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INVESTIGATIONS AND ANALYSES OF HEAVY METAL IONS IN HUMAN BLOOD SAMPLES

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Abstract:

Toxic heavy metals are toxins that are persistent and non-biodegradable and build up via the food chain. Therefore, it is considered to represent a serious risk to human health when any dangerous heavy metal is present in the soil, water, air, or food over a certain threshold. There is no concrete information on the level of heavy metal contamination in food or other environmental samples or the quantity of heavy metal content in Keralans' blood. Dentistry continues to be one of the main sources of mercury contamination for both consumers and professionals globally. The consumption of fish is regarded to be one of the key factors in human exposure to mercury. Even though some Keralites are vegetarians, the normal diet of the average Keralite still consists mostly of rice and fish. In the aforementioned conditions, a quasi-experimental analysis of the accumulation of three harmful metals, including mercury, in various ambient samples and nine heavy metals in human blood was done. Mercury was specifically examined in relation to dentistry. The effects of heavy metals on persons were assessed based on each heavy metal's blood levels (BL). Environmental and nutritional factors included fish, rice, paddy soil, fairness creams, and drinking water samples. Fish consumption among the study population, occupational exposure in dentistry due to amalgam treatment, and exposure due to amalgam treatment in both dental professionals and the general public were the three sources of human mercury exposure that were explicitly evaluated.

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1 INTRODUCTION:

Any metallic element that has a relatively high density and is dangerous or deadly even at low concentrations is referred to as a "heavy metal" [1]. A generic phrase used to refer to a set of metals and metalloids having an atomic density larger than 4 g/cm3, or 5 times or more, than water, is "heavy metals" [2]. Lead (Pb), cadmium (Cd), zinc (Zn), mercury (Hg), arsenic (As), silver (Ag), chromium (Cr), copper (Cu), iron (Fe), and the elements belonging to the platinum group are examples of heavy metals [3]. Heavy metal toxicity is the excessive concentration of toxic heavy metals that have built up due to human-caused activities. These metals can enter plant, animal, and human tissues through inhalation, diet, and manual handling. They can also bind to and impair the function of essential cellular components [3]. For ecological, evolutionary, nutritional, and environmental reasons, heavy metals are major environmental contaminants, and their toxicity is an issue that is becoming more and more important [4]. They are often scattered throughout rock formations. Heavy metals were anthropogenically added to the biosphere as a result of increased industry and urbanization, and they were most readily available in soil and aquatic environments. Since many heavy metals are thought to be necessary for plant development, heavy metal toxicity in plants varies with plant species, individual metal, concentration, chemical form, and soil composition and pH [5].

Since they cannot be broken down or eliminated, heavy metals are persistent environmental pollutants that naturally reside in the earth's crust [6]. They minimally enter the body by food, air, and water, where they bio-accumulate over time [7]. They are collected as minerals from the various chemical forms in which they are present in rocks as their ores. Sulfides like those found in iron, arsenic, lead, lead-zinc, cobalt, gold, silver, and nickel as well as oxides like those found in aluminum, manganese, gold, selenium, and antimony are examples of heavy metal ores [8]. Some, like iron, copper, and

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cobalt, are present and may be extracted as both sulphide and oxide ores. Mineral processing processes essentially recover heavy metals from their ores [9].

Heavy metals may enter the environment as a result of both natural and man-made sources. One of the primary human-made sources of emissions of heavy metals is mining [10]. Sometimes, even after mining activities have ended, the discharged metals remain in the environment for a very long period. Hard rock mines are claimed to run until the minerals are depleted after 5 to 15 years, but the metal pollution they produce continues for hundreds of years after the mines are closed [11]. In addition to mining, mercury is also released into the environment during the manufacture of sodium hydroxide and cosmetic products [12]. The atmosphere is exposed to both elemental and compound (organic and inorganic) heavy metals. A large number of industrial point sources, such as former and present-day mining operations, foundries, smelters, combustion by-products, and transportation, are categorized as anthropogenic sources of emission [13].

2 LITRAETURE SURVEY

Natural and human sources are the two primary sources of heavy metals in water and wastewater. The human elements include metal polishing and electroplating procedures, mine extraction operations, textile businesses, and nuclear power. The natural aspects include soil erosion caused by volcanic activity, urban runoff, and particle aerosols. The primary natural sources of heavy metal contaminants in wastewater effluents include aerosol particles, soil erosion, volcanic activity, and urban runoff. Volcanic eruptions are said to have dangerous effects on the environment, climate, and those who are exposed to them. 2018 (Bhosale)

Lead

The Agency for Toxic Substances and Disease Registry (ATSDR) has created a Priority List for 2011 dubbed the ATSDR 2011 Substance Priority List in collaboration with the United States Environmental Protection Agency.

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According to the ranking, arsenic and lead are the two most dangerous heavy metals (ATSDR, 2011).Due to its acute and long-term hazardous effects on animal and human health, lead, one of the most poisonous heavy metals, is gaining significant attention from environmentalists. In addition, lead poisoning in humans severely affects the neurological system, kidney, liver, and reproductive system. The current Environmental Protection Agency (EPA) threshold for lead in drinking water and wastewater is 0.5 and 0.05 mg/L, respectively, according to US EPA (1986). However, the EPA's mandated limits are being greatly exceeded by the amount of lead ions added to the water stream, posing health risks and degrading the ecosystem (Shao et al., 2011).

Features of Lead

Lead is a shiny, bluish-white metal. It is ductile, very malleable, and soft, and it conducts electricity comparatively poorly. Although it is exceptionally corrosion-resistant, it tarnishes when exposed to air. Each of the three series of naturally occurring radioactive elements produces lead isotopes as a byproduct. Atomic mass of lead is 207.2 g/mol. Lead has a density of 11.34 g/cm3 at 20 oC. At 327 oC, lead melts and boils at 1755 oC.

Source and Usage of Lead The main sources of lead in the environment include recycled steel, ceramics, cathode ray tubes, plastics, finishing tools, solders, fragments of lead flashing, and other small products. Based on the extent and length of exposure, lead may have a broad variety of biological impacts. Lead strongly attaches to substances in the environment, including oil, sediments, and sewage sludge, making its removal a major problem (Sud et al., 2008). In addition to lead acid batteries, solder, alloys, cable sheathing, pigments, rust inhibitors, ammunition, glazes, and plastic stabilizers, lead is utilized in the manufacturing of these items as well (WHO, 1989). Tetraethyl and tetramethyl lead were significant due to their considerable usage as antiknock chemicals in gasoline in the past, but this use has nearly entirely been phased out globally. The practically widespread use of lead compounds in plumbing fittings and as

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solder in water distribution systems is significant from the standpoint of drinking water. In ancient plumbing and distribution systems, lead pipes may be utilized.2012's Kemertian Pariwisata dan Ekonomi Kreatif

3 Methods and Analysis

One gram of each dust sample was weighed out into a Teflon tube, mixed with six milliliters of HNO3, two milliliters of hydrochloric acid (HCl), one milliliter of HF, and let to rest at room temperature for an entire night to allow the acids to break down the sample. The samples were stored in a desiccator after being dried thoroughly at 50oC for two hours. They were cooked at 105°C for two hours. The samples were chilled and filtered using a 0.45 m PTFE syringe filter. In preparation for instrumental analysis, the filtrate was diluted with ultrapure water to a final amount of 50 mL and kept in plastic tubes in the refrigerator.

Instrumental analyses of arsenic (As), cadmium (Cd), chromium (Cr), copper (Cu), iron (Fe), lead (Pb), manganese (Mn), nickel (Ni), scandium (Sc), tin (Sn), titanium (Ti), vanadium (V), and zinc (Zu) were performed using an Agilent ICP-MS model 7700. Before being included in the sample analysis, each targeted trace element underwent an external calibration spanning 11 concentration ranges, ranging from 0.5 to 1000 ppb. The following parameters were used: RF power was 1550 watts, RF matching was 1.78 volts, carrier gas flow was 0.9 liters per minute, He gas flow was 4.5 milliliters per minute, and nebulizer pump speed was 0.1 revolutions per second. Integral time was 0.1 seconds, acquisition time was 22.76 seconds, sampling period was 0.31 seconds, and RF power matching was 1.78 volts. Three duplicate readings were conducted.

Health Risk Evaluation

In this research, I utilized the lifetime absorbed daily dose and absorbed daily dosage obtained by the human body by ingestion to complete the health risk assessment using the (USEPA) modal.

$$ADDing = \frac{Cs \times IgR \times EF \times ED \times CF}{BW \times AT} \quad (1)$$

$$LADDing = \left(\frac{Cs \times EF \times CF}{AT}\right) * \left(\left(\frac{IgR \times ED}{BW}\right) Children + \left(\frac{IgR \times ED}{BW}\right) Adult\right) \quad (2)$$

Where CF is the conversion factor (0.000001kg/mg), BW is body weight

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(children 15 kg, adults 70 kg), IgR is the rate of ingestion (children 200 mg soil/day, adults 100 mg soil/day), EF is the exposure frequency (350 days), ED is the duration of exposure (children 6 years, adults 24 years), and AT stands for a noncarcinogenic element over a year (356 x ED), and LADD is calculated for noncarcinogenic elements over

Numerous criteria are calculated to determine the carcinogenic and noncarcinogenic risk.

To calculate the non-carcinogenic impact HQ and determine the non-carcinogenic hazards in the dust, the ADD for exposure routes was divided by a Reference Dose RfD. The HQ from ingesting xposures is added to get the HQ; values greater than 1 suggest a possible or probable negative impact on health. Values below 1 however, do not significantly indicate any potential harm to health.

$$HQ = \frac{ADD(ing)}{RfD} \quad (3)$$

$$HI = \sum HQ \quad (4)$$

evaluation of the risk of cancer

The following formula was used to determine the carcinogenic risk.

Reference dose (RfD), a non-carcinogenic threshold, and cancer slope factor (SF), a carcinogen potency factor, are two crucial toxicity metrics. By integrating all of the data that have been gathered to provide quantitative estimates of cancer risk and hazard indices, risk characterization analyzes the potential for carcinogenic and non-carcinogenic risks in adults and children in the research region. According to the International Agency for Research on Cancer's (IARC, 2011) order of categorization group, Pb, V, and Mn were considered to be non-carcinogenic elements, while Cr, Cd, As, and Ni were categorized as potentially carcinogenic pollutants. The hronic Daily Intake dosage acquired from exposure assessment stages multiplied by the Slope Factor SF may be used to represent both carcinogenic and non-carcinogenic risk. As stated in Table 1, RfD and SF values mostly sourced from the USEPA are used to construct both the non-carcinogenic and carcinogenic risk assessment of trace metals.

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Table 1: frequency doses (RfD) and sloppy factor (SF) of exposure to trace metals by food.

project	As	Cd	Cr	Co	Cu	Fe	Pb	Mn	Ni	Sc	Sn	Ti	V
RfD	0.0003	0.0001	0.003	0.0003	0.04	0.7	0.0035	0.14	0.02	ND	0.6	ND	0.0(
SF	1.5	6.3	0.5	ND	ND	ND	0.0085	ND	0.84	ND	ND	ND	NI

Before analysis, all data were checked to see whether they were normally distributed using the Shapiro-Wilk test. The majority of the trace elements investigated had abnormal distributions (p0.001). Thus, it was assumed that all trace metals had non-normal distributions across all sample contexts. The mean, standard deviation, median, minimum, and maximum descriptive statistics were used to examine the trace metal concentrations in household dust. Environmentally distributed metals including cadmium, lead, and copper. hazardous heavy metals are used. Humans have negative and severe side effects from them. Although some metals have positive effects, they also present significant risks. Because of accelerated industrialisation and pollution, the level of heavy metals is rising. Metal toxicity results in illnesses and other health problems in individuals. Measuring the potential health risk of workers is challenging. Therefore, finding these metals in blood is a crucial concern. Even a little quantity of a trace element might cause health issues in humans. When these metals are inhaled from an environment where the presence of heavy metals is significant, blood toxicity is immediately impacted. The study on scientifically detecting metals' effects on people and health evaluation has only begun. According to the research, blood samples included metal concentrations of copper, cadmium, and lead that were slightly over the permissible levels. mild examination of cadmium concentration. According to the results, the contacted HM group's whole blood had concentrations of 0.56 to 8.78 ppm and.08 to 4.67 ppm, respectively. The range of whole blood exposure samples' maximum cadmium concentrations is (.03 -.98 ppm). Whole blood has a copper concentration range of 0.01 to 1.107 ppm.Metals were more prevalent and linked to the contact time in the blood samples from the afflicted individual. Metal vapors inhalation in industrial settings poses risks.

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4 EVALUATION OF THE ANALYSIS

The health effects that metals and metal compounds may have on any organ or physiological system can range from those that result from a brief exposure to those that are believed to result from lifelong exposure to a metal. Target organs or end organs that represent the clinically relevant effects may be used to find these effects. The Critical impact, the first unfavorable impact, or its recognized precursor, that affects the most vulnerable species when an agent's dosage rate rises, may be the target organ effect for the EPA IRIS program. The neurological, cardiovascular, hematological, gastrointestinal, musculoskeletal, immunological, and epidermal organ systems are just examples of the target organs that may be affected.

The effects of exposure to a metal on a target organ are determined by a variety of circumstances. Some of these variables have to do with exposure, such as dose rate variables, which compare high-level, short-term exposure against low-dose, long-term exposure. The metal may stay in the body for a long period of time without having a hazardous or pathological impact thanks to binding or sequestration in a harmless form and retention time. While cadmium and lead may remain bonded or hidden in inactive forms for years, arsenic and mercury have biological half-lives that can be determined in days. Through intracellular interaction with metallothionein, cadmium is kept in soft tissues for 10 to 20 years (such as the liver and kidney). This has a finite capacity, and when the capacity is surpassed, liver and kidney damage develops. The production of metallothionein and competitive binding by other metals, notably zinc and copper, affect the limitations of cadmium retention by metallothionein.

Although lead is bound in several bodily compartments and may be said to "accumulate" in one or more of them, the relatively labile plasma fraction contains the most toxicologically important systemic lead. Blood plasma that contains "free lead"

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may be quickly excreted or transferred to soft tissues. The distribution of lead to different tissue locations in humans has been seen to have a non-linear connection between blood lead concentration and lead intake, which points to the possibility of a saturable absorption mechanism or another capacity-limited process. At least three distinct tissue pools are thought to exist in lead. The half-life of blood lead is the shortest at 36 days, whereas that of bone lead is the longest at many decades. The half-life of lead in soft tissues is around 40 days. The PBPK models take these elements into account. As lead consumption grows and the ratio of lead to calcium declines, lead absorption may increase as a non-linear function of dosage. At least in children, iron status has an adverse effect on lead absorption. These connections show the interactions between metals that are necessary for nutrition and those that are not.

The problems found in PBPK models and the susceptibility variables mentioned above are connected to other factors. Target organ effects from short-term exposures could be quite different from those from longer-term exposures at a dosage that is equivalent. Short-term, high-level exposure by ingestion may result in well-known acute toxicity syndromes, which often start in the gastrointestinal tract and may later affect the cardiovascular, neurological, renal, and hematopoietic systems. Acute high-dose arsenic survivors often exhibit numerous organ effects, sometimes with long-term aftereffects. Metals that slowly build up in target organs are exposed to long-term, low-dose intake via food and drink. Over time, these exposures may affect any organ system, although they often do not cause obvious gastrointestinal symptoms. For instance, low-level, long-term exposure to cadmium in food—often combined with inhalation exposure from smoking—will cause cadmium to accumulate in target organs, but not produce any obvious clinical effects until "excess" capacity is diminished to a point where the normal function is lost (for example, the onset of renal disease and/or osteoporosis later in life).

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Overexposure to metals, especially those that are nutritionally unnecessary, may have toxic or pathological consequences on the majority of organ systems. Due to their widespread occurrence in the environment and known negative effects on human health, arsenic, cadmium, lead, and mercury have been the most thoroughly researched for their effects on target organs. Reports from the EPA (IRIS reports), the ATSDR Toxicological Profiles, studies from the World Health Organization's International Programme for Chemical Safety, and toxicology textbooks all assess these substances' possible health impacts in great depth. The purpose of the following succinct summaries is to highlight the differences between acute and chronic exposures (arsenic and lead), the variety of target organ effects that can arise from varying dosages and susceptible populations, and the effects of inorganic forms and organic forms (mercury and arsenic).

ASPECTS OF HUMAN HEALTH

This study takes into account elements that affect human health outcomes, biomarkers of exposure and impact, and human health-related concerns. The link between exposure and numerous host variables is a major consideration in the evaluation of human health risk. When determining the risk of exposure to lead, the toxicokinetic or PBPK/PBPD models are often utilized as predictive models. Models for risk assessment incorporate a variety of variables that allow for the evaluation of elements unique to the host and the metal of concern. Currently, RfDs are defined as an expression of risk for non-cancer health endpoints from exposure to potentially hazardous compounds, including metals, in the EPA national regulatory assessment scenario including the formulation of media standards (e.g., soil, air, and water). A certain amount of exposure may be utilized to predict health outcomes using PBPK models. This study discusses the differences between the PBPK models for metals and organic toxicants. Animal models are being created for additional metals, such as chromium and uranium, while PBPK models for lead and cadmium are also available. Although the models must be complicated, they might be

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beneficial for translating environmental data into information about danger to human health.

At the level of national regulatory assessments for particular metals (e.g., ambient water quality requirements, maximum contaminant level targets, RfDs, or reference concentrations), toxicokinetic concerns related to metals may have the greatest impact on the regulatory framework. The effect of toxicokinetic concerns in these domains will depend on how much such health-based criteria are employed as inputs to site-specific assessments (for example, Superfund assessments) and national hazard/risk rating and characterization. The mechanisms governing the disposition of metals in general must be given particular attention since they may be innately capacity-limited and extremely metal-specific (e.g., specific protein binding, specialized transport pathways). This suggests that in order to model these processes and devise techniques for estimating binding constants, it is necessary to comprehend the underlying physiology. Another recurring theme is the frequent occurrence of various forms of metal-metal interactions throughout the absorption, distribution, metabolism, and excretion processes. Because of the numerous levels of metal-metal interactions, it is essential to address problems with groups of metals; thus, risk assessments for metals must take into account the problem of simultaneous exposure to several metals.

Another distinguishing feature of metals is their propensity for prolonged residence durations following typical sequestration processes such absorption into bone and binding to storage proteins. This necessitates, according to O'Flaherty (1998), that models describing metal kinetics over a long period of time include age dependence. To put it another way, anatomical measurements and physiological processes that are important factors in metal disposition can be expressed mathematically as functions of age or body weight. It is also important to assess if metal binding to certain proteins represents a mechanism for sequestration or a component of the pharmacodynamic process that results in toxicity. Effects

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on the most vulnerable groups are a consideration in EPA risk assessment scenarios. The risk assessment procedure may take into account vulnerability characteristics including age and gender, and corrective measures may focus on addressing nutritional inadequacies. However, the general population's variability—now acknowledged as a result of recent findings about human polymorphisms—presents further difficulties.

Separating organic from inorganic metal forms is one method that might be used to describe metal forms for health risk assessments. However, toxicity statistics indicate that from the perspective of health risk, this distinction is often insufficient. For instance, valence plays a significant role in classifying the toxicity of transition metals inorganic forms like chromium and arsenic. Furthermore, it might be crucial to draw differences between diverse biological forms. Organotins have a substantially lower hazardous impact threshold than inorganic tin (stannous chloride). However, for aryl (triphenyltin, fenbutatin) and alkyl tins as well as for alkyl tins of different chain lengths (triethyltin, trimethyltin), the pattern of toxicity and threshold harmful doses differ (ATSDR, 1992). Additionally, dibutyltin, a marine snail reproductive toxin, may have species-specific mechanisms of action, necessitating separate evaluation for human and aquatic risk assessments (Gooding and LeBlanc, 2001). This problem is not specific to metals; the toxicity of organic substances may vary based on the target species, substitutions, and optical or structural isomers. These factors imply that it is necessary to first analyze the toxicity data for every form of the metal and that a great deal of judgment is required when determining what classifications are suitable for the hazard identification and dose-response analyses that are supplied for certain regulatory reasons. These classifications are most suitably based on the toxicity empirical evidence. Furthermore, when new data are released, these groups could need to be changed

5 CONCLUSION

Animal toxicologists often use bioavailable forms of metals to get an

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acceptable internal dosage for the research of toxicity. It is not practicable to evaluate every metal form that could be implicated in a human exposure at once for the first characterisation of a toxicity syndrome. For instance, aluminum lactate is often used in studies on the metal because it consistently results in higher tissue amounts in lab animals. Aluminum maltolate is also employed because, unlike other salts that gradually hydrate as the solution sits, it offers a stable ion pool in aqueous solutions. A site assessor is quite unlikely to come across aluminum in its lactate or maltolate forms, however. Thus, it sometimes occurs that the site assessor has deal with a different form of etal despite the fact that toxicity statistics have been prepared for a bioavailable form. It is possible to take one of three approaches: (1) assume that the metal is in its most toxic form in environmental samples; (2) adjust the effective dose determined in the animal study using additional scientific data; or (3) conduct new animal toxicology studies using the metal form discovered during the site assessment. The second strategy is more scientifically sound, whereas the first is the most health-conservative. The third method could be possible in certain situations, but it is often not an option due to time and resource constraints.

Establishing a connection between a toxicant's known biological activities and the functions of a target organ is the last stage in describing target organ toxicity. For instance, it may be assumed that organs that largely depend on continued cell proliferation for their function, such as the skin, immune system, and embryo, would be susceptible target organs for toxicants that interfere with cell proliferation. While it is uncommon for basic research to thoroughly identify the mechanism of action of a toxin, it is often able to establish biological plausibility for target organ effects, which is a well-recognized component of risk assessment, especially at the weight-of-evidence level. Metals are sometimes researched as a group for mechanism of action due to their physical chemistry characteristics. For instance, according to Ercal et al. (2001), transition metals may promote

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ROS formation via the Fenton reaction and other mechanisms. According to Verstraeten et al. (1997), trivalent metals may alter the structure of lipid membranes to encourage the production of lipid peroxidation. Transferrin's and metallothionein's ability to bind metals is mostly restricted to trivalent cations and divalent cations, respectively.

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