Original Article

Effects of Lead (Pb) and Cadmium (Cd) Exposure on Infertility Issues in Targeted Male Population in Industrial area of Hayatabad Peshawar Khyber Pakhtunkhwa

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ABSTRACT

Objective: To find serum level of lead and cadmium in male population of reproductive age, correlate it with infertility issues and to recommend safety and remedial measures in industrial work place in Hayatabad Peshawar.
Study Design: Cross sectional study
Place and Duration of Study: This study was conducted at the Tertiary Care Hospital Dr. Fida Painless Hospital and Health Care Center Peshawar KPK from June to November 2021.
Materials and Methods: The study population was 70 infertile male divided into two equal groups. G1 consists of 35 male in age group (20-35 years) and G2 (36-55 years). Data was collected on a questioner designed for the study. The living samples of nail were donated by the patient on informed consent. Wet Acid Digestion of nail was carried with nitric acid for 60 minutes at 60°C. The Pb and Cd content of nails were measured by atomic absorption spectrophotometers (Model Perkin Elmer AAS 700).
Results: Mean BMI of G1 population was lower (25.35 kg/m2) than G2 (28.71 kg/m2). The mean lead level in nail of G1 ((303.23ug/g) was higher than in G2 ((297.9ug/g). Similarly The mean Cd level in nail of G1 ((92.86 ug/g) was also higher than in G2 ((33.36 ug/g). Cd was positively related with age and negatively correlated with BMI. Pb was negatively correlated with both age and BMI in G1 and G2.
Conclusion: The findings of this research reveal that exposure of industrial workers to Pb and Cd contamination may increase their level in their body tissues and may be a potent threat to their sexual health and infertility issues in male. Thus safety measured should be adopted to avoid the accumulation of these toxic heavy metals and their long term effects on their health.
Key Words: Effects of Lead (Pb), Cadmium (Cd), Population, Industrial area.

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INTRODUCTION

Toxic metals are any metallic elements that pose a risk to the environment or public health. Built on the idea that heaviness and toxicity are related, toxic metals and metalloids including lead, cadmium, arsenic, chromium, zinc, and copper, these substances can cause toxicity even at low exposure levels. Environmental pollution brought on by these metals has recently become a growing threat to both the environment and worldwide health care.

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Moreover, because of an exponential growth in their usage in a number of industrial, agricultural, technical and residential applications, human exposure has considerably risen. Due to geological, industrial, agricultural, pharmaceutical, household effluent, and environmental activities, toxic metals have been discovered in the environment[1]. Despite the fact that dangerous metals are present throughout the earth's crust, human endeavors, including mining, smelting, manufacturing, domestic and agricultural use of metal-containing compounds account for a significant portion of pollution. Environmental contamination can be caused through the corrosive environment, air deposition, heavy metal absorption and soil depletion of metal ions and metal escape from water to soil and spring water[2]. Extraction of base metal and other metal-processing industries are highly toxic for overall human health .Many biochemical and physiological processes need metals, including cobalt (Co), copper (Cu), chromium (Cr), iron (Fe), molybdenum (Mo), nickel (Ni), selenium (Se), and zinc (Zn)[3]. Many diseases or syndromes are brought on by a deficiency in certain micronutrients. Heavy metals are also categorized as trace elements because of their occurrence in numerous environmental matrices at very small amounts (ppb to ≤ 10ppm). Physical criterion such as temperature, appearance and surface assimilation influence their bioavailability[4].

There are several industrial, agricultural, and domestic applications for lead. Nowadays, it is used to produce lead-acid batteries, explosive, metal goods (such as pipes and solder), and X-ray shielding devices[5]. A total amount of 1.52 million metric tons of lead were consumed in the US in 2004 for various industrial uses. After being ingested, Lead pile up in the blood, body matter and bone with a half-life that ranges from 35 days in the blood to 20–30 years in the bone. Lead is categorized as a male reproductive toxicant since it has been identified in male reproductive tissues. The overall blood lead level of an adult was 19 g/L in a study of a random selection of the US population, which is rather high. In animal studies, lead exposure has been associated with testicular shrinkage, modifications in the weights of the accessory glands, modifications in the quality of the sperm, and disorder of the hypothalamic-testicular pituitary axis[6]. The environment and employees are both are also at risk from the heavy metal cadmium (Cd). It is abundantly distributed throughout the crust of the planet, where its average concentration is 0.1 mg/kg. The majority of environmental cadmium compounds are absorbed by sedimentary rocks, while marine phosphates have a cadmium content of around 15 mg/kg. In several industrial processes, cadmium is often used. In addition to other things, cadmium is employed in the production of metals, pigments, and batteries. Cd causes damage to the testicles within 24-48 hours[7]. The blood-testis barrier can also be damaged by cadmium. Cd toxicity can affect both Sertoli and Leydig cells. Also, it has been shown that cadmium builds up in the pituitary and hypothalamus, reducing prolactin levels. These results suggest that cadmium may have both direct (via injury to the testicles and hypothalamus-pituitary) and indirect (through improve hormone synthesis) effects on the reproductive system[8]. According to another study, blood cadmium levels (mean 1.35 g/L) were favorably linked with sperm midpiece abnormalities (r=0.42, p0.05), immature forms (r=0.45), and is inversely linked to sperm volume (r=0.37, p0.05)[9].

We conducted this study in industrial area Hayatabad Peshawar to see the effects of Lead (Pb) and Cadmium (Cd) exposure on infertility issues in targeted male work force who are working in these industries for along time.

MATERIALS AND METHODS

Patients: The study population was 70 infertile male divided into two equal groups. G1 consists of 35 male in age group (20-35 years) and G2 (36-55 years). Data was collected on a questioner designed for the study. The living samples of nail were donated by the patient on informed consent. A stainless steel nail cutter was used to harvest the fingernails. The nail sample was stored at room temperature in covered polyethylene vials prior to the digestion procedure.

Reagents and standard solutions: Very pure chemicals including acetone, hydrogen peroxide, nitric acid, and Triton X-100 were provided by E. Merck. Ultra-pure (deionized) water from a Milli-Q filter system was used throughout the project. Before being washed with distilled water, all of the apparatus was properly cleaned. The apparatus spent the night submerged in a 10% (v/v) nitric acid solution. After 12 hours, the equipment was washed with deionized water, and placed for 90 minutes in the oven to dry.

Sample washing procedure: The sample's obvious filth was removed by breaking it into little pieces and washing it with cotton. Each sample was gathered and placed in a 100ml beaker. Each sample was cleaned using a variety of solvents in the sequence mentioned below: Using a mechanical shaker, add 0.5 percent Triton-X100 first, followed by three cleaning sessions with deionized water, three sessions with Methyl Ethyl Ketone, then three sessions with deionized water again. For the nail sample, everything needed to be rinsed, dried overnight at 60°C in an oven, and then stored in polyethylene tubes before the digestion process.

Wet Acid Digestion of nail: Fingernail samples weighing 25 mg were placed in a 50 mL volumetric flask for digestion. One mL of HNO_3 was added to the flask, left at 25º C for 12 hours. In a drying oven, the samples were dried for 60 minutes at 60 ° C. The volumetric flask was cooled, 0.5 mL of H_2O_2 was added, the flask was sealed, and the liquid was heated to around 60 °C until it was clear. After that, the solution was poured into a sample tube and deionized water was added to a volume of 25 mL.

Atomic Absorption Spectrometry: With the use of an acetylene flame and an atomic absorption spectro-photometer, the Pb and Cd content of nails were measured (Model Perkin Elmer AAS 700). As stated in the Standard Conditions for Pb and Cd, standards were created by diluting the stock standard solution with 5% (v/v) glycerol to 0.5 ppm, 1.0 ppm, and 1.5 ppm. A 5% (v/v) glycerol solution was used as a blank. Reference levels of metals in nails [mg/kg=mcg/g]

Normal level; Pb = 2.0 and Cd = 0.14 [mg/kg=mcg/g]

Pathological levels of metals in nails;

Pb >2.0 Cd >0.14[mg/kg=mcg/g)]

Statistical Examination of Data: SPSS software of version 22 was used for the statistical analysis of data. Two types of Deviations were used that is mean and standard to present the data. To determine whether there was a connection between lead and cadmium levels present in nails and reproductive difficulties of the research population, the gathered data was statistically analyzed. A two-tailed p value of less than 0.05 was considered statistically significant.

RESULTS

Patient's medical record of infertile male population: Table1 show the the medical record of the population which encompasses the numerous issues faced by infertile men in G1 and G2 which are listed below in percentages.

Comparison of baseline characteristics and Pb and Cd in study subjects: Figure 1 shows parameters for the G1 and G2 infertile male population. Mean BMI of G1 population was lower (25.35 kg/m2) than G2 (28.71 kg/m2). The mean lead level in nail of G1 ((303.23ug/g) was higher than in G2 ((297.9ug/g). Similarly The mean Cd level in nail of G1 ((92.86 ug/g) was also higher than in G2 ((33.36 ug/g).

Table No. 1: Medical record of infertile male population.

S.No	Mean	G 1 Age 20-35 years certainty%	Uncertainty %	G 2 Age 36-55 years certainty %	Uncertainty %
1.	Fertility therapies				
I	IVF	22.85%	77.14%	25.71%	74.28%
Ii	Intracytoplasmic sperm injection	17.14%	82.85%	14.28%	85.71%
Iii	IUI	28.57%	71.42%	40%	60%
2	TB	45.71%	54.28%	65.71%	34.28%
3	Chemical exposure	74.28%	25.71%	82.85%	17.14%
4	Radiation sickness	91.42%	8.57%	85.71%	14.28%
5	Chemotherapy	34.28%	65.71%	51.42%	48.57%
6	Feverish infection	80%	20%	71.42%	28.57%
7	Mumps in adolescence	42.85%	57.14%	51.42%	48.57%
8	Diabetes mellitus	8.57%	91.42%	14.28%	85.71%
9	Hypertension	5.71%	94.28%	17.14%	82.85%

Daily habits of infertile male population: Table 2 shows daily habits of infertile male population of G1 and G2 which is given below in percentages.

Table No. 2: Daily habits of infertile male population.

Mean	G 1 Age 20-35 years Yes %	No %	G 2 Age 36-55 years Yes %	No %
Smoking cigarettes	88.57%	11.42 %	82.85%	17.14%
Sleep disturbance	34.28%	65.71 %	37.14%	62.85%
Caffeine utilization	25.71%	74.28 %	22.85%	77.14%
Processed food utilization	48.57%	51.42 %	60%	40%

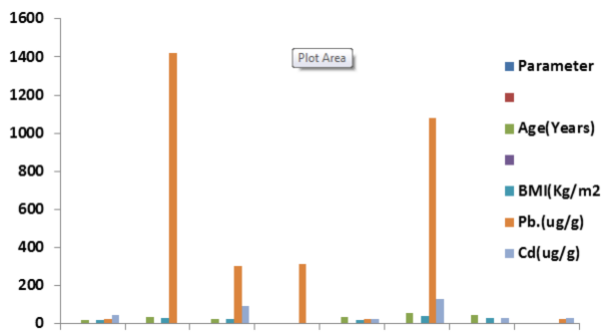

Figure No. 1:Comparasion of base line and NAIL Pb and Cd in study subjects.

Pearson bivariate correlation analysis

Infertile male G1 age (20-35 years) populations' bivariate nail concentration of Cd (mcg/g) and Pb (mcg/g) with age and BMI is shown in Table 3. Age and BMI among infertile men were strongly linked with lead and cadmium nail level (p=0.01).

Table No.3 Pearson bivariate correlation analysis

Parameter	Mean	G 1				G 2			
	Pearson Correlation	Age	BMI	Pb	Cd	Age	BMI	Pb	Cd
Age	Sig(2 tailed)	1	.171 .326	.220 .205	.196 .260	1	.291 .090	-.035 .84	-.077 .667
BMI	Sig(2 tailed)	.171 .326	1	.178 .307	-.032 .854	.291 .090	1	-.022 .900	-.016 .928
Pb.	Sig(2 tailed)	.220	.178	1	.860**	-.035	-.022	1	.716**

		.205	.307		.000	.843	.900		.000
cd.	Sig(2 tailed)	.196 .260	-.032 .854	.860** .000	1	-.077 .662	-.016 .928	.716** .000	1

**. Correlation is significant at the 0.01 level (2-tailed)

DISCUSSION

Heavy metal toxicity on the male reproductive system has been thoroughly examined and verified, also at low doses. Proteins, carbohydrates, ions, and tiny organic compounds all work together to keep sperm moving. It is one of the most important components that aid the sperm's trip to the egg and following fertilization. Infertility in humans is frequently caused by sperm motility defects. ROS induction is the most common cause of infertility related to metal poisoning. Antioxidant therapy is a viable therapeutic option for heavy metal poisoned patients.

In this research study we collected nails samples from infertile workers working in various industries of industrial area Hayatabad in Peshawar, for the analysis of lead and cadmium levels in their nail. We looked at a group of males seeking infertility treatment, which enabled us to look at the link between high prevalence risk variables and infertility results exposed to heavy metals in their work place. We found a very high concentration of both lead and Cd in the G1 Population comprising workers in the age range from 20-35 years .it is in close agreement with earlier reported work that testicular cadmium levels are age-dependent, with increase in cadmium concentration occurring predominantly during the fourth decade of life. It was discovered that seminal plasma cadmium and patient age have a statistically significant positive relationship.

Smoking cigarettes is linked to smaller testicles, higher levels of reproductive hormones in the blood, and worse sperm concentration and motility. It was discovered that mice treated with cadmium had a lower proportion of sperm cells with proper morphology. Another two investigations in animals exposed to Cd found similar effects to our research. Dipankar Bhattacharyya, Famurewa, A. C. and coauthors also found higher of plasma lead and cadmium in infertile men ($p=0.001$).[10]

The consequences of smoking in workers on blood lead levels may have an impact on sperm quality. The mechanisms behind its harmful effects on male reproductive capacity, are yet unknown as observed by PC[11].

The percentage of workers with caffeine use and sleep disturbance was lower in our both study groups. Caffeine use is linked to double-strand DNA breaks and sperm genomic instability's. Healthy non-smoking males who consumed more than 308 mg (2.9 cups) of coffee per day showed elevated double-strand sperm DNA injury regardless of age.

Research shows that sleep deprivation has impact on sperm function in an animal research, suggesting that sleep disorders may have a deleterious influence on male fertility. The quantity of semen was smaller in individuals with trouble commencing sleep.

CONCLUSION

The findings of this research reveal that exposure of industrial workers to Pb and Cd contamination may increase their level in their body tissues and may be a potent threat to their sexual health and infertility issues in male. Thus safety measured should be adopted to avoid the accumulation of these toxic heavy metals and their long term effects on their health.

Author's Contribution:

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Conflict of Interest: The study has no conflict of interest to declare by any author.

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