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Original Article

Investigating the Effects of Elements and Minerals on Public Health: An Overview of Medical Geology

Rouhollah Nadri[1*]

[1]Department of Geology, Payame Noor University (PNU),Tehran, Iran

Abstract

Background & Aims: Medical geology is an emerging branch of geological sciences, which examines the relationship between geological findings and human and ecosystem health, as well as the effect of environmental factors and elements on the geographical distribution of diseases in the field of health and treatment. The aim of this research was to provide a comprehensive understanding of how geological factors and minerals affect public health outcomes.

Materials and Methods: A total of 1561 publications including books and papers published from 1992 until 2024 were reviewed, 168 of which were chosen and 21 articles were mentioned.

Results: Medical studies on patients showed that there is a direct relationship between minerals and diseases, which is caused by the lack of some minerals in the food chain, or the excessive presence of some of these substances in the food chain of people of different regions of the world. These minerals cause changes in the cellular and molecular structure, which can lead to the development of various diseases.

Conclusion: It seems that in the future, with scientific investigations in the field of medical geology, important results can be achieved in the prevention of various diseases. It is obvious that the realization of this requires increased cooperation of medical, health, and earth science researchers and it can be an effective step towards improving the health of the society and preparing and producing new drugs and new treatment methods. It will be presented using this knowledge.

Keywords: Geology, Minerals, Environment, Public health

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1. Introduction

The relationship between earth's constituent materials such as rocks and minerals and human health has been known for centuries. In ancient Chinese, Egyptian, Islamic, and Greek texts, many therapeutic uses of different stones and minerals are mentioned. Health problems caused by the earth's materials and elements have also been mentioned.

The history of studies in the field of medical geology dates back to 2000 years ago. Hippocrates, the ancient Greek physician who is known as the father of modern medicine, mentioned some human diseases in his writings, which were related to the geological conditions of the geographical areas where they live. He believed that every disease has a natural cause and can be treated [1]. Abu Ali Sina, an eminent Iranian philosopher and physician, also wrote about it in his book entitled "Law in Medicine", as a magnificent work in medical sciences that Europeans used in scientific centers for more than 700 years, and also now as an important part of ancient medicine in most of the important centers and universities of the world. In other words, the use of minerals in pharmaceuticals was mentioned in it. Additionally, he has discussed the role of mineral elements such as gold, silver, lead, sulfur, lapis lazuli, whitewash, and arsenic in producing medicine and treating some diseases.

Today, with scientific studies and research in the field of geology and medicine, new findings have been published regarding the effective role of stones and minerals in the production of various complementary medicines and curing diseases. The geography of regions can affect the health of plants, animals, and humans in a physical sense. For example, problems and risks related to volcanoes, earthquakes, subsidence, droughts, or floods can be mentioned.

Medical geology, as an emerging interdisciplinary science, will soon find its place in human life, and mankind will witness many developments in this field in the near future. Geological researchers play an important role in understanding medical geological issues, which require a comprehensive and multidisciplinary approach to develop effective solutions. New international initiatives in this field provide an excellent framework for researchers from many disciplines around the world to collaborate [2]. Therefore, with the cooperation and interaction of experts from various scientific fields, human society will take steps towards better health and a brighter future (Figure 1). Natural stones and minerals are the building blocks of the earth. These materials are not uniformly distributed throughout the planet, and different types of stones and minerals are formed by natural processes during different

*Corresponding Author: Rouhollah Nadri, Email: Nadri@pnu.ac.ir

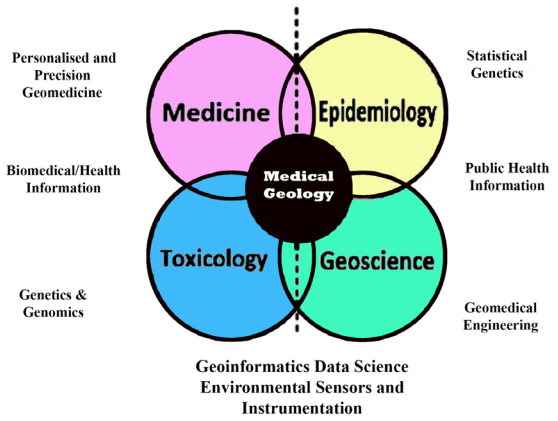

Figure 1. Activities carried out in the name of medical geology that require the interaction of many disciplines such as epidemiology, toxicology, earth sciences, and medicine in order to achieve the relationship between the environment and health [3]

geological times under specific environmental conditions. They represent vital minerals or toxic elements found in soil and water and form the basis of the plant-animal-human food chain [3].

For example, calcium is essential for healthy teeth and bones, while elements such as arsenic and mercury are toxic in high doses. The aim of this research was to investigate the importance of geological behavior and mineral elements on human health and to present and introduce examples of specific geochemical behaviors and diseases that are related to rocks and minerals.

1.1. Basics of medical geology

Medical geology is a science that deals with the influence of geological materials and processes on human health and well-being. Medical geology requires that geologists and biomedical and public health researchers deal with health problems caused by earth materials and elements such as trace elements, rocks, minerals, water, and oil and natural geological processes such as volcanic eruptions, earthquakes, subsidence, and dust.

Ensuring human health requires the knowledge of essential elements (such as Cr, Cu, Fe, Ca, and Se) and non-essential elements (such as Pb, As, and Hg) and their function in providing health. Such elements are present in different concentrations and forms throughout the world. Atmosphere, lithosphere, and hydrosphere are the main spheres that comprise the earth. Soil, water, and air are the three main components of the environment. Soil is the final product of erosion and weathering of rocks, which has two key roles in nature. The first one is to store and supply water and mineral nutrients for the growth of living organisms, and the other is to refine or store all kinds of organic and mineral pollutants.

Therefore, soil plays an essential role in the formation and continuation of life of living organisms. Trace elements or minerals also play a role in the life of other living organisms. Excessive concentration or deficiency of these essential elements can have adverse health effects and lead to destruction and death in certain cases. These elements do not behave in the same way in living organisms and can show different functions. For example, vanadium (V) is essential for photosynthesis by green and blue algae, but this element is very toxic to humans.

The knowledge of medical geology is growing rapidly and has made great progress in recent decades. From the small efforts of a handful of geochemists in the early 1960s to decipher possible links between the natural geochemical environment and the health of people in a region to the founding of the International Medical Geology Association (IMGA) in 2006, it has gained an important place in the field of global community health. Today, this science is recognized as a suitable field of study and many masters and doctoral research projects have been completed at universities around the world.

Therefore, recent developments in the branch of medical geology are affected by applied research in the field of treatment and health, and the most important topics discussed include: health effects caused by rare elements, metals and metalloids, regional and global effects of natural dust (including the study nanoparticles), chemical and environmental pathology of diseases related to the natural environment, new analytical approaches to study geochemical and natural environmental factors, risk management and risk reduction in medical geology, remote sensing and GIS applications in medical geology, epidemiology and health studies in medical geology, climate change in medical geology, clinical and toxicological research on biomarkers, veterinary medical geology, and biomonitoring studies in medical geology.

Medical geology surveys are different from medical geography. Medical geography deals with the geographical distribution of diseases and examines the relationship between specific diseases and different environments [4]. According to the International Association of Medical Geology, the study perspective of medical geology is defined in four directions, which include:

a. Identifying geochemical abnormalities in soil, sediments, and water that may negatively affect human and animal health
b. Identifying environmental causes of known health problems in collaboration with biomedical/public health researchers and seeking solutions to prevent or minimize these problems
c. Evaluating the beneficial effects of geological materials and processes on health
d. Creating links between developed and developing countries to find solutions to global environmental health problems.

Study areas of medical geology are divided into two natural and artificial groups based on the adverse effects

caused by pollutants, which are related to the environment and human health [5]. In the natural part, geological phenomena and processes affect the environment, which are called geogenic factors, and in the artificial part, they are formed under the influence of human activities, which are known as anthropogenic factors (Figure 2). Their effects on air, rock, and soil can be transferred to agriculture, fisheries, livestock, and underground water reserves, thereby affecting human health and well-being.

1.2. Geogenic factors

In many cases, natural agents can be considered as sources of environmental pollution and pose a threat to the health of living organisms. For example, karst areas in carbonate rocks, which today serve as one of the reserves of water resources in areas that face water shortages, are an example of this sector. The most important problems of these limestones and dolomites are the hydrological pollutants that cause the pollution of underground water reserves and aquifers. Different concentrations of other elements such as strontium (Sr), sodium (Na), potassium (K), magnesium (Mg), sulfate (SO_4), nitrate (NO_3), and calcium (Ca) are found in karst lands.

Moreover, dust and particulates suspended in the air, which today have global dimensions, sometimes carry fungal spores that can cause diseases such as valley fever (coccidioidomycosis). They cause acute respiratory problems and lead to fatigue, cough, fever, and rashes. Ashes released from volcanic eruptions can also cause destructive effects on the environment of volcanic areas. Sulfur gases and elements of arsenic and mercury that are found in these areas are very harmful to the health of living organisms, and this pollution can penetrate into the underground water table of the area.

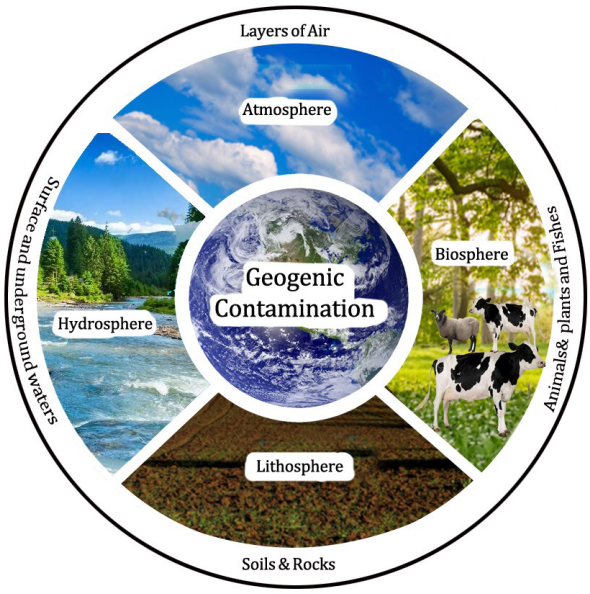

Figure 2. The Earth systems and Natural Pollutants Related Factors in Human Health

1.4. Anthropogenic factors

With the expansion of urbanization and the movement towards machine life, most human activities for the environment were accompanied by pollution. Examples of these activities include mining and extraction of industrial stones and minerals, oil and gas drilling, exploitation of fossil fuels, geothermal energy production, chemical material production, and construction material production.

Asbestos or refractory cotton is a type of fibrous mineral consisting of silicate. Due to the high resistance of its fiber against heat, it is used in building materials as insulation against fire.

It is also used in the manufacture of a wide range of industrial goods such as false ceilings, tiles, and some paper industries and also in the production of brake pads, clutch plates, and some other parts of the car due to its high friction. In the 1980s, the US medical community found that asbestos mine workers were more likely to develop acute respiratory diseases than other people. The results of the investigations showed that exposure to asbestos fibers can cause serious health problems including mesothelioma (a rare type of cancer that appears in the thin lining of the lungs, chest, abdomen, and heart), lung cancer, and asbestosis (a type of acute lung disease). Consequently, many asbestos mines in the United States were closed and concerted efforts were made to remove asbestos from schools, workplaces, and public buildings.

Silicosis is a common occupational lung disease associated with the sand (aggregate) mining industry. Silica particles can be transported in the air under wind conditions, during agricultural, urban, and construction activities, and due to volcanic eruptions. When small crystalline silica particles are absorbed by macrophages in the lungs, they accumulate near blood vessels and connective tissues and produce fibrous nodules in the lungs, leading to major respiratory problems and death in severe cases. In geological environments that contain ultramafic and serpentine rocks, pollutants have also been observed, which can affect human health. These pollutants can be categorized as man-made or natural. The elements of these pollutants include iron, chromium, nickel, manganese, zinc, cobalt, and chrysotile, which enter the human body through swallowing (food and water) and inhalation of dust and cause poisoning and various diseases [6].

2. Materials and Methods

To conduct this research, study and library methods and case studies have been used in different areas of Iran. A total of 1561 publications including books and articles published from 1992 to 2024 in the fields of medicine, toxicology, geology and environment were collected and their thematic relationship with each other was examined. In these library studies, the impact of geological pollutants

on water, soil and air was discussed. The effects of these geological pollutants on livestock, agriculture and water resources cause disease on the health of humans and living organisms.In this study, the areas with mineral resources on the map of Iran were also investigated using GIS. The distribution of these minerals was consistent with the prevalence of diseases related to the geology of the region. Among these minerals, there are elements that have a direct impact on human health, and these diseases have been proven in medical studies and findings. In these findings, case studies in Golestan province in the northern region of Iran have also been used. Of these, 168 articles were selected and 21 articles were mentioned in the sources.

3. Results

3.1. Minerals and rare earth elements (REE)

Rare elements with different geochemical characteristics are found in different geological environments and in different rocks and minerals [7]. Most of the rare elements are extracted as a byproduct of lead, zinc, titanium, iron, and aluminum deposits. In terms of geological conditions and different phases of orogeny, the land of Iran contains 68 types of non-oil minerals, which includes about 7% of the world's mineral reserves, and is one of the mineral-rich countries in the world (Figure 3).

The most important mines in Iran include fossil fuels, metal minerals, coal, sand and construction stones, precious and semi-precious stones, rare earth elements, industrial and chemical minerals, and salt, each of which has different applications in various industries. As a result of mining activities, significant amounts of minerals are dispersed in the air in the form of dust, which, depending on the type of mineral that is inherently toxic or non-toxic, can cause pollution in the air, water, and soil, and subsequently have effects on human health. Dust is of special importance in occupational health given that certain diseases are caused by dust and that it has plagued humans since ancient times.

The results of studies on diseases such as goiter and fluorosis, and so on, which are reported sporadically from different parts of the country, show the importance of medical geology studies in our country. The dispersion of mineral particles and the resulting mining and processing activities have led to the occurrence of environmental pollution, especially in the mining regions of the country, and the spread of disease among residents. Therefore, in order to advance as best as possible and to reach the goals that preserve the health of the society, more studies in the field of medical and environmental geology in Iran seem to be necessary.

The provinces of South Khorasan, Kerman, Yazd, Zanjan, Isfahan, Golestan, Kurdistan, Qazvin, Ardabil, Gilan, East Azerbaijan, Sistan and Baluchistan, Qom and Bandar Abbas are among the mining regions of the country, in which industrial and mineral processing activities are performed along with mining activities. Therefore, attention to the health of the environment and native residents of these provinces is emphasized from the point of view of medical geology.

Rare earth elements are used in steel metallurgy industries, catalysts, petrochemicals, fluorescent lighting, permanent magnets, jewelry, laser light, nuclear industry, radiography, and medicine in order to ensure the health of the people [7]. During the last decade, progress in analytical methods has increased the awareness of the role of trace elements in the human body and their impact on health. Trace elements play an essential role in the natural metabolism and physiological functions of humans. The human body has an essential and vital need for some mineral elements in the milligram range, such as iron, zinc, and copper, and some elements in the microgram range, such as iodine, manganese, selenium, cobalt, chromium, molybdenum, nickel, and so on, which are called Rare Earth Element (REE) (Figure 4).

The relationship between geological materials and trace element deficiencies is well recognized for elements such as iodine (iodine deficiency disorders) and selenium, and the effects of overexposure to toxic trace elements such as arsenic, fluorine, and mercury have also been demonstrated. Exposure to natural dust (volcanic activity or mining) can cause a wide range of respiratory problems such as black lung disease and silicosis [8]. Calcium, phosphorus, magnesium, and fluoride are required for the structural functions of bones and membranes.

Sodium, potassium, and chloride are needed to maintain water and electrolyte balance in cells. Zinc, copper, selenium, manganese, and molybdenum are essential components of enzymes and act as carriers of essential ligands in metabolism. Chemical elements are also important in the functioning of the endocrine system. In this context, iodine is a clear example. Iodine is an essential part of the thyroid hormone thyroxin [9]. Therefore, it seems necessary to maintain the required amount of these elements in the body. Today, there is a large number of studies related to the importance of rare elements in biological systems. These elements are involved in various biochemical pathways, including protein synthesis and enzyme regulation. The lack of these elements leads to the emergence of some diseases such as anemia, skin diseases, delayed growth, and hemochromatosis, and the excessive amount of these elements also causes poisoning. The deficiency of trace elements as well as the excess of iodine, copper, zinc, selenium, molybdenum, manganese, iron, calcium, arsenic, and cadmium has been reported to cause some diseases. Iodine deficiency disorders including goiter and myxedematous cretinism are their prominent examples [10]. Zinc is essential for growth in humans and many animals. In growing children, its deficiency causes growth retardation, gonad failure, and

Figure 3. A simple map of the distribution of key mineral mining activities in mining regions of Iran [7].

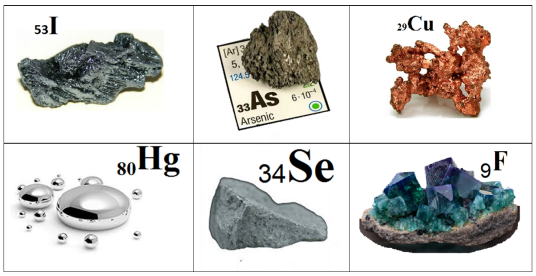

Figure 4. Mesoscopic examples of elements and minerals that are discovered and extracted in nature as mineral deposits [7].

premature death. In addition, it has been determined that copper in drinking water and copper supplements are the main cause of Alzheimer's disease. Therefore, people can reduce the risk of contracting this disease by stopping the use of copper supplements and testing the amount of copper in drinking water [11].

Considering the importance of these elements in human health and the occurrence of various diseases [12], we introduced some of the diseases associated with mineral elements in the human body (Figure 5).

3.2. Arsenic (As)

Arsenic is a semi-metallic mineral whose oxide state is called raticide and its sulfide is called orpiment or arsenic. This substance is associated with minerals such as lead, zinc, and copper and is often observed in basic volcanic rocks. Arsenic compounds are toxic and lead to death by disrupting the digestive system and causing shock. The presence of this element in the environment causes environmental damage to humans and other creatures. Arsenic is absorbed through water, breathing, and the skin, and it is the most common type of poisoning caused by heavy metals, which causes diseases such as bronchitis and laryngitis. Cardiovascular disorders, high blood pressure, skin ulcers, heart failure, and destruction of the vascular system (arsenicosis) are caused by exposure to this substance in small amounts. Its chronic effects can also cause widespread disruption of the digestive system, causing shock leading to death and intestinal and stomach cancers, anemia caused by red blood cell destruction,

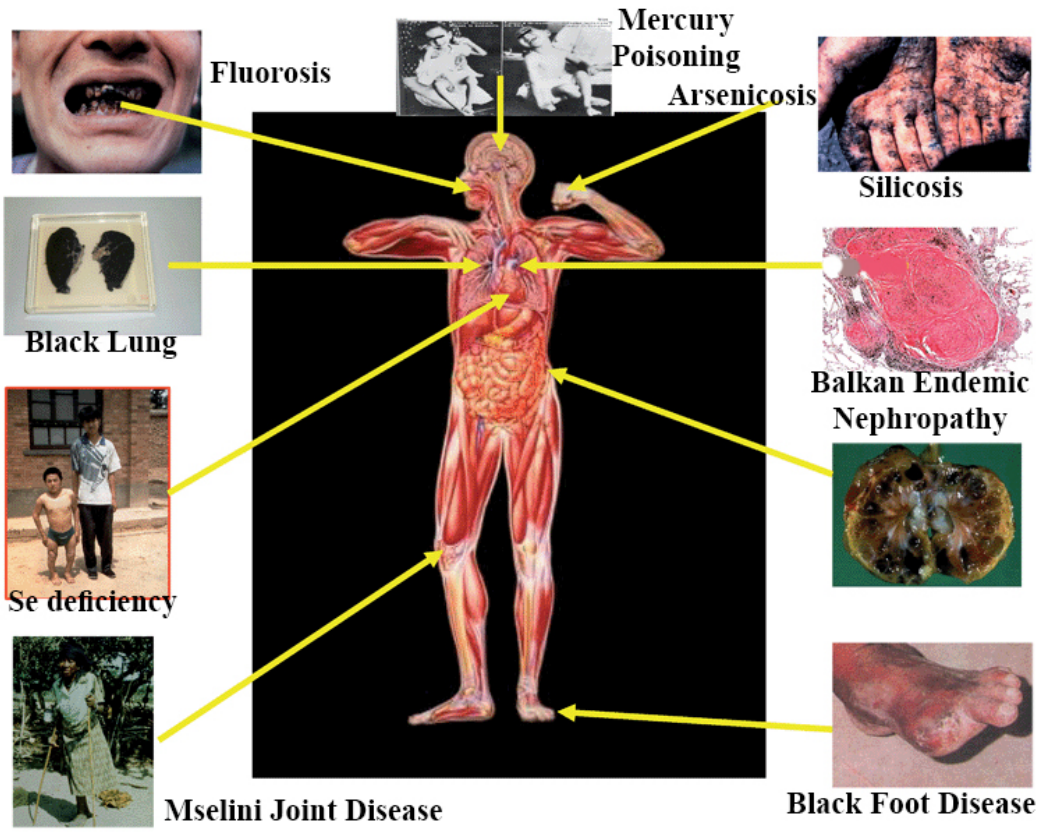

Figure 5. Examples of Diseases Related to the Role of Mineral Elements in the Human Body [12].

reduction of white blood cells, and hair loss. Cancers such as hyperkeratosis, hyperpigmentation, lung, bladder and liver cancers are among other diseases that can occur in humans [12]. Industrial cities have high prevalence rates of arsenic poisoning due to their proximity to polluting industrial centers. For example, the research conducted by the Medical Geology Working Group in Kurdistan and Qazvin provinces, a subset of Geological Survey and Mineral Exploration, of Iran (GSI) shows that due to the lithology of the region and the presence of mines such as gold mine, many heavy metals such as arsenic enter the environment. They seriously threaten the health of the people of the region whether they like it or not. Arsenic affected countries of the world with intensity shown by the size of the plots (Figure 6). South Asian and South American regions are the worst affected [13]. International incidents of Arsenic contamination in groundwater and consequences for the health of people have been widely reported from other places as well as.

3.3. Selenium (Se)

Selenium is a rare non-metallic substance that is found in some porphyry copper mines. Selenium is an important factor in many body processes. Along with iodine, this nutritious mineral plays an important role in maintaining thyroid hormone metabolism, DNA synthesis, and protecting the body against oxidative damage and infection. Selenium is an antioxidant that protects cells from damage caused by free radicals. Free radicals and oxidative stress are the cause of cancers and heart diseases.

Arthritis is another problem that can be improved by using selenium supplements. Inflammatory destruction in the joints occurs due to the presence of free radicals. Selenium can reduce the pain and inflammatory effects of arthritis. The important effect of selenium on the immune system is due to the increase in the growth of type B lymphocytes and the production of antibodies. This effect is very important in controlling AIDS. Selenium reduces HIV replication. Selenium has an important role in the treatment of infertility, skin disorders, anxiety, and asthma, maintaining youth, flexibility of tissues, and prevention and treatment of dandruff. It should be mentioned that vitamins E and C and Se strengthen the activity of each other [14].

The lack of selenium causes dangerous complications for human health, the most common of which is Kashin-Beck disease, during which the growth of cartilages is stopped, the shape of organs is changed, and the development of the human skeleton is disrupted [15].

3.4. Fluorine (F)

Fluoride is obtained from the mineral fluorite or fluorspar which is the mineral form of calcium fluoride and comes in an array of colors. As a result of the rocks washed away by streams, there is insoluble fluoride from volcanic gases, fresh and mineral water lakes, and sea suspended particles

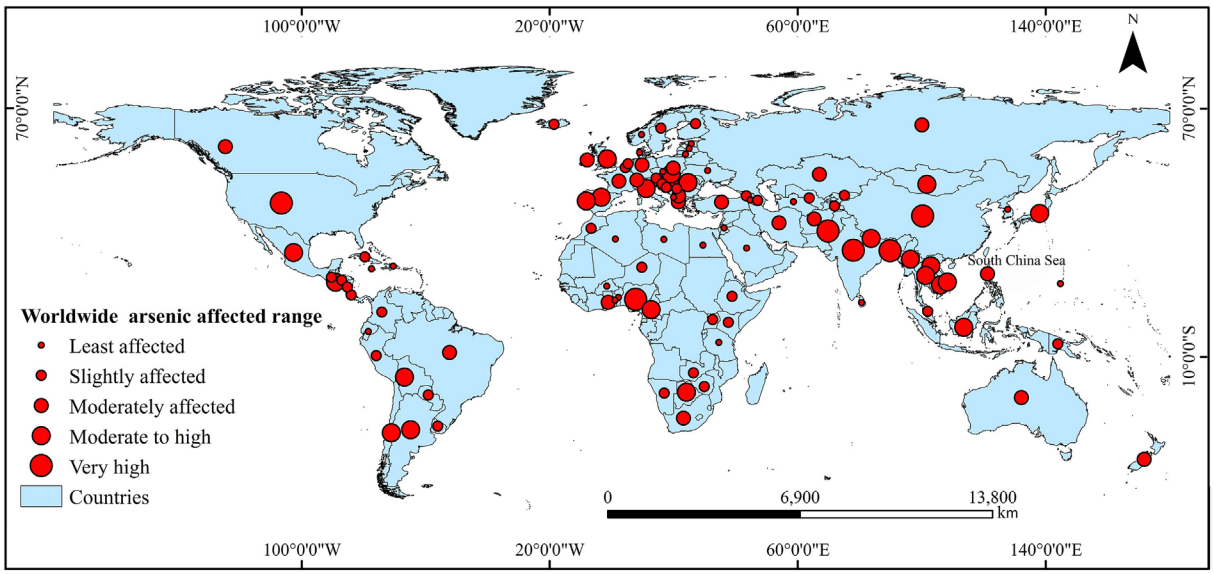

Figure 6. Arsenic affected countries of the world with intensity shown by the size of the plots. Note that South Asian and South American regions are the worst affected [13]

in groundwater and surface water. The permissible amount of fluorine in drinking water ranges between 0.1 and 1 ppm and its daily consumption dose ranges from 1.5 to 4 mg per day. If the absorption of fluorine is less than this amount, problems such as tooth decay will occur. Exposure to fluorine beyond the permissible limit causes bone fluorosis and teeth discoloration. Fluorine prevents the absorption of aluminum and reduces the rate of Alzheimer's disease in society [16].

3.5. Iodine (I)

Solid iodine is a bluish-black crystalline solid with a metallic luster in the form of shiny flakes and exists in the sea and the earth's crust. Iodine is discovered and extracted only in certain areas, such as the coasts of the Pacific Ocean and the Caspian Sea. This mineral is not available in all regions of Iran. Traces of iodine have been detected following the oil discoveries of the Geological and Mineral Exploration Organization of the country in Golestan province, 27 kilometers north of Agh Qala city.

Iodine is used as a tracer of underground water and indicates the spread of pollution in the environment. The use of iodine in medical sciences and body health was also reported. Iodine is a mineral that exists mainly in the form of ions. It is mainly concentrated in the thyroid gland and a smaller amount of it is found in the salivary glands and stomach. Iodine deficiency causes brain damage, especially in the fetus of pregnant women. If women do not get enough iodine during pregnancy, their children will be born with learning disabilities or congenital thyroid dysfunction. This disorder is known as cretinism. Iodine deficiency is one of the main factors affecting children's IQ and learning and reading disabilities in the world. In areas where people's food has a small amount of iodine (areas far from the sea where no seafood is consumed), the incidence of goiter due to iodine deficiency is high. Iodine and thyroxin are used in internal medicine in combination with alcohol (tincture of iodine) to disinfect skin wounds [17].

3.6. Mercury (Hg)

Mercury occurs naturally in the earth's crust. This substance is released into the environment from volcanic activities, weathering of rocks, and as a result of human activities. Mercury is one of the metal elements that has a wide range of uses, and due to its known toxic effects on humans and its bioaccumulation in the food chain, it is considered one of the most hazardous occupational and environmental pollutants. It is the only metal that is liquid at room temperature. The most common use of mercury is in the manufacture of industrial chemicals and electrical and electronic appliances. In addition, mercury is used in thermometers. Besides thermometers, mercury is used in pressure gauges and many other laboratory devices. It is also used in dentistry as an amalgam. Mercury can enter the human body through the respiratory system, digestive system, and skin. Mercury is a neurotoxin and can affect a person's health in different ways. Symptoms of mercury exposure may include muscle weakness, numbness in hands and feet, skin rash, anxiety, and problems with memory, speech, hearing, or vision. Inorganic salts of mercury are corrosive to the skin, eyes, and digestive system and may cause kidney poisoning if swallowed. The nervous system is the most sensitive organ of the body against contact with mercury vapors. A wide range of respiratory, mental, cardiovascular, gastrointestinal, reproductive, liver, kidney, blood, skin, musculoskeletal, immunological, sensory, cognitive, and genotoxic disorders are among the effects of mercury.

3.7. Lead (Pb)

Lead is a heavy and toxic metal that is extracted from

galena. This element in combination with sulphide groups of proteins and enzymes involved in the production of molecules causes disruption in the Na-K AT Pase pump in the membrane of red blood cells. This leads to premature death, chronic nephritis, myocarditis, neurotoxicity, passage of the placenta, premature rupture of the amniotic sac (Prom), and finally premature delivery. The absorption of more than half a gram per day leads to death after a while. In low concentrations, it damages the nervous system. Contact with lead in children can lead to concentration disorder and aggression [18].

3.8. Copper (Cu)

Copper is found in nature in three forms: oxide, sulfate, and free. Copper, as a mineral, is essential for the health of organs because it plays an essential role in the construction of the respiratory enzyme cytochrome oxidase [19]. Lack of copper in the diet can cause hair loss and weight loss in the short term, and it can cause blood sugar disorders, abnormal functioning of defense systems, and even heart damage in the long term. Additionally, similar to other elements, its excessive amount also causes abdominal pain, nausea, headache, lethargy, diarrhea, breathing problems, gastrointestinal bleeding, and kidney disorders [20]. Copper sulfate is a medicinal substance that is used as a substitute for copper in the body and its 1% solution is used to wash the stomach in phosphorus poisoning. However, copper sulfate must be removed from the body quickly so as not to lead to copper poisoning.

3.9. Aluminum (Al)

Aluminum is one of the most widely used metals in the field of medical engineering. This metal, due to its high resistance and strength against corrosion, non-oxidation, and rusting, low density, non-toxicity, high machinability, and ease of recycling, is among the metals that can be used in industries, medical equipment, and hospital settings. It is considered one of the best metals in the field of health. Aluminum hydroxide is also one of the medicinal substances that is used as an antacid in raising blood phosphate levels in kidney failure, indigestion, and preventing the formation of phosphate urinary stones.

3.10. Cadmium (Ca)

Cadmium is one of the polluting elements whose penetration into water can be caused by the use of chemical fertilizers (phosphate fertilizers) in agricultural activities, polluted atmospheric sediments caused by industrial factories, and wastewater from industrial activities or mines. Although cadmium is present in water in very small amounts, its accumulation beyond the permissible limit can cause prostate cancer, high blood pressure, destruction of testicular tissues and red blood cells, blockage of kidney ducts, and coagulation of some proteins. It is also associated with itai-itai disease. The symptoms of this disease appear as bone abnormalities such as softness and osteoporosis. Certainly, cadmium is a dangerous pollutant of water sources and it is very difficult to clean the water that is contaminated with it.

3.11. Chromium (Cr)

Chrome ore is often found in the form of ferrous chromite ($FeCr_2O_3$). Divalent chromium is relatively unstable and is easily oxidized to trivalent chromium. This white metal is a toxic element and its toxicity depends on its chemical forms; therefore, hexavalent chromium is much more toxic to marine organisms than trivalent chromium and can easily pass through cell membranes [21]. Many other metallic and non-metallic elements are used in medicine and health care system. For example, gold as a valuable metal plays a role in the treatment of rheumatoid arthritis, asthma, malaria, cancer, and bacterial infections, and silver is also used in the treatment of skin diseases and parasitic and microbial infections, as well as medical diagnosis and imaging. The role of halite or table salt has also been proven in salt therapy (halotherapy) for the treatment of respiratory disorders such as asthma and allergies. In Table 1, other mineral elements that can cause complications due to deficiency or toxicity in humans are briefly mentioned.

4. Discussion

Joint research conducted between geologists and doctors will improve global health. The human body and the earth are comprised of many minerals such as calcium, phosphorus, sodium, potassium, manganese, and so on, and on the other hand, there are many stones containing heavy and toxic elements that are accumulated in some areas and cases [4]. It has been considered a serious threat to the environment of the region as well as the health of the society.

Therefore, in order to establish a healthy life cycle, investigating and recognizing the mutual effects of biology and geology or the relationship between life and the earth is necessary, unavoidable, and vital, and since in this establishment and recognition, geological studies are clearly needed in medicine, scientists are increasingly identifying important relationships between these two scientific fields [16].

Medical geology research gathers information from various fields including medical geochemistry, hydro-geochemistry, geobotany, petrology, mineralogy, medicine, radioecology, geo-microbiology, epidemiology, immunology, pathology, geographic medicine, computer science, informatics, and GIS systems. It can provide the possibility of obtaining information by combining medical and veterinary disciplines, identifying high-risk areas in the country, and developing macro-level health policies [3]. In this context, studies conducted on esophageal cancer in Golestan province indicate that the main cause of

Table 1. Diseases Caused by Deficiency and Toxicity of Elements and Minerals

Cause of disease	The name of the disease	Cause of disease	The name of the disease
Low concentration of selenium	Keshan	Caused by iodine deficiency	Goiter
Caused by iodine deficiency	Cretinism	The concentration of arsenic exceeds the permissible limit	Blackfoot
Caused by copper deficiency	Osteoporosis	Increased concentration or excessive consumption of mineral fluoride	Skeletal fluorosis
Caused by iron deficiency	Anemia	Increased concentration or excessive consumption of mineral fluoride	Dental fluorosis
Cobalt deficiency	White Liver	Light waters: lack of calcium and magnesium in natural waters	Ischemic heart
Zinc deficiency	Acrodermatitis enteropathica	Low concentration of selenium	Kashin–Beck
High radiation of radioactive substances such as radon	Lung cancer	The concentration of arsenic exceeds the permissible limit	Keratosis
In connection with aluminum	Alzheimer's disease	Inhalation of asbestos or cotton smoke inhalation	Asbestosis
Inhalation of asbestos or cotton smoke inhalation	Mesothelioma	Earthquake dust carrying fungal spores	Valley fever

the spread of this disease in the northern part of Iran is the type of soil in the region [18]. Additionally, the presence of arsenic in the rock and soil of Kurdistan province has caused an increase in the incidence of stomach, intestinal, and kidney inflammation [21].

5. Conclusion

The effect of the earth's mineral resources, natural environmental factors, and land use on human health has been known. Due to its geological and geographical features, Iran is one of the areas prone to the spread of diseases with terrestrial origin. The dispersion of mineral particles and the resulting mining and mineral processing activities have led to environmental pollution. Diseases such as anemia, diabetes, and cancer were found to be prevalent in Iran. In this regard, it is also suggested that medical geology be included in general education curricula so that students can be aware of the relationship between geology and health.

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Competing Interests

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Ethical Approval

Not Applicable.

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