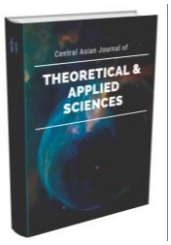

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Article

Assessment of Saliva Lead and Cadmium Levels and Its Association with Dental Caries in Fuel Stations Workers in the City of Nasiriyah

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Abstract: According to certain notions, saliva can be a helpful indicator of environmental contamination, especially exposure to heavy metals like lead and cadmium. The study examined the associations between salivary lead and cadmium level with the dental caries: 35 saliva samples of workings in gasoline stations were analyzed for lead and cadmium . A clinical oral examination was performed using the World Health Organization's criteria to identify carious lesions. The median (range) (0.128 ± 0.056) µg/dl concentration of lead in the saliva of fuel stations workers was significantly higher than the median (range) of control group ($p< 0.05$). The results obtained also showed that the values of saliva lead levels in many workers were higher than action and upper limits acceptable for age > 35 years at p. value < 0.05 while Cd level a significant increase of Cd level in patients that age ≤ 35 years, while decrease in patients that age > 35 years. In fuel station workers, the duration of exposure to leaded fuel was significantly correlated with the saliva lead level. Also significant differences in saliva lead and cadmium concentrations were found in relation to smoking. The current study showed a significant increase of both Cd and Pb levels in caries patients those who did not take care of oral hygiene compared with those who take care of oral hygiene the medium range (0.083 ± 0.032) of lead and (0.0344 ± 0.008) of cadmium. The salivary lead level significantly correlated with the dental caries. The findings showed that tooth caries is associated with high levels of heavy metals in saliva. According to the current research, saliva might be a suitable substitute for biological lead exposure monitoring.

Keywords: Dental caries, Cadmium, Lead, Saliva

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1. Introduction

Indicators of biological contamination, such as teeth, bones, hair, blood, and nails, can be used to quantify physical, chemical, and biological means of controlling the release of heavy metals into the environment [1]. Microbiological, genetic, immunological, behavioral, and environmental factors all play a role in the risk and severity of dental caries, which is a complicated disease.Acid-producing bacteria and host components, such as teeth and saliva, interact over time to cause dental caries [2].Surface demineralization of teeth results from endogenous bacteria producing organic acid that lowers the pH of plaque [3].

The workers in oil refineries and gas stations are constantly exposed to a variety of dangerous pollutants. They are always at risk of severe pollution, accidents, and even

death due to their working circumstances. Workers at oil refineries are regularly exposed to the hazardous heavy element lead [4]. Emissions of lead and cadmium have skyrocketed in the 20th century. Lead exposure was mostly caused by gasoline, whereas cadmium levels rose because goods containing cadmium were frequently disposed of with household waste rather than being recycled.

In order to limit the potential of negative health impacts, It is important to take action to shield the general public from lead and cadmium exposure. Cadmium exposure can have negative health effects even at low exposure levels [5].

Pb is a divalent cation, its metabolism is influenced by the same factors that affect calcium metabolism, and Pb has a propensity to "follow the calcium stream," which are potential mechanisms by which Pb could increase susceptibility to caries. It appears that lead ions directly interact with bone mineral, substituting calcium and phosphorus in the crystal structure and increasing the susceptibility of enamel to dissolve and trigger the caries process [6].

Lead (Pb) and cadmium (Cd) are prevalent contaminants. They are linked to harmful health impacts and are hazardous even at low concentrations. According to [7, 8] Pb is integrated into calcified tissues including teeth and bones, whereas Cd primarily accumulates in the kidneys, liver, and bones. Workers at gas stations have high-risk jobs where they could be exposed to lead from dust and gasoline fumes. Lead exposure periods are often higher for employees working eight hours a day at gas stations than for non-workers. In addition, in the event that workers neglect to use gloves and masks with tiny pores as personal protective equipment.

The study of results in the evaluation of blood plasma; nevertheless, certain investigations function as an objective indicator of illness monitoring, risk assessment, diagnosis, prognosis, and detection. These biomarkers could include DNA, immunoglobulins (IgA), toxins, heavy metals (leads), hormones (cortisol), enzymes (amylases), and poisons [9, 10]. Numerous research on the impact of petroleum on health have been carried out. Some researchers evaluated the oral health of employees who were exposed to petroleum on the job. Petrol filling workers had higher rates of dental cavities and periodontal disease [11].

2. Materials and Methods

Study Design for methods This study design is cross-sectional and employs an analytical observational methodology. A study on lead and cadmium in saliva conducted at petrol benzene stations in the Iraqi governorate of Thi Qar. Thirty-five people (G1: Gasoline Fuel Station) and fifteen people (G2: students in Dental Hospital Faculty of Dentistry Thi Qar University) made up the test group for this study, which ran from January to March 2023. Criteria for Evaluation Saliva samples are subjected to an atomic absorption spectrophotometer to determine their lead content.

Data Gathering Researchers write out an informed permission letter to be the study's subject after explaining the methods, goals, and procedures of the research to be conducted at the Gasoline Fuel Station and Dental Hospital. Interviews were held regarding the pertinent topics, duration of employment, usage of PPE (masks and gloves), smoking, dental hygiene, age, duration of employment, and dental caries. Procedure for Sampling Saliva Subjects were instructed not to eat for the preceding hour before providing saliva for sample collection.

Subsequently, the participants were told to rinse for 30 seconds using pure water. Using the passive drooling approach, or the topic of passive salivary flow as much as 5 ml into the plastic tube, saliva collection methodology without stimulation was carried out in the morning from 09.00 to 11.00. Atomic Absorption Spectrophotometry in the Science Laboratory measures the amounts of lead and cadmium in saliva at a wavelength of 217 nm.

Dental Assessment

A dental hygienist with training examined the mouth cavity visually and tactilely. Under the operating light of the dental equipment, the caries condition of the teeth was assessed using a probe and a plain mouth mirror. In order to assess the teeth, the World Health Organization's standards were used for recording the number of primary teeth that were missing (m), filled (f), and decaying (d) [12].

Preparation of laboratory instruments

Vials were used to collect the teeth and saliva, glassware, and laboratory containers. These were cleaned using distillated water and then left overnight to soak in a 10% HNO_3 solution. Following numerous rounds of washing in deionized water, they were left to dry overnight.

Sampling saliva and measuring the pH of the saliva

The employees of the gasoline fuel station provided a sample of their saliva. Prior to saliva collection, the individual requested that no food or liquids be consumed for one hour. Afterward, distilled water should be used to rinse the mouth. The personnel were instructed to chew an unflavored, standardized-size piece of paraffin wax for one minute in order to stimulate salivary flow.

After that, expectoration was used to gather about 5 ml of saliva in a polypropylene tube over the course of 5 minutes. One saliva drop was pipetted onto a pH test strip paper before the saliva sample was ready to be frozen. (pH range: 4–8) for analysis. To remove any remaining cell debris, the saliva sample was immediately centrifuged at 1000 g for 5 minutes. Blood was clearly present in the samples, which were thrown out. Before being subjected to examination, the samples were kept frozen at -20 ºC. Between nine and eleven in the morning, every saliva sample was collected.

Salivary sample preparation for Pb and Cd analysis

Saliva (3 ml) and nitric acid (7 ml; 65%) were mixed together for examination. Pb and Cd were added to three milliliter aliquots of saliva by mixing them with a standard solution. To provide varied matrices for the methods' development (recovery studies), ten saliva samples were used.Statistical Analysis (for research involved of Pb and Cd).

The current study's data were statistically analyzed using the independent sample t test at p. value < 0.05, which was based on SPSS (Statistical Package of Social Science, version 26). The mean, standard deviation, and absolute and relative frequencies were computed using descriptive statistics. Use a t-test to determine the lead level differential between the test group and the control group as well as the association to dental caries.A 5% threshold for significance was established. The Moral Aspects The Faculty of Dentistry at Thi-Qar University's Dental Hospital has recommended ethical approval for this research.

3. Results

Estimation of Cd and Pb in Caries Patients and Control Group

The current study showed a significant increase of Cd and Pb concentration in patients with caries disease than control group at p. value < 0.05 as show in Table 1.

Table 1. Level of Cd and Pb in patient and control

Groups	Patients No. 20	Control No. 15	p. value
Heavy Elements	Mean ± SD		
Cd	0.0470 ± 0.004	0.0379 ± 0.009	0.002
Pb	0.128 ± 0.056	0.114 ± 0.048	0.018

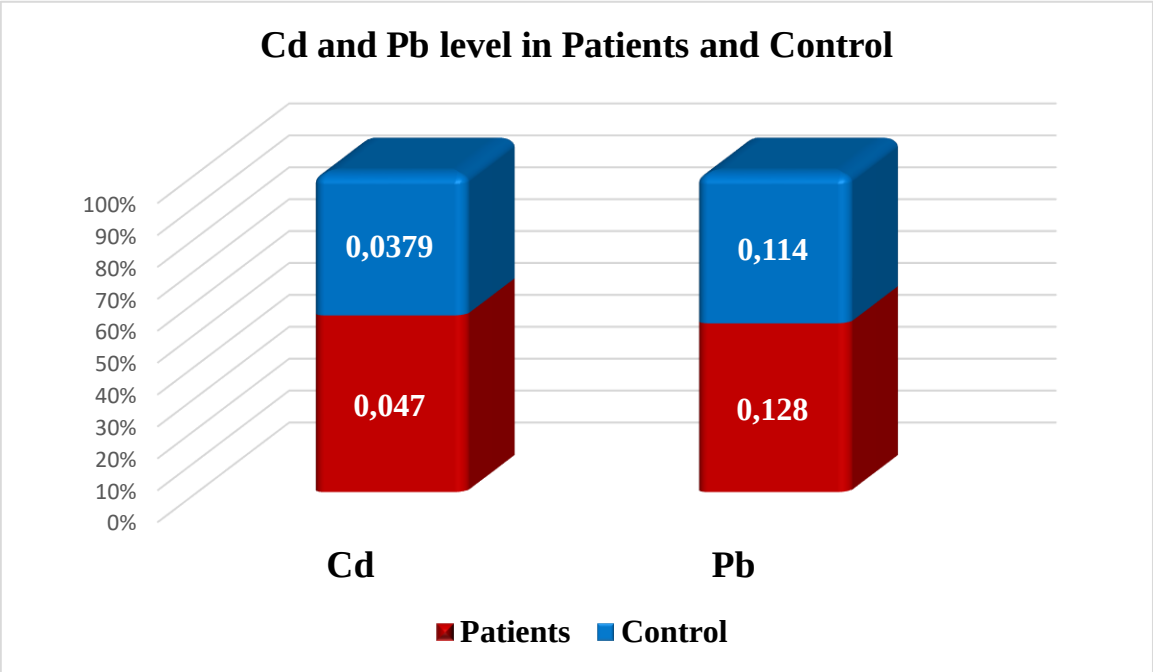

Figure 1. Level of Cd and Pb in patient and control

Estimation of Cd and Pb in Caries Patients According to Age Groups

The current study showed a significant increase of Cd level in patients that age ≤ 35 years, while decrease in patients that age > 35 years, whereas the Pb concentration increased in patients that age > 35 years at p. value < 0.05 as show in Table 2.

Table 2. Level of Cd and Pb in caries patient according to age groups

Age of Patients	≤ 35 years No. 8	> 35 years No. 12	p. value
Heavy Elements	Mean ± SD		
Cd	0.0501 ± 0.004	0.0449 ± 0.005	0.001
Pb	0.119 ± 0.046	0.134 ± 0.044	0.021

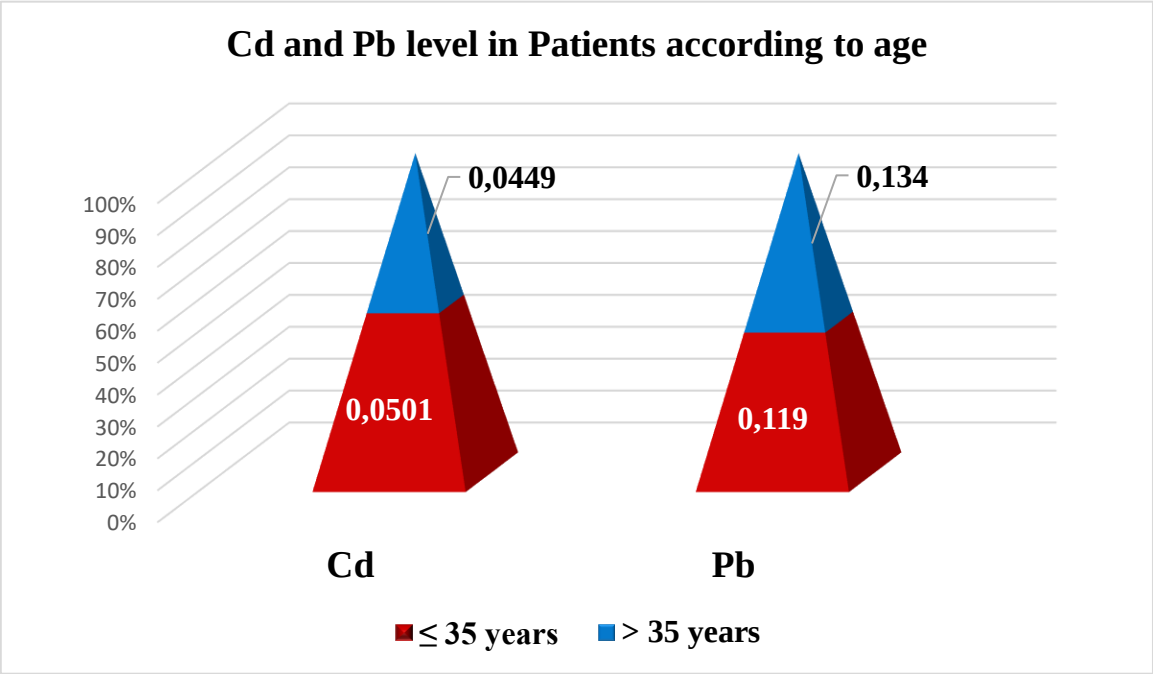

Figure 2. Level of Cd and Pb in caries patient according to age groups

Estimation of Cd and Pb in Caries Patients According to Work Duration

The current study showed a significant increase of both Cd and Pb levels in caries patients that work duration above 10 years than caries patients that work duration below 10 years as show in Table 3.

Table 3. Level of Cd and Pb in caries patient according to work duration

Work Duration	**≤ 10 years No. 15**	**> 10 years No. 5**	**p. value**
Heavy Elements	Mean ± SD		
Cd	0.0242 ± 0.003	0.0546 ± 0.008	0.001
Pb	0.105 ± 0.032	0.136 ± 0.059	0.020

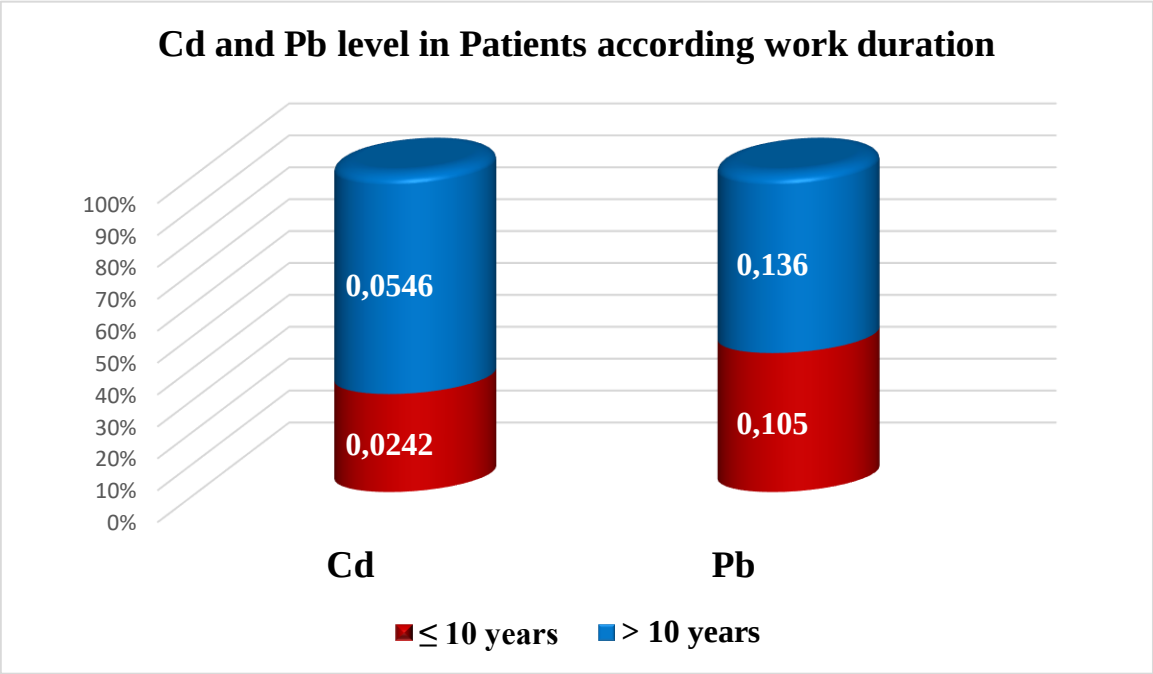

Figure 3. Level of Cd and Pb in caries patient according to work duration

Estimation of Cd and Pb in Caries Patients According to Oral Hygiene

The current study showed a significant increase of both Cd and Pb levels in caries patients those who did not take care of oral hygiene compared with those who take care of oral hygiene as show in Table 4.

Table 4. Level of Cd and Pb in caries patient according to oral hygiene

Oral Hygiene	**Good No. 13**	**Bad No. 7**	**p. value**
Heavy Elements	Mean ± SD		
Cd	0.0344 ± 0.008	0.0538 ± 0.009	0.006
Pb	0.083 ± 0.032	0.211 ± 0.063	< 0.001

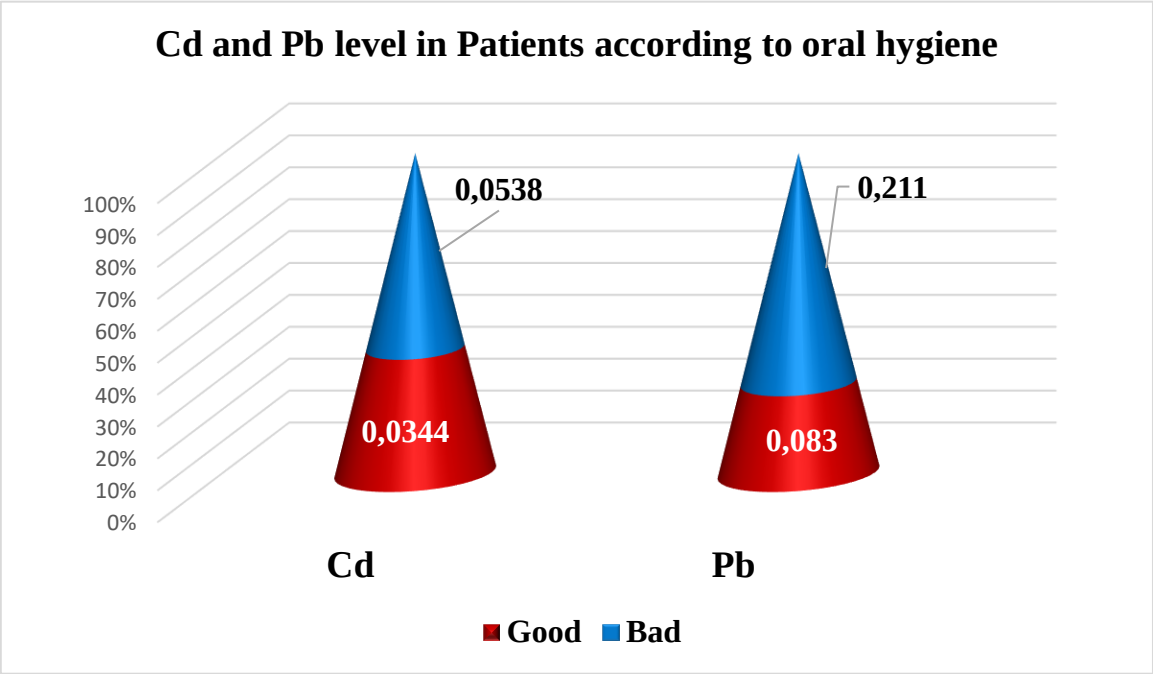

Figure 4. Level of Cd and Pb in caries patient according to oral hygiene

Estimation of Cd and Pb in Caries Patients According to Smoking

The current study showed a significant increase of both Cd and Pb levels in patients with dental caries smokers compared with those non-smokers as show in Table 5.

Table 5. Level of Cd and Pb in caries patient according to smoking

Smoking	**Non-smokers No. 7**	**Smokers No. 13**	**p. value**
Heavy Elements	Mean ± SD		
Cd	0.043 ± 0.008	0.054 ± 0.009	0.012
Pb	0.072 ± 0.032	0.159 ± 0.086	< 0.001

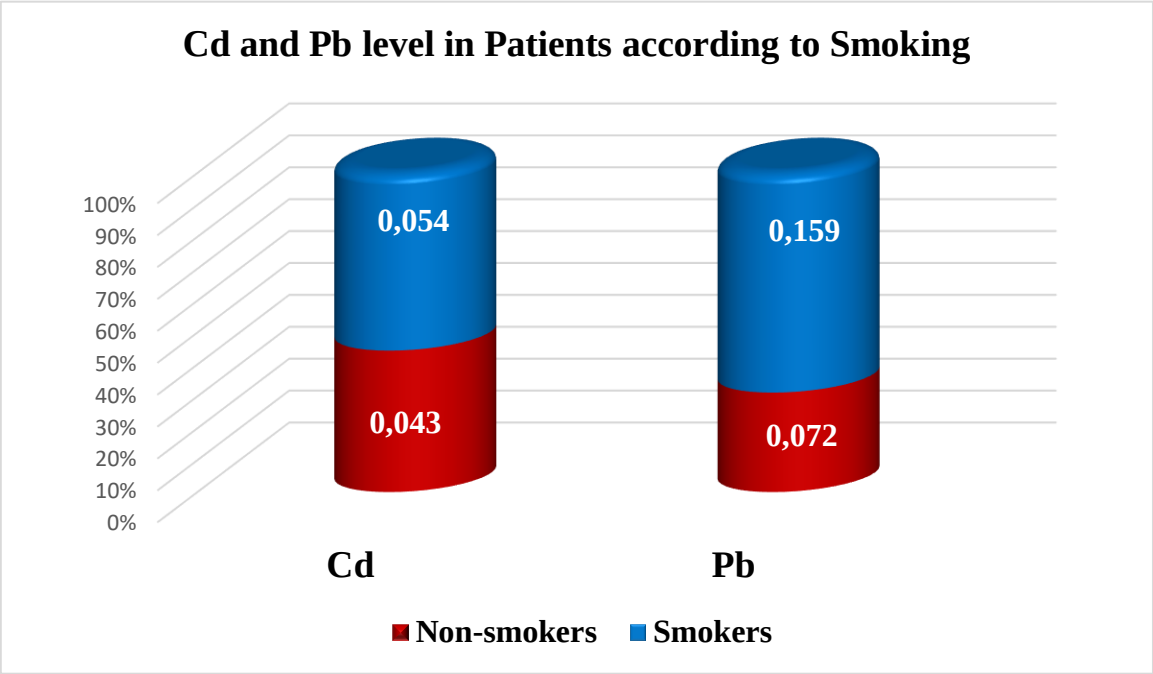

Figure 5. Level of Cd and Pb in caries patient according to smoking

Estimation of Cd and Pb in Caries Patients According to No. of Caries Teeth

The current study showed a non-difference in concentration of Cd, while the concentration of Pb was increased significantly in patients with more than 5 caries teeth as show in Table 6.

Table 6. Level of Cd and Pb in caries patient according to No. of caries teeth

No. of Caries teeth	**≤ 5 caries No. 10**	**> 5 caries No. 10**	**p. value**
Heavy Elements	Mean ± SD		
Cd	0.048 ± 0.007	0.046 ± 0.0012	0.407
Pb	0.110 ± 0.059	0.146 ± 0.063	0.027

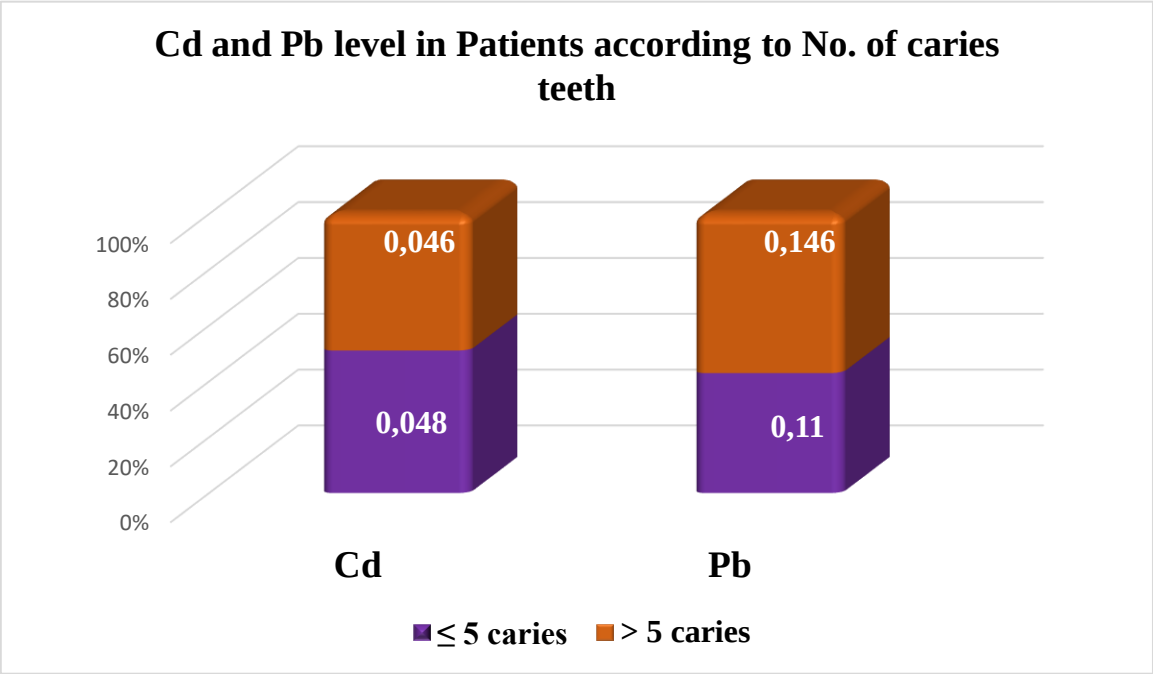

Figure 6. Level of Cd and Pb in caries patient according to No. of caries teeth

4. Discussion

This study aimed to assess the associations between salivary Pb and Cd levels and tooth caries workers, a group aged 20–45 who presented to Thi Qar University's pediatric dentistry department. We also examined how confounding variables affected dental caries and Pb/Cd levels. The findings showed show a statistically significant correlation between dental caries and Pb/Cd levels, confounding variables (Table 1).

The molecular mechanism that underlies the sensitivity of lead-exposed persons to dental caries remains unclear, despite multiple studies describing this susceptibility in recent years. It is suggested that lead has two effects: one direct and one systemic, through the mouth environment and blood and saliva. This could be explained by the fact that children's teeth from industrial areas had greater levels of lead detected in the surface enamel [13].

It has been proposed that lead cariogenicity may occur through effects on salivary gland function, which raises caries susceptibility. According to [14], an animal investigation revealed that rats exposed to lead throughout the prenatal and perinatal periods exhibited an increase in dental caries and a marked decrease in salivary flow rate. However, in a subsequent investigation, the same author found contradictory results regarding the impact of lead exposure on salivary gland weight [15], another study revealed that rats exposed to lead had lower concentrations of calcium and protein in their saliva [16].

There was a decrease in total antioxidant capacity, a drop in thiol group levels, and an increase in lipid peroxidation in the salivary gland tissue, confirming the presence of lead-induced oxidative stress, even if the rats' salivary flow rate was unaffected [16]. Nonetheless, the results of the current investigation indicate that salivary lead concentrations had an impact on tooth caries. Cadmium may have a caries-promoting effect due to disturbance of salivary gland function. When rats were given cadmium subcutaneously, their salivary glands showed histologic evidence of tubular and acinar injury. Additionally, exposure to cadmium lowered salivary secretions and decreased the amount of amylase, the main salivary digesting enzyme, in parotid gland saliva [17].

According to [18], these effects of cadmium may be related to the suppression of parasympathetic impulses and the regulation of acetylcholine release, both of which are important in controlling salivary secretions. There have also been reports of oxidative

stress induction in salivary glands [19] and competitive blockage of calcium channels by cadmium [20, 21].

Similar to the current investigation, a number of earlier investigations demonstrated that Pb and Cd concentrations vary with age. For instance, Baranowski et al. discovered that Pb in human teeth and age had a positive link [22]. Additionally, Nowak discovered that age had a definite impact on Pb levels [23]. When Komarnicki examined the concentration of lead and cadmium in several organs of moles, she discovered that as age advances, both metals build up in bone tissue [24].

The findings of other research, however, regarding the impact of age, such as those on lead and cadmium concentrations [25, 26] are in contrast. lead concentrations; however, according to Asaduzzaman et al. [27], the concentration of the ten heavy substances varied with age. In contrast, Alomary et al. [28] found no discernible variation in the concentration of heavy metals until the age of 50. However, other research found that the kind of tooth affected the statistical differences in copper and zinc contents.

The quantities of Pb and Cd in saliva samples from people who brush their teeth every day are lower than those of people who don't, but the difference between the two groups is not statistically significant, according to Table 4 data. The Pb (0.083 ± 0.032) and Cd (0.0344 ± 0.008) levels found in human saliva.

For at least 25 years, it has been known that smoking can expose one to lead and cadmium. Cadmium levels in cigarettes were found to range from 1.56 to 1.96 micrograms. According to the research [29], smoking a single cigarette may have resulted in the inhalation of 0.1–1.2 μg of cadmium.As previously reported, this study indicated that the concentration of cadmium was higher in smokers than in non-smokers. Cadmium accumulated significantly in smokers' saliva.

The primary source of cadmium is probably tobacco smoke, and the high cadmium content of tobacco leaves might be due to the extensive use of chemical fertilizers. In our study, smokers with dental caries had a much higher amount of cadmium. According to the research, smoking more cigarettes per day was associated with higher concentrations of lead and cadmium.

5. Conclusion

Salivia are readily obtainable biological elements that are useful indicators of pollution exposure in the environment. Teeth offer a steady, cumulative, and persistent record of environmental exposure. Dental caries is also caused by the amounts of Pb and Cd found in the saliva of gas station employees. The current study's findings show that the levels of lead and mercury in human salvia are significantly influenced by smoking, age, and length of employment.

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