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The Role of Health Risk Assessment Techniques in Controlling Air Pollution: A Mini Review

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A B S T R A C T

Health risk assessment is a method that can be used to determine the potential effects of a risk on the well-being of an individual, a group of individuals, or a whole community. In order to comprehend the potential adverse impacts on health, factual and technical information is employed. In the current mini-review, the updated publications regarding the issue of HRA are systematically reviewed based on the performance and purposes. The main sources of extracting paper are Elsevier and Springer in the Google Scholar and Sience Direct. Volatile Aromatic Hydrocarbons (VAHs) are a significant cause of pollution in petrochemical and petroleum refineries. It is a known human carcinogen, and epidemiological investigations have demonstrated that it, even at low doses, contributes to the development of both acute and chronic leukemia. Chronic exposure to high levels of benzene can result in more serious negative health effects like blood illness, haematotoxicity, genotoxicity, an increase in persistent chromosome aberrations, problems with reproduction, and mortality. Acute exposure to high levels of benzene can also affect the brain and spinal cord and cause headaches, nausea, and dizziness. The importance of HRA in the refinery industry is highlighted in the previous works. However, the use of Artifical Intelligence techniques has been rarely considered as an approach. The gaps and shortcomings obtained in this review can be starting point for the future investigations.

Keywords: *Health Risk Assessment; Air pollution; Refinery industry; NO2; SO2; CO*

1. Introduction

Health risk assessment (HRA) refers to the tool employed for gathering health information considering a biometric experiment to evaluate the public health situation, risks, and habits (1). Research determining the level of people's exposures at varying distances from the origin of the pollutant is combined with research that examines the health effects of various exposures in animals

and humans to provide a risk assessment for a toxic air pollutant. Air pollution is responsible for an estimated 8.9 million fatalities annually, accounting for 7.6% of the world's annual mortality and resulting in a loss of 103.1 million healthy life years (2-4). The World Health Organization (WHO) reports that every year, 4.2 million people die from outdoor air pollution, and another 3.8 million die from interior air pollution (5). Evidence shows that short- and long-term exposure to particulate material (PM) increases mortality and decreases life expectancy (6). Premature deaths attributed to air pollution are expected to treble by 2050, and the issue is often viewed as one of the gravest in terms of global health concerns.

Overall, in the human body, the heart and lungs are particularly vulnerable to the negative consequences of poor air quality. Plants and structures can be harmed by pollution, and sight can be impaired by smoke or haze. Accordingly, many studies have been conducted for controlling air pollution based on the issue of HRA. Air pollution has become an urgent issue for public health. Air pollution has a major role in the illness burden in the general population, from subclinical consequences to premature death, as shown by many epidemiological studies linking air quality with a wide variety of adverse health impacts. At both the local and international levels, health risk assessment of air quality plays a substantial role in health promotion and illness prevention. The Air Pollution Health Risk Assessment (AP-HRA) is vital for directing public policy decisions since it predicts the health effects of policies altering air quality under different policy, environmental, and socio-economic contexts (7).

Numerous studies indicate that the main environmental element contributing to the high health risk in metropolitan regions is atmospheric air pollution (8-10). The air basin of practically every community is contaminated with many different chemical chemicals. In virtually every instance, the amount is higher than the maximum allowable threshold, and the cumulative effect of these pollutants is even more substantial (1-3). Cars that run on gasoline or diesel fuel are a further significant cause of air pollution (11). The growing popularity of automobiles, especially in major cities, contributes to high levels of air pollution from nitrogen dioxide, carbon monoxide, and organic compounds (12). Industries, including oil refineries, are one of the main contributors to air contamination, emitting harmful metals, particulates, and various gases (nitrogen oxides, sulfur oxides, methane, carbon monoxide, benzenes, and other toxins). Petroleum is crucial for multiple businesses because of its manufacture of a diverse range of processed goods, resulting in it being an essential natural resource in the growth of the global economy through energy usage, representing 32% for Europe and Asia, 53% for the Middle East, 44% for South and Central America, 41% for Africa, and 40% for North America. The petroleum industry's most significant visible air pollution constraints are centered around its refining division. Various contaminants are released during various stages of the petroleum refining operation (13). Thus, considering the HRA techniques for controlling the cities in which the refinery pollution is substantial is important.

In today's world, crude oil refineries incorporate the processing of petrochemicals and operations such as conversion, fractionation, blending, and the handling of refined products. Reforming, cracking, and other conversion processes change the less dense distillates into more valuable petroleum products. These improvements are made by modifying the hydrocarbon molecules' structure and size in transforming the distillates (13). In order to avoid contaminants and improve the quality of finished goods, various streams of crude oil go through a series of separation methods, such as extraction, sweetening, and hydrotreating. These processes are among many more. In general, the processes that take place in a refinery can be broken down into three parts (14):

- Fractional distillation: This process involves separating the crude oil produced in the vacuum distillation and atmospheric towers into various categories of hydrocarbon compounds with varying boiling points. These categories are referred to as cuts or fractions.
- Light oil handling involves arranging hydrocarbon molecules using procedures such as catalytic restructuring and isomerization or combined procedures involving polymerization and alkylation. This results in the production of light distillates.
- The treatment and environmental protection techniques consist of physical or chemical

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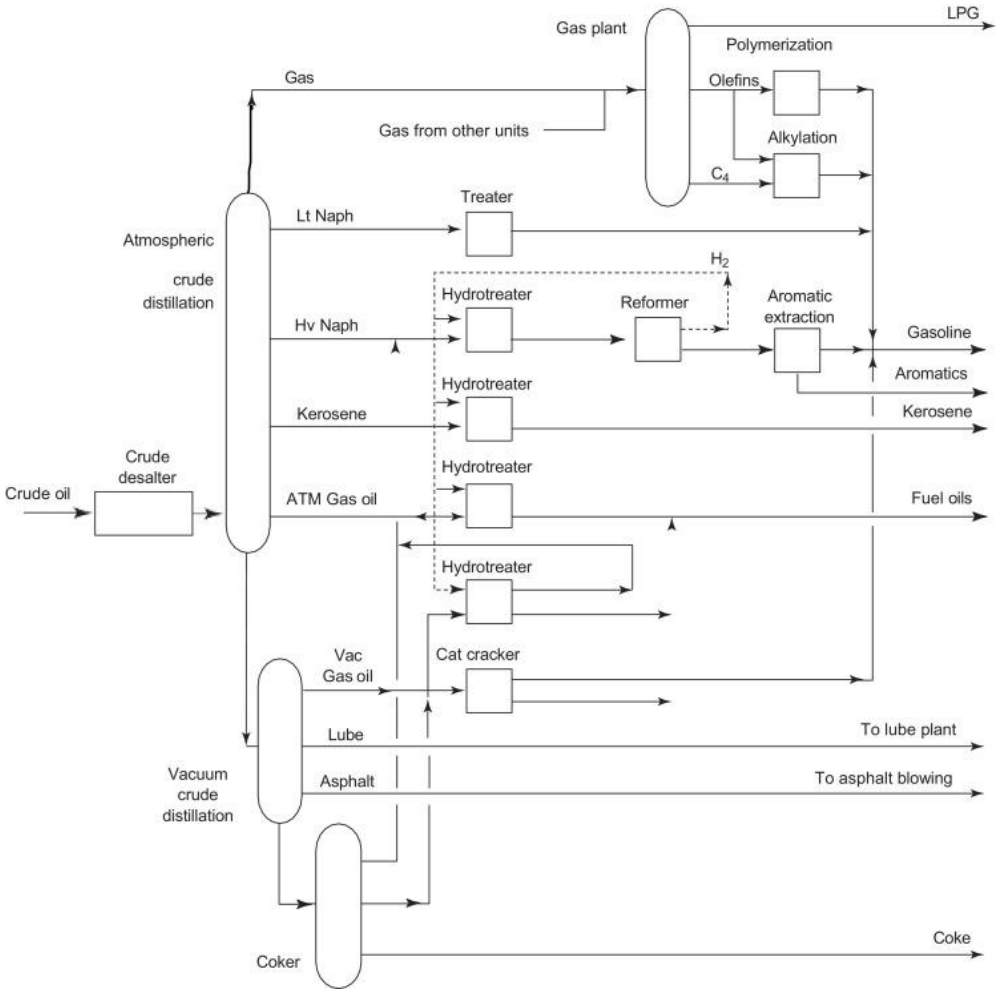
separations like precipitation, absorption, or dissolving, using diversity and blend of activities such as solvent refining, sweetening, and drying.

- Heavy oil processing alters the structural arrangement or extent of hydrocarbon molecules through catalytic or thermal cracking processes (15-17).

Figure 1

The diagram of a high-conversion refinery with air contamination (15)



Based on the given information, since the study in the field of HRA is of great importance, a systematic review is conducted here to examine the various HRA techniques. The methodology in the second section specifies the procedure for collecting the papers and investigating. The third section reviews the related research, and the fourth section comprehensively illustrates the HRA techniques. Finally, the conclusions and suggestions for future work are drawn in the fifth section.

2. Methods and Materials

The issue of HRA has received much attention in the literature, as seen in Figure 2. The term "health risk assessment" is used significantly in the research, as Google Trends reported.

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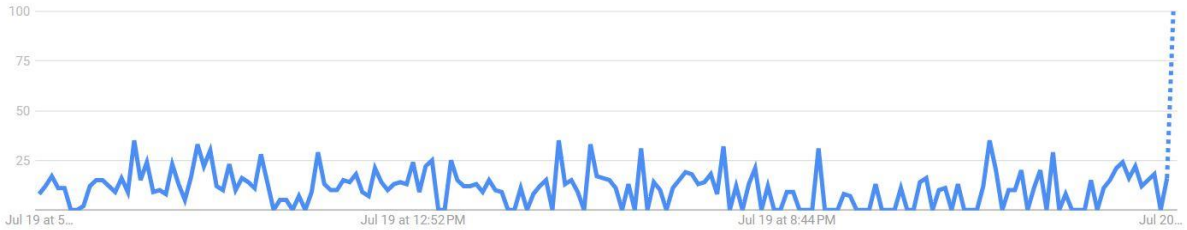
Figure 2

The remarkable growth of attention to the issue of HRA (18)



The current paper is a systematic review focusing on the pros and cons of the various HRA techniques used to control air pollution. About 100 papers were initially extracted from major journals, including Elsevier and Springer. The main source for extracting the papers is science direct and Google Scholar. The papers are categorized based on the main purposes, methods, and conclusions. The papers unrelated to the research topic were eliminated, and finally, 78 papers have been cited in the manuscript.

3. Related Works

Those who conduct risk assessments of human health hold degrees in science, engineering, or medicine and have expertise pertinent to the problem or circumstance being researched (19). Assessors of risks to human health frequently collaborate with specialists in related fields, such as toxicology, epidemiology, and chemistry, particularly when the evaluation concerns potentially dangerous substances, such as chemicals. Risk assessors for human health receive training to comprehend each stage of the risk assessment process and to analyze a problem logically (20). They dissect the examination into its components and use reasoning and deductive reasoning to solve each sub-problem, much like they would with a puzzle. After that, the puzzle pieces are put back together to form an overall knowledge of the scale and nature of dangers to human health in the past, present, or future (19). Depending on the nature of the problem, government departments and agencies may assess the danger to human health or hire an outside expert to carry out this function. In some circumstances, a department or agency of the government may instruct an individual or business owner to carry out a human health risk assessment at their own expense. This may include an additional round of peer review to ensure the findings are objective and reliable (21-23).

It is common knowledge that the refining industry is the leading producer of volatile organic compounds (VOCs) emissions produced by industrial processes. There is a class of chemicals known as volatile organic compounds (VOCs) responsible for generating ground-level ozone, also known as smog (20). Byproducts of fossil fuel combustion include greenhouse gases and several other types of air pollutants, such as sulfur dioxide, nitrogen oxides, trace metals, and volatile organic compounds (VOCs) (24). When the oxides of nitrogen and sulfur get released into the environment, they can rise to high altitudes in the air. At this point, they might mix and react with water vapor, oxygen, and other chemicals to form further acidic pollutants, known as acid rain (19). Both sulfur dioxide and nitrogen oxides are able to be easily absorbed in water. They are carried great distances by the wind, where they become a component of weather phenomena such as fog, rain, snow, and hail that are commonplace in our everyday lives. Since the middle of the 21st century, research has shown that greenhouse gases, produced when fossil fuels are used, are the primary cause of climate change, such as an increase in temperature (15). Alarms about climate change have led to a variety of people advocating for alternative energy sources, which has resulted in the implementation of various processes to source energy, including solar, biofuel, and wind, amongst others. The majority of a petroleum refinery's input of raw materials is comprised of crude oil. On the other hand, petroleum refineries also utilize and produce a significant volume of chemicals. Many of these chemicals are discharged outside the plants by discharges of solid trash, air pollutants, or effluent waters. The most common types of air pollutants that are created are sulfur oxides (SO_X), nitrogen oxides

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(NO_X), particulate matter, volatile organic compounds (VOCs), NH_3, CO, H_2S, and other trace metals (25, 26).

A large number of existing studies in the broader literature have examined the issue of HRA methods and obtained important results (27-30). In 2023, Panneerselvam et al. (31), the hydrochemical method was combined with the entropy water quality index (EWQI), nitrate pollution index (NPI), and human HRA, which indicated 44.19% of the specimen locations considered prior to consumption. A significant amount of the area under study (37.20%) had groundwater that contained a high percentage of nitrate. According to the NPI's findings, 41.86 percent of the samples contained moderate or considerable pollution levels. Based on the findings of the non-carcinogenic risk assessment, it was determined that children aged 6 to 12 in the research region pose a higher risk than adolescents, adults, and elderly persons. Nag et al. (32) proposed a probabilistic farm-to-fork human HRA for Pb and obtained essential outcomes in another work. A Geographic Information System (GIS) survey of levels of metals in soil was combined with a probabilistic quantitative evaluation of the danger of lead through the progression in the food industry supply. Considering the framework boundary of the probabilistic model, the research indicated a low to medium danger posed by lead, and it emphasized the importance of decreasing the amount of lead present in agricultural soil that produces vegetables. In another work, the groundwater quality was assessed in the wet and dry seasons of Hua County, and the reasons for seasonal changes were investigated to find the regions with serious pollution (33). This study examined Groundwater quality using the entropy water quality index (EWQI) and certain graphical methodologies such as Gibbs and Piper diagrams. The boundary maps of groundwater quality were created using GIS. According to the collected data, the places where groundwater quality was classified as outstanding or good in the rainy and dry seasons were mainly in the eastern and northern regions of the research area. In 2022, Panneerselvam et al. investigated the groundwater quality and undertook a non-carcinogenic risk assessment of nitrate contamination in an industrial and high-level area of South India (34). The non-carcinogenic risk level to the exposure demographic in the research location declined in descending order: children > > females > males. The study revealed that low body weight in youngsters is a direct effect of drinking low-quality water and that adult men and women experienced less severe impacts. More studies regarding the HRA methods are reviewed in Table 1 based on the purposes and methods.

Table 1

A review of related works based on the purposes and methods

No	References/Year	Methods	Purposes	Conclusions
1	(35)/2022	Considering topsoil and pak choi (Brassica chinensis L.)	Controlling the greenhouse vegetable production (GVP)	Based on the outcomes, strategies to limit heavy metal/metalloid pollution hazards must be explored extensively throughout the growth of GVP in the major metropolis in Northwest China.
2	(36)/2022	A screening-level risk assessment	Controlling pharmaceuticals and personal care products (PPCPs)	The findings are useful for prioritizing the found PPCPs in the natural resources of India, which means immediate attention and enforced norms are needed
3	(37)/2022	HRA based on exposure and toxic factors	Controlling Pb, Cd, Zn, Ni, and As	Suggestions for better risk management of residues are presented based on the full assessment of pollutants and human health risk
4	(38)/2022	An atomic absorption spectrometer	Examining concentrations of As, Cd, and Cr in 26 water specimens	The health risk assessment results of groundwater around the mining area could be beneficial for effective oversight of water supplies in rural regions, especially to other mining sites.
5	(39)/2022	Review paper	Considering soil contamination through potentially toxic trace elements (PTEs) near uranium (U) mines	In this investigation, data of U, Cd, Cr, Pb, Cu, Zn, As, Mn and Ni concentrations in U mine-associated soils were collected and filtered from recent studies

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6	(40)/2021	The pivotal first step toward human health risk assessment	The main goals included collecting information from what is known about the quantity and mass of microplastics from different sources, identifying challenges in the data, establishing new areas of study, and calculating the average global prevalence of microplastic ingestion to help with the creation of risk assessments for human health as well as efficient policy and management options.	Determining an ingestion rate is essential to evaluate the dangers of ingesting microplastics to human health.

4. Health Risk Assessment Techniques

Based on the purpose of the related works, several HRA techniques have been proposed in the literature (41). Accordingly, the purposes of the related works including the issues of water shortage and air poluttions play a key role in the selection of HRA methods. Since it constitutes one of the most dependable alternative sources of water in arid and semi-arid regions of the globe with little to no rainfall, groundwater serves as the primary source of clean water for drinking, agriculture, industrial, and recreational uses (42, 43). The quality of groundwater is crucial, particularly from the perspective standpoint of the well-being of people. Around the world, dry and semiarid regions are where groundwater contamination occurs most frequently (42, 44). According to the lack of rainfall, groundwater serves as a valuable resource for drinking, irrigation, and industrial uses in many areas (42). As a result, the majority of people living in arid and semiarid regions rely on aquifers. Over the years, this dependence has risen. But for the nation of India, groundwater is a vital resource. Over sixty percent of agricultural water, 80%-95% of the water used for drinking in rural areas, and fifty percent of drinking water in cities come from groundwater. Just fifty percent of groundwater in France and 70% in China are employed for drinking water, respectively (45, 46).

Alluvial basins have experienced pollution of groundwater as a result of individual intervention, which has an impact on the health of the exposed population. In another work, 74 samples of groundwater from the semi-arid Panipat area in India's Yamuna sub-basin were examined as part of the current investigation to determine any potential non-carcinogenic risks to the local adult and pediatric population (47). Also, the non-carcinogenic human health risk associated with consumption of fluoride and nitrate contaminated water was examined utilizing two distinct methodologies: linear and probabilistic (Monte Carlo simulation). Hazard quotient (HQ) values calculated using deterministic and probabilistic approaches were very similar. Children are more vulnerable to non-carcinogenic health risks than the adult population, as shown by the hazard index (HI) values of 69.7% of samples for children and 40.8% of samples for adults being over unity. The concentration factor (CF) was shown to be the most influential variable in sensitivity analysis, which was used to determine the effect of the non-carcinogenic human health risk predictor variables for the prediction of risk. To determine the positive and negative correlations between fluoride and nitrate and other parameters, multivariate statistical approaches were used. Principal component analysis/factor analysis (PCA/FA) results showed that the amount of calcium controls the concentration of fluoride since there is a negative association between the two in groundwater samples. Both the results of PCA/FA and the hierarchical agglomerative cluster analysis (HCA) suggested that the fluoride and nitrate in groundwater came from anthropogenic sources. In many parts of the world, groundwater nitrate pollution poses a major risk to human health. In the area of Nirmal Province, South India, where residents solely rely on groundwater for drinking purposes, the current study was carried out to evaluate the presence of nitrates in groundwater. The related human health hazards for various age groups (men, women, and children) were also assessed using a model developed by the US EPA. According to the findings, the mean nitrate concentration in groundwater is 36.51 mg/L, with a range of 0.8-130 mg/L. Additionally, 26.47% of samples of groundwater in the research area had NO3 levels that were higher than the WHO drinking water standards. Oral consumption contributes significantly more to the overall hazard quotient or noncarcinogenic health risk than cutaneous contact does. For adult males, adult females, and children, the overall hazard quotient values varied from 0.02 to 3.13, 0.02 to 3.70, and

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0.03 to 4.32, respectively. In another research (47), adolescents have greater exposure compared to mature females and males to the noncarcinogenic health risks of nitrate, according to the health risk assessment. As a result, appropriate groundwater quality policies should be developed to address the issues with children's health in the research area.

Acrylamide is a water-soluble toxin present in foods heavy in protein and carbohydrates that are heated, such as bread, which is a common food (48). In another work, the Maillard process was employed to create this toxicant. The monitoring of acrylamide is necessary due to any potential negative effects, including any potential human carcinogenicity from food exposure. Its level needs to be researched due to the presence of its antecedents in wheat bread formulation, extreme bread consumption by the majority of the population, and variety of bread kinds. Wheat bread's indicative level of acrylamide has been set at 80 g/kg. Therefore, including both the risk assessment and quality control aspects, its detection by liquid chromatography-tandem mass spectrometry (LC-MS/MS), gas chromatography-mass spectrometry (GC-MS), or capillary electrophoresis (CE) may prove useful. In this regard, LC-MS/MS-based methods exhibit good recovery and experimental repeatability with detection limits of 3–20 g/kg and quantification limits of 10–50 g/kg, respectively, which are adequate to meet the immediate needs of food product management and consumer exposure computation (49).

The source identification and human health risk of soil contaminants near municipal solid waste incinerators (MSWI) in densely populated areas have not been thoroughly examined by many studies. Eight metals (Cr, Pb, Cu, Ni, Zn, Cd, Hg, and As) were identified in another research (50) using fly ash, soil samples from various functional regions, and vegetables gathered near the MSWI in North China. In this investigation, the dose-response model, absolute principle component score-multiple linear regression (APCS-MLR) model, single contamination index, combined Nemerow pollution index, principal component analysis (PCA), and single pollution index were all employed. The findings demonstrated that the soils surrounding the MSWI were significantly contaminated by As and Cd and slightly contaminated through Cu, Pb, Zn, and Hg. The movement of soil heavy metals at various distances from MSWI was significantly impacted by MSWI. The results of the source apportionment revealed that the four main possible sources of heavy metals in the soils were MSWI, natural sources, industrial discharges, and coal combustion, with the following percentages: 36.08%, 29.57%, 10.07%, and 4.55%, accordingly. The pollution of soil with Zn, Cu, Pb, Cd, and Hg was significantly impacted by MSWI. The pH- and temperature-dependent heterogeneity of ammonia (unionized ammonia nitrogen, NH3-N) causes variations in ammonia toxicity. In environmentally relevant areas of Tai Lake, China, the yearly and long-term trends of ammonia danger were unclear. A two-level (deterministic and quantitative) methodology was created for another work (51) to evaluate the unique ecological threats that NH3-N posed at 37 sites over the course of two seasons in 2014 in Tai Lake. In 2015, the dangers of benzene in the petroleum industry were examined using HRA techniques (52). Each scenario's health risk was assessed using the Hazard Quotient (HQ) at exposure levels of 50% (CEXP50) and 95% (CEXP95). With HQ50 > 1 and HQ95 > 1 for employees who were exposed to benzene as relying projections for petroleum refinery workers (Scenario 1), petroleum refinery workers assessed with personal samplers in Bulgarian refineries (Scenario 2B), and petroleum refinery workers assessed via air inside petroleum refineries in Bulgarian refineries (Scenario 3B), benzene levels were estimated to pose a significant risk. For workers at oil refineries in Italy (Scenario 2A), the air inside refineries (Scenario 3A), and the air outside refineries (Scenario 4) in India and Taiwan, HQ50 1 was computed, indicating little potential health consequences. In addition, the HQ95 for Scenario 4 was less than 1, but the HQ95 for Scenarios 2A and 3A was greater. Using the Slope Factor and Overall Risk Probability (ORP) techniques, the excess Cancer risk (CR) for lifetime exposure to benzene was assessed for each scenario. The conclusion points to a possible cancer risk for contact with benzene in each case. Workers at petroleum refineries (2B), who had a CR of 48,000 per 106, and those who were exposed to benzene in the air inside of petroleum refineries (3B), who had a CR of 28,000 per 106, had a higher cancer risk at 95% (CEXP95).

Methods from the US Environmental Protection Agency (EPA) and the American Conference of Governmental

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Industrial Hygienists (ACGIH) were used to evaluate the dangers that volatile organic compounds (VOCs) pose to the health of refinery workers. The hazard of the health risk assessment was evaluated using Monte Carlo simulation and sensitivity analysis (53). Emission studies indicated that C5-C6 alkanes, such as 2-methylpentane (17.6%), 2,3-dimethylbutane (15.4%), and 3-methylpentane (7.7%), were the predominant volatile organic compounds (VOCs) in the refinery. Basic research laboratories had the highest concentrations of p-diethylbenzene (9.3%), 2-methylpentane (8.1%), and m-diethylbenzene (6.8%), whereas sewage treatment plants had the highest concentrations of 2-methylpentane (20.9%), 2,3-dimethylbutane (11.4%), and 3-methylpentane (6.5%). The findings of the measurements revealed that the VOC data collected in the petroleum refineries was significantly impacted by external pollutants, meteorological circumstances, and photochemical processes. Another study found that the most abundant species in refinery emissions were propene (34.2%), propane (10.2%), n-butane (5.6%), and i-pentane (5.0%), however the emission composition varied significantly between refineries (54). In 2021, the levels of pollution, the identity of the sources, the oxidative potential, and the hazards to human health posed by fourteen potentially harmful substances found in the dust of the oldest oil refinery zone in the Middle East were examined (55). Thirty-five samples of street dust were taken from different parts of the cities of Abadan and Khorramshahr. Compared to Khorramshahr, where the average concentrations of As, Mo, Cu, Pb, Hg, Zn, Cd, and Sb were 14, 2.58, 74.35, 56.50, 0.74, 214.26, 0.62, and 1.18, the street dust in Abadan had significantly higher mean concentrations of As, Mo, Cu, Pb, Hg, Zn, Cd, and Sb.

Moreover, more related works are also reviewed in Table 2 based on the purposes, methods, and findings. It can be said that the pollution of alluvial aquifers due to human activities has resulted in adverse consequences for the health of the population that comes into contact with the affected groundwater. Accordingly, the role of the risk assessment in preventing from excessive emission of non-carcinogenic and carcinogenic is important. The adopted techniques were considered for devising the novel plan to reduce the pollution and have the better weather in the world (47).

Table 2

A brief review of the previous risk assessment

Row	References/Year	Method	Findings
1	(56)/2022	Monte Carlo Simulation (MCS) method	The majority of exposed population groups exhibited non-carcinogenic risk from nitrate and fluoride, however exposure to nitrite lacked a non-carcinogenic risk.
2	(57)/2018	Systematic review regarding the role of risk assessment for reducing the dangers of nanocomposites	The findings from the qualitative analysis revealed that many parameters, including the kind of composite material, functionalization of carbon nanotubes, and the amount of energy input throughout the manipulation process (namely, grinding), might potentially influence the release of carbon nanotubes.
3	(58)/2017	Multivariate statistical techniques	The hazard quotient (HQ) value surpassed the established threshold of 1 for elements such as Arsenic (As), Boron (B), Aluminum (Al), Chromium (Cr), Manganese (Mn), Cadmium (Cd), Lead (Pb), and Uranium (U) at specific locations. Additionally, the hazard index (HI) exceeded 5 in approximately 30% of the samples, suggesting a potential health risk for the local population if they consume groundwater from these tubewells.
4	(14)/2022	Remediation methods	The assessment of metal contamination concentrations and fractions can serve as a valuable tool in evaluating possible health risks.
5	(59)/2017	The AirQ2.2.3 software developed by the WHO European Center for Environment and Health	The findings of the study indicate that PM10 concentrations over 10 μg/m3 were associated with 3.9% (95% CI: 3.3–4.5%) of total mortality, 4.2% (95% CI: 2.7–9.05%) of cardiovascular mortality, and 6.2% (95% CI: 4.2–16.9%) of respiratory mortality.
6	(60)/2015	Unsupervised multivariate methods	The evaluation methodology that has been presented for sediment polluted with heavy metals has the potential to be utilized in river sites contaminated with silt in various geographical locations.
7	(61)/2020	Principal component analysis (PCA) and cluster analysis (CA)	The anticipated results of this study are likely to yield valuable insights into the provision of clean water for urban populations and the sustainable administration of groundwater resources in order to mitigate risks to human health.
8	(62)/2022	Meta-analysis of Cd contaminations	In lieu of employing chemical adsorbents, alternative methods such as nanoparticles, phytoextraction, and bioremediation approaches have demonstrated considerable efficacy in the cleanup and management of cadmium-contaminated groundwater, offering a cost-effective approach.

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5. Discussion and Conclusion

Nowadays, potentially toxic elements (PTEs) are a major concern among environmental contaminants due to their pervasiveness, toxicity, and longevity in the natural environment. In summary, the HRA methods based on the performance and purposes were reviewed systematically here. Risk assessment is a method of identifying risks and analyzing them to determine the appropriate safety precautions. It may be applied in a number of circumstances, including the creation of an item, feasibility analyses, and even workplace structure. The high levels of surface O_3 pollution and the formation of secondary organic aerosols (SOAs) in Iran are largely attributable to VOC emissions from human activities. Based on the review, it can be said that many volatile organic compounds (VOCs) are hazardous air pollutants (HAPs) that offer direct dangers to human health, ranging from stimulants to carcinogenic substances, and contribute to the elevated levels of ozone (O_3) and particulate matter (PM) in the atmosphere. The danger of inhalation, ingestion, and skin contact with polycyclic aromatic hydrocarbons (PAHs) is higher for populations living in close proximity to oil refinery sludge dump sites. There are no fully "stand-alone" technologies for risk assessment, despite the fact that computers can do activities that are frequently linked with human intellect. Because of this, businesses that want to use AI-powered strategies must put protocols in place to adequately test such strategies' efficacy both before and after they are launched, providing ongoing monitoring. Because mistakes in risk analysis might have disastrous results.

Authors' Contributions

R.K. conceptualized the study, designed the research methodology, and led the systematic review process. A.P., the corresponding author, conducted the data analysis, interpreted the findings, and took the lead in drafting and revising the manuscript. M.A.Z. assisted in the literature search, supported the data extraction process, and contributed to the discussion and analysis of the review. All authors participated in discussing the findings, critically reviewed the manuscript for important intellectual content, and approved the final version for publication.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethics Considerations

The study placed a high emphasis on ethical considerations. Informed consent obtained from all participants, ensuring they are fully aware of the nature of the study and their role in it. Confidentiality strictly maintained, with data anonymized to protect individual privacy. The study adhered to the ethical guidelines for research with human subjects as outlined in the Declaration of Helsinki.

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