ORIGINAL ARTICLE

Plumb as a cause of kidney cancer (case study: Iran from 2008-2010)

Hamid Mazdak, Maasoumeh Rashidi[1], Moien Zohary[2]
Department of Urology, Isfahan University of Medical Sciences, Isfahan, [1]Departments of Remote Sensing and GIS and [2]Remote Sensing, University of Tehran, Tehran, Iran

Background: The main threats to human health from heavy metals are associated with exposure to plumb (Pb), cadmium, mercury, and arsenic. Some hazards that threat human health are the results of environmental factors and the relevant pollutions. Some important categories of diseases including (cancers) have considerable differences in various places, as observed in their spatial prevalence and distribution maps. The present study sets out to investigate the correlation between kidney cancer and the concentration of Pb in Iran. **Materials and Methods:** In this study, the first challenge was to collect some relevant information. In this connection, the authors managed to gain access to data concerning kidney cancer in Iran. The data were collected by a health centre for the period of 2008-2010. Besides, a map of Pb distribution in soil, drawn by the Mineral Exploration Organization, and Plumb Concentration Information, collected by Agriculture Jihad Organization, were used. Using a geographic information system (GIS) software such as ArcGIS (USA), the researchers drew the map of the spatial distribution of kidney cancer in the Iran country. In the indirect methods, one measures vegetation stress caused by heavy metal soil contamination. In direct methods, target detection algorithms are used to detect a selected material on the basis of its unique spectral signature. In this research, we applied target detection algorithms on moderate resolution imaging spectroradiometer (MODIS) images to detect Pb. MODIS is a sensor placed on the Terra satellite that collects data in 35 spectral bands with 250-1,000 m special resolutions. **Results:** The spatial distribution of kidney cancer in Iran country delineated above revealed a positive correlation between the amount of lead and the high frequency of kidney cancer. Regression analyses also confirmed this relationship ($R^2 = 0.77$ and $R = 0.87$). **Conclusion:** The findings of the current study underscore not only the importance of preventing exposure to Pb but also the importance of controlling Pb-producing industries.

Key words: Correlation, Iran, Isfahan, kidney cancer, plumb (Pb), spatial distribution

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INTRODUCTION

Presently, one of the most immediate concerns in the Iranian Healthcare System is the rapid spread of malignant diseases such as cancer.[1] It is estimated that one-third of the cases of malignant diseases is preventable and a third is contingent on early diagnosis.[2] Advances in medicine and cancer therapy have led into an increase in long-term survival for patients with a wide range of invasive diseases, though. Despite recent attention, environmental pollution is still one of the main reasons causing malignant diseases. On a more global level, nearly one million ton of plumb (Pb) is added to our environment annually.[2,3] Increased levels of Pb in the body cause proximal tubular injury that gradually progress to tubulointerstitial disease and cancer. Pb Deposition the proximal tubule Pbs to hyperuricemia and gout, presumably by inhibiting uric acid secretion. With more than 1,650 industrial manufactories, large consortium efforts employing genome-wide scanning technology are underway, how effect of Pb in renal carcinogenesis.[4] Iran country is a region prone to industrial pollutants. The area is also considered as one of the Iran's major agricultural poles and the frequent use of chemical fertilizers for agricultural purposes adds a rather high amount of Pb to the soil annually. Pb is absorbed by plants and thus finds its way into our daily diet. The most serious problem with the Pb element in

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Address for correspondence: Dr. Masoumeh Rashidi, Department of Remote Sensing and GIS, Faculty of Geography, University of Tehran, Tehran, Iran. E-mail: masoumeh.rashidi@ut.ac.ir
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the body is that it cannot be metabolized. In point of fact, Pb cannot be disposed of by the body. This causes some malignant diseases such as cancer. The environmental exposure to heavy metals is a well-known risk factor for cancer.[5] The heavy metal Pb is known to be a widespread environmental contaminant and a potential toxin that may adversely affect human health. Exposure is largely via the respiratory or gastrointestinal tracts; the kidney is the main organ affected by chronic Pb exposure and toxicity.[6] An early and sensitive manifestation of chronic Pb renal toxicity, which can be useful in individual and population screening, impaired reabsorption of low molecular weight proteins (LMWPs) (also a receptor-mediated process in the proximal tubule) such as retinol binding protein (RBP). This so-called "tubular proteinuria" is a good index of proximal tubular damage, but it is not usually detected by routine clinical dipstick testing for proteinuria. Continued and heavy Pb exposure can progress to the clinical renal Fanconi syndrome, and ultimately to renal failure. Environmental Pb exposure may be a significant contributory factor to the development of chronic kidney disease, especially in the presence of other comorbidities such as diabetes or hypertension; therefore, the sources and environmental impact of Pb, and efforts to limit Pb exposure, justify more attention. The current study was an attempt to map the distribution of Pb and the spatial distribution of the kidney cancer in the province.

MATERIALS AND METHODS

In this experimental study, the first challenge was to collect some relevant information. In this connection, the authors managed to gain access to data concerning kidney cancer in Iran. The data were collected by a health centre in Iran that provided information for the period of 2008-2010. Besides, a map of Pb distribution in soil, which had been drawn by the Mineral Exploration Organization, and Plumb Concentration Information, which had been collected by Agriculture Jihad Organization, were used. Using a geographic information system (GIS) software such as ArcGIS, the researchers drew the map of the spatial distribution of kidney cancer in the province. In the indirect methods one measures vegetation stress caused by heavy metal soil contamination. In direct methods, target detection algorithms are used to detect a selected material on the basis of its unique spectral signature [Figure 1] that this figure (Most Relevant Components of Pb. x-axis is wavelength in micrometer and y-axis is an index showing the amount of reflectivity of Pb in each wavelength comparing with a pure white and pure black imaginary material). In this research, we applied target detection algorithms on moderate resolution imaging spectroradiometer (MODIS) images to detect Pb. MODIS is a sensor placed on the Terra satellite that collects data in 35 spectral bands with 250-1,000 m special resolutions. Remote sensing is a useful environmental monitoring tool. We used this technique to map spatial variability of different components of Pb. Using hyper spectral images is the most common method to detect soil contamination. Different hyperspectral sensors collect data from surface such as Hyperion and Aviris. Those sensors collect data with 20-100 m special resolution and in 50-200 spectra. There are indirect and direct methods for using hyper spectral images.[7] Target detection algorithms work on hyperspectral images that have more than 50 bands, but in order to apply this technique in MODIS we compute 10 more indexes including normalized difference vegetation index (NDVI) and other indexes introduced by researchers for different substances to increase diversity of different materials.[8-10] The referring Target detection algorithms we compensate high spatial resolution of MODIS which Pbs to a mixture of different materials in each pixel. We implemented the following target detection methods to the images[11]: Constrained energy minimization (CEM) and, in the next step, decision fusion method was used to combine the results. In this combination, each pixel is contaminated detect it as pollutant [Figure 2]. Table 1 shows the results of our calculations.

RESULTS

The population under investigation included 81,287 medical records for patients suffering from kidney cancer. Because of its rather high number patients with kidney cancer,

Table 1: Prevalent components of plumb

Name	Class	Particle size (μm)
Cerussite, $PbCO_3$	Carbonates	Coarse (74-250 μm)
Smithsonite, $PbCO_3$	Carbonates	125-500
Leadojarosite, $PbFe_3(SO_4)_4(OH)_{12}$	Sulfates	45-125
Anglesite, $PbSO_4$	Sulfates	45-125
Galena, PbS	Sulfides	125-500
Mimetite, $Pb_5(AsO_4)_3Cl$	Arsenates	45-125

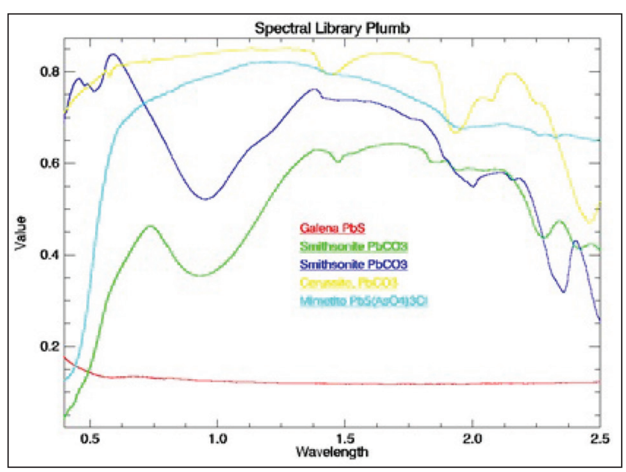

Figure 1: Spectral signature of targets

the period studied (2008-2010) is sufficiently reliable [see Figures 3 and 4]. Plants absorb a number of elements from soil, some of which have no known biological function and some are known to be toxic at low concentrations. As plants constitute the foundation of the food chain, some concerns have been raised about the possibility of toxic concentrations of certain elements being transported from plants to higher strata of the food chain. Special attention has been given to the uptake and biotransformation mechanisms occurring in plants and its role in bioaccumulation and impact on consumers, especially human beings. This element (Pb) was selected because it is well established as being toxic for living systems and its effects on humans have been widely documented. Pb and mercury are well-known neurotoxins that can be consumed via seafood, vegetables, and rice.[12]

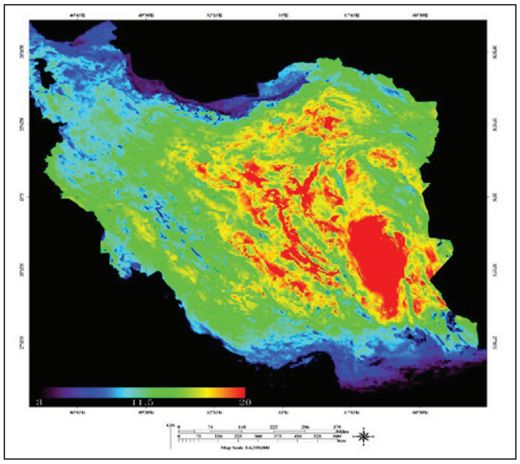

Figure 2: Plumb element distribution maps

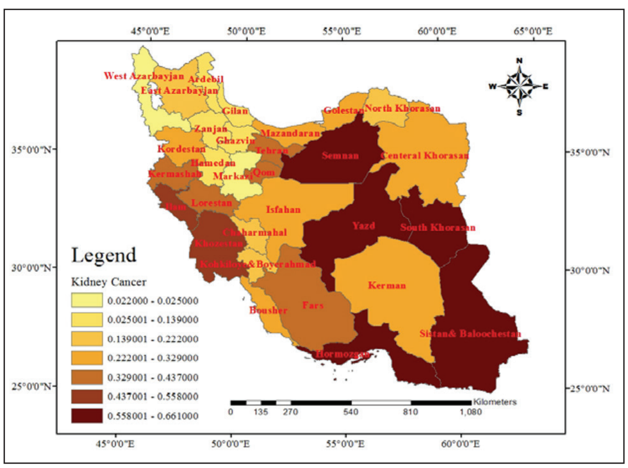

Figure 3: Spatial distribution of kidney cancer (ratio to population)

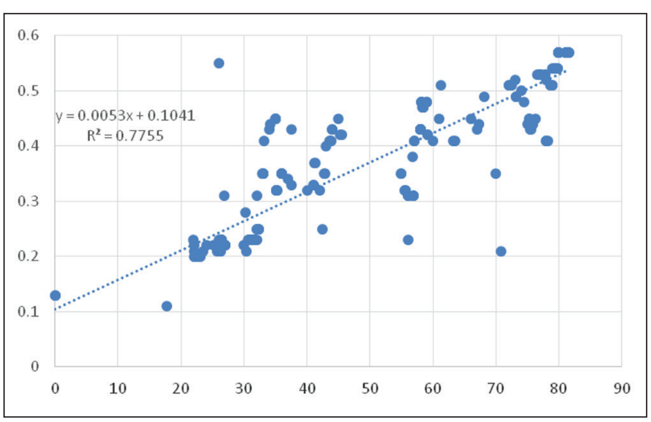

Figure 4: Relation between kidney cancer and Pb concentration

The map for the distribution of kidney cancer is presented in Figure 3. As the figure shows, the provinces of Yazd, Semnan, South Khorasan, Sistan, and Hormozgan have hosted the highest number of kidney cancer. This rate positively correlates with the distribution of Pb in the country.

The potential relationship between lead in the soil and cancer incidence was examined using a regression analysis. To test the hypothesis, "Do lead in soil in country have an impact on cancer incidence values?" analysis was conducted. The analysis revealed to what extent lead in the soil explained the observed cancer incidence values. Regression analyses were showed $R^2 = 0.77$ and $R = 0.87$ [Figure 4]. Most of the research into the health effects of soil pollution relates to a few substances that tend to be part of soil quality regulations. This means their levels are measured in many places around the world, so scientists can look for links between the amounts people were exposed to and whether they developed cancer. Epidemiologic evidence on the relation between ambient soil pollution exposure and cancer is reviewed, and the results of this study confirm this.

DISCUSSION

According to the results of this study, not all diseases are caused by inheritance or genetic factors. In fact, environmental factors could also be responsible for some malignant diseases. The findings of this study underscore the importance of preventing Pb exposure. Control Pb producing industries to improve work-related environmental health and increasing the knowledge of health professionals and the general. Plumb is a bluish-white metallic element, which is extremely toxic[13]. Pb is one of the most detrimental elements.[14] Impaired synthesis of hemoglobin and anemia, malignant diseases, hypertension, kidney damage, miscarriages and premature infants, nervous system disorders, brain damage, male infertility, loss of learning, and behavioral disorders in children are only some of the negative effects of high concentrations of Pb. Pb exists naturally in the environment, but in most cases the increase in quantity is the result of human activities.[15,16] The spatial distribution of kidney cancer in Iran delineated earlier in this article revealed a positive correlation between the amount of Pb and the high frequency of kidney cancer. Pb exists in industrial pollutants, fertilizers, and other agricultural items. The average concentration of Pb in the three consecutive years under investigation in Iran was above the limit.[17] Prevention through community intervention is possible by identifying harmful elements in the environment. The best strategy is prevention from exposure. Reducing the number of Pb-producing industries can also be helpful. In this way, collaboration between geographical and medical sciences, health workers, legislators, and the community is definitely needed. To solve the global problem, soil resources should be evaluated and tested periodically. In the case of toxic poisoning of soil, preventive measures should be taken such as using filters to prevent the entry of sewage into rivers, freshwater resources, and soil. Health warnings should be given to people at risk. Cultivation of plants that absorb toxic elements has to be suspended.[18,19] By analyzing the elements and patterns, it is possible to determine and track the spatial distribution of various diseases.[20]

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Conflicts of interest

There are no conflicts of interest.

AUTHOR'S CONTRIBUTION

All authors contributed in the conception of the work, conducting the study, revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work.

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