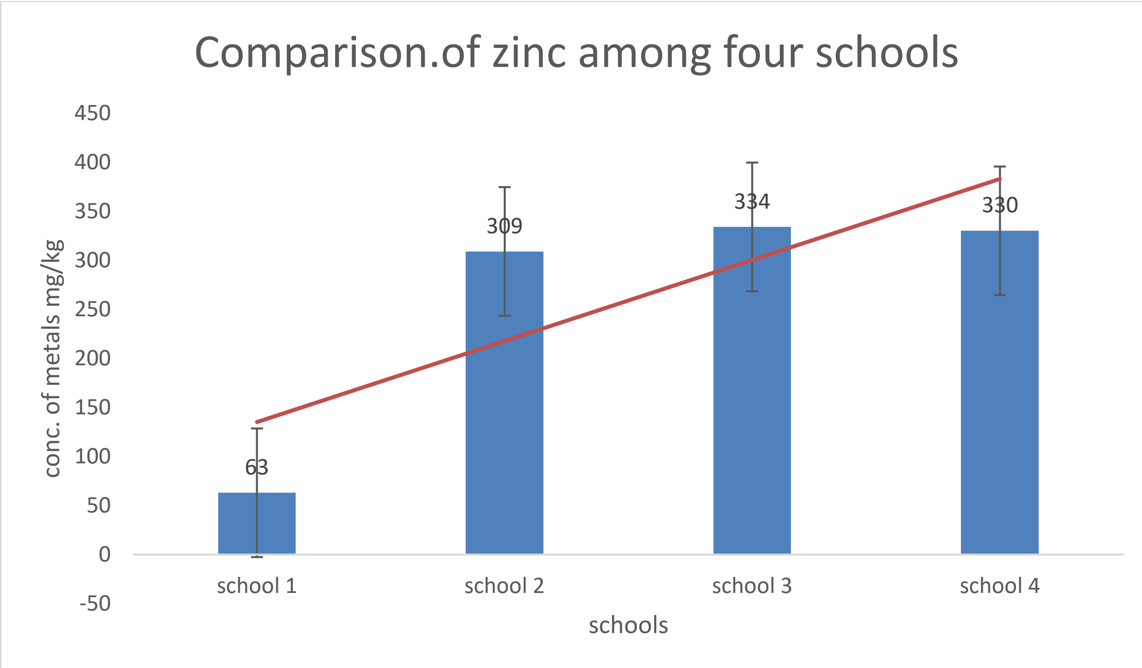
4.4 Graph showing concentration of chromium, zinc and lead mg/kg in school 4

4.3 Comparison of Metals (chromium, zinc, lead) among four schools:

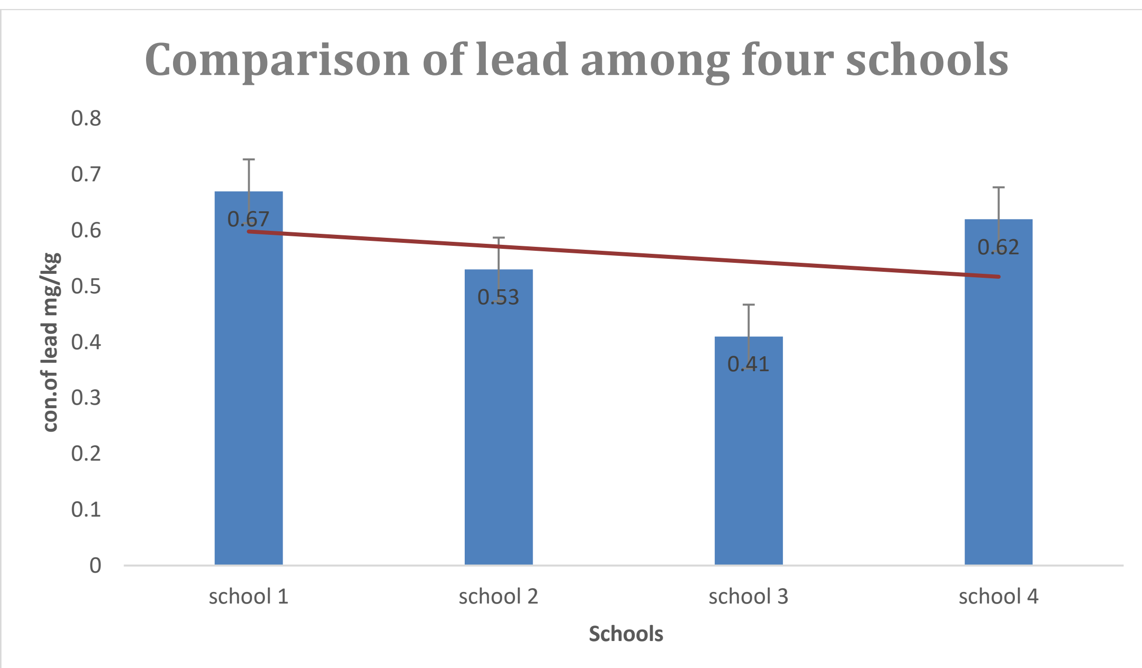
Comparison of chromium metal among four schools have been done through this study. Among these, School 3 shows higher concentration of chromium metal 0.30mg/kg. Then school 4 shows conc. of chromium 0.29mg/kg. School2 shows 0.26mg/kg conc. of chromium. School 1 shows 0.22mg/kg conc .of chromium. School 1 shows lowest conc. of chromium that is illustrated in figure 4.5 with trend line. School 3> school 4>school 2>school 1. Comparison of zinc metal among four schools have been done that is illustrated in bar graph 4.6. That bar graph shows School 3 shows higher concentration of zinc metal 334 mg/kg. Then school 4 shows conc. of zinc 330mg/kg. School 2 shows 309mg/kg conc. of zinc. School 1 shows 63mg/kg conc. of zinc. Again, School 1 shows lowest conc. of zinc that is illustrated in figure 4.6 with trend line. Comparison of lead metal among four schools have been done that is illustrated in bar graph 4.7. That bar graph shows School 1 shows higher concentration of lead metal 0.67mg/kg. Then school 4 shows conc. of lead 0.62mg/kg. School 2 shows 0.53mg/kg conc. of lead. School 3 shows 0.41mg/kg conc. of lead. At this time, School 3 shows lowest conc .of lead that is illustrated in figure 4.7 with trend line.



4.5Graph showing comparison of chromium mg/kg among four schools



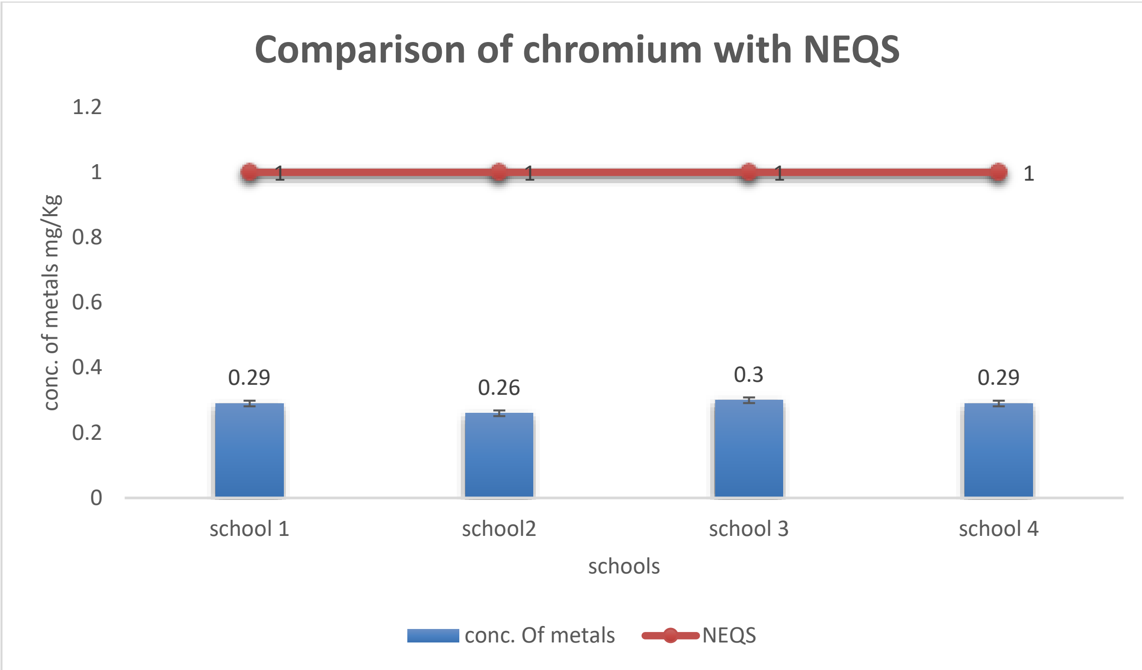
4.6 Graph showing comparison of zinc mg/kg among four schools



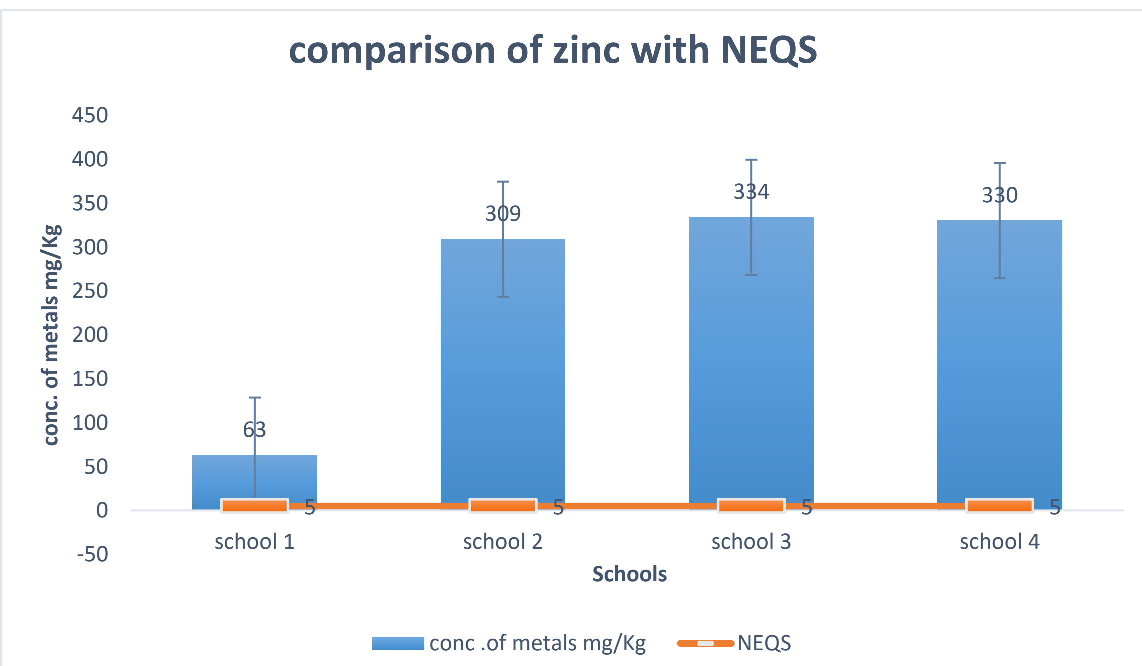
4.7 Graph showing comparison of lead mg/kg among four schools

4.4 Comparison of metals (lead, chromium, zinc) with NEQS:

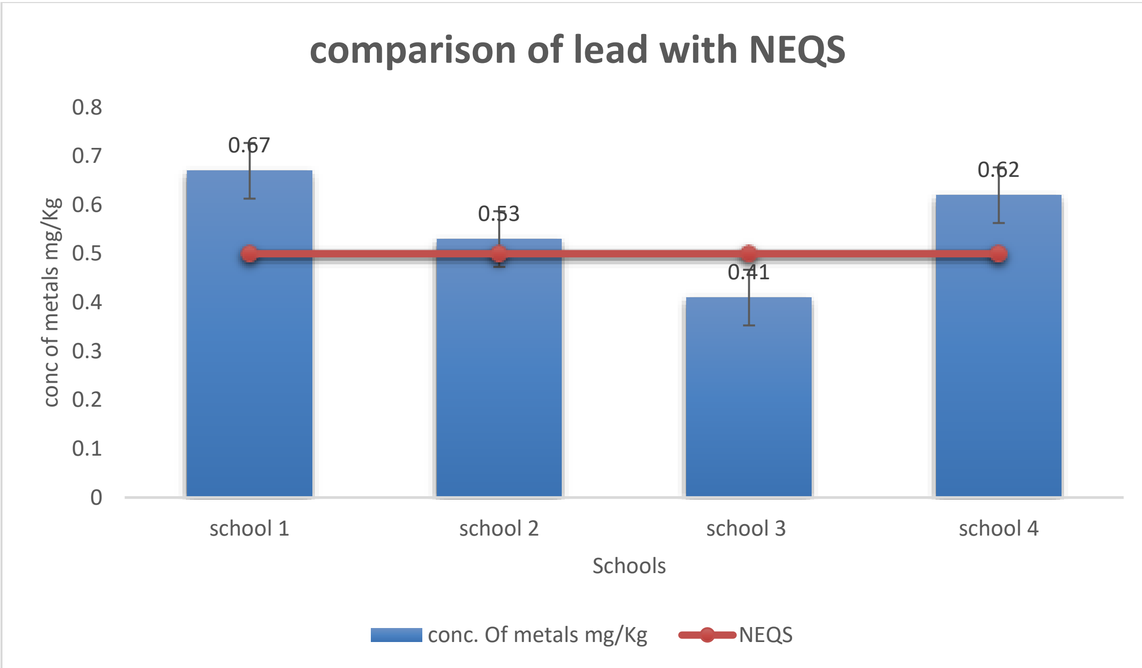
Comparison of chromium metal among four schools with NEQS have been done through this study. Among these, School 3 shows higher concentration of chromium metal 0.30mg/kg but NEQS standards shows 0.5mg/kg so, it is below the normal range. Then school 4 shows conc. of chromium 0.29mg/kg. School2 shows 0.26mg/kg conc. of chromium. School 1 shows 0.22mg/kg conc. of chromium. School 1 shows lowest conc. of chromium that is illustrated in figure 4.8 with trend line. School 3> school 4>school 2>school 1. All schools show value below the NEQS standards. Comparison of zinc metal among four schools with NEQS have been done that is illustrated in bar graph 4.9. That bar graph shows School 3 shows higher concentration of zinc metal 334 mg/kg while NEQS shows 5mg/kg. Then school 4 shows conc. of zinc 330mg/kg. School 2 shows 309mg/kg conc. of zinc. School 1 shows 63mg/kg conc. of zinc. Again, School 1 shows lowest conc. of zinc that is illustrated in figure 4.9. All schools shows the exceeding values of zinc metal. Comparison of lead metal among four schools with NEQS standards have been done that is illustrated in bar graph 4.10. That bar graph shows School 1 shows higher concentration of lead metal 0.67mg/kg while NEQS shows 0.5mg/kg. Then school 4 shows conc. of lead 0.62mg/kg. School 2 shows 0.53mg/kg conc. of lead. School 3 shows 0.41mg/kg conc. of lead. School 1 shows highest conc. of lead that is illustrated in figure 4.10. schools1, school 2 and School 4 shows the exceeding values of lead metal compared with NEQS standards. School 3 shows the normal values.



4.8 Graph shows Comparison of chromium with NEQS



4.9 Graph shows comparison of zinc with NEQS



4.10 Graph shows comparison of lead with NEQS

Discussion:

Density of population/area and pollution are directly proportional. Pakistan faces a pressing challenge due to rapid population growth and high fertility rates. Over the past 50 years, the population has surged more than threefold, primarily driven by elevated birth rates and growth. Consequently, population density has escalated from 82 people per square kilometer in 1972 to 303 people per square kilometer in 2023. (GOP, 2024)

Environmental pollution can be caused by natural events such as forest fires and active volcanoes, use of the word *pollution* generally implies that the contaminants have an anthropogenic source—that is, a source created by human activities. Pollution has accompanied humankind ever since groups of people first congregated and remained for a long time in any one place. Indeed, ancient human settlements are frequently recognized by their wastes—shell mounds and rubble heaps, for instance. Pollution was not a serious problem as long as there was enough space available for each individual or group. However, with the establishment of permanent settlements by great numbers of people, pollution became a problem, and it has remained one ever since (Abbas *et al.*, 2017).

In this study, the Shalimar town LAHORE, dust samples were collected at different locations in order to explain the regional pollution distribution and various emission sources. Because children are more sensitive to air pollutants, the indoor and outdoor environments of primary schools were selected for sampling. Four different schools have selected for this study. In school 1 the Chromium shows conc. of 0.22mg/kg, zinc the results shows conc. of 63mg/kg and lead shows concentration of 0.67mg/kg. Among these metals zinc show highest concentration which is 63.0 mg/kg. In school 2, the Chromium shows concentration of 0.26mg/kg, zinc shows conc.309mg/kg and lead shows concentration of 0.53mg/kg. Among these metals zinc show highest concentration which is 309mg/kg. In school 3, the Chromium shows concentration of 0.26mg/ kg, zinc shows conc.334mg/kg and lead shows concentration of 0.53mg/kg. Among these metals zinc show highest concentration which is 334mg/kg. In school 4, Chromium shows concentration of 0.22mg/ kg, zinc shows conc.330mg/kg and lead shows concentration of 0.67mg/kg. Among these metals zinc show highest concentration which is 63.0mg/kg. Results show that the conc. of zinc was higher. Which may be higher due to traffic related pollution or other waste products. As zinc is very harmful metal for children and it cause many detrimental effects to human body. As the value of zinc exceeding from the NEQS standard, which also shows alarming situation of environment around schools.

For essential elements such as zinc, environmental effects must be considered within the context of an organism's natural ability to regulate (uptake and excretion) and maintain a certain level of homeostasis. That is, environments containing zinc at very low, or very high, concentrations may produce undesirable effects. The range between the minimum and maximum is often called the optimal window of essentiality. Organisms have evolved mechanisms to supply their needs independent of the external concentration by regulating an essential element to a constant internal level. Zinc concentrations in the environment result not only from the production of zinc and the use of zinc in products, but also from the natural background and from other non-intentional sources, where zinc is emitted due to its presence in the raw materials, e.g. combustion of fossil fuels. Risk assessments in Europe have demonstrated that the current general and widespread use of zinc in products does not result in risks for agricultural soils, road border soils and general water quality. Also, it has been demonstrated that the waste of non-recycled zinc products and other materials containing zinc does not pose an environmental risk. And pollution related to traffic also elevated the value of zinc in the environment (Saleem *et al.*, 2015).

Over the last few decades, zinc emissions from zinc manufacturing and processing have been reduced substantially by process improvements and the progressive implementation of more efficient emission abatement techniques. As a result, present-day emissions from industrial processes are limited. The impacts of lead exposure on humans depend on the level or severity of exposure. Exposure to very high levels of lead in children has been found to decrease attention span, increased irritability, increased dullness and shorter attention span in the central nervous system subsequently resulting to seizures, headache, coma and even death (Pfadenhauer *et al.*, 2014).

Conclusion:

The present study was conducted to analyze the heavy metal conc. at government schools of Shalimar town. According to our findings, schools shows higher conc. of zinc metal which were extremely higher and are exceeding the standards of NEQS. Lead also shows higher standards values that are exceeding the NEQS standards. During this visit, it was found that there were so many garbage, sewage, improper disposal of waste at school sites and traffic was higher. From this study it is concluded that traffic, sewage, sludge and manure are one of the major reason of zinc conc. Higher in our environment. It causes great health impact on children and residents as well. It is suggested that proper handling of traffic related pollution, disposal of sewage, garbage should be done by that community administration. And school administration should also take step on it and raise awareness among children and manage proper disposal and garbage.

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