Research Paper

# Challenges of Controlling Vector and Vector-borne Diseases at the Flood Disaster of Khuzestan Province in 2019 According to the Experts of Health Center

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## ABSTRACT

**Background:** Natural disasters, such as floods provide the basis for spreading vector-borne diseases by creating environmental changes. This study aims to investigate the common vector-borne diseases during floods in Khuzestan Province, Iran, in 2019 and the strategies and challenges to control them.

**Materials and Methods:** This research is applied objectively and it is a descriptive survey in terms of collecting data using a qualitative method. The statistical population in the qualitative section included 15 experts from health centers in Khuzestan Province with a history of presence in flooded areas who were purposively selected using the snowball technique. The data collection tool was a semi-structured interview.

**Results:** Qualitative data were categorized into 5 categories of common arthropods, common vector-borne diseases, vector control strategies and challenges, and organs involved in vector control programs during floods. The most common arthropods were lice, mites, mosquitoes, flies, and scorpions. The most prevalent vector-borne diseases during the flood were scabies, pediculosis, mosquito bites, and scorpions. The critical challenge was the lack of national vector control guideline in disaster condition.

**Conclusion:** Considering the history of floods and health problems caused by these natural disasters, it is necessary to recognize the common vector-borne diseases, develop national guidelines, and provide solutions to deal with them.

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## 1. Introduction

Unforeseen events are a series of unpredictable events occurring as a result of natural disasters or human manipulations. These events are usually unpredictable with available tools, or at least the exact time of their occurrence cannot be determined [1]. Iran is classified as a disaster-prone country, therefore out of 44 types of natural disasters that occur worldwide, about 33 types of natural disasters occur continuously in different parts of Iran. In this way, Iran ranks sixth among the top 10 disaster-prone countries in the world [2].

Floods are one of the natural events that during rapid and severe environmental changes cause major disruptions in the life pattern, i.e., not equipping the facilities on time, which ultimately cause stress in people and jeopardizes their health status. The flooded population is often forced to congregate in a crowded area. Usually, these areas have unsanitary conditions causing the spread of infectious diseases in that area and the surrounding area [3].

Iran is considered one of the most polluted regions in the world regarding the diversity and spread of vector-borne diseases. So far, diseases, such as malaria, leishmaniasis, tick-borne relapsing fever, Crimean-Congo fever, West Nile fever, pappataci fever, dengue fever, and chikungunya have been reported in Iran. Also, a diverse fauna of disease-carrying insects and poisonous arthropods has been reported in Iran [3-5].

During floods, the growth and living environments of insects and rodents also change, and the accumulation of stagnant water and garbage and the suspension of common vector control programs provide the environmental conditions for their rapid growth and reproduction [6]. The formation of stagnant water provides suitable breeding environments for Anopheles, Culex, and Aedes mosquitoes, and depending on different regions, it causes the spread of mosquito-borne diseases, such as malaria, Rift Valley fever, dengue fever, West Nile fever, and chikungunya [7]. It can also cause an outbreak and an explosive increase in the population of Culex mosquitoes. However, Culex mosquitoes do not transmit crucial diseases except for West Nile fever in Iran [4, 8]. However, their various and annoying bites can cause many health problems in flooded areas. Seasonally low or dry river floods and overflows can also cause a rapid increase in the population of Aedes mosquitoes. At the same time, disruption of the usual insect control systems in health networks causes the rapid proliferation of mechanical disease-carrying insects, such as flies and cockroaches [9]. However, the occurrence of every natural event does not necessarily lead to the spread and epidemic of infectious diseases. In some mosquito-borne diseases, such as malaria, dengue fever, and encephalitis, the insects in the immature stages urgently need water environments, and the mature stages need resting environments, these diseases may disappear for several weeks after the incident due to the loss of a favorable substrate for the growth of mosquitoes. This state is temporary, and after some time, if the control and protection operations are not carried out properly, these diseases will break out [10].

Very little information is available on diseases transmitted by insects and how to control vectors in unexpected incidents in Iran. Studies show that the recent floods in Iran in 2020 have caused an increase in the water in the wetlands and the return of water to the dried-up wetlands in central and southern Iran and their restoration, which on the one hand, has caused the migration of birds to these wetlands and on the other hand, due to the increase in spawning sites of mosquitoes, can spread vectors of West Nile fever.

Therefore, the probability of seeing disease cases in the provinces where this virus has been reported, such as Golestan, Gilan, Kermanshah, Isfahan, Khuzestan, Qom, Khorasan Razavi, and Tehran Provinces, Iran, is not far from expected [6]. Therefore, natural disasters do not always cause new diseases in the region; however, changing the environment, may increase the transmission of diseases that already exist in the area in different ways. The direct effects of physical events, such as the contamination of water and food sources with feces due to the entry of sewage into drinking water, and the indirect effects of factors, such as overcrowding and non-observance of health principles, increase and displacement of the population, disruption in the implementation of common vector control programs in the region lead to transformation and change in the distribution of vector species and a good platform for the proliferation of insects and disease vectors [11].

In many cases, it is possible that after the occurrence of a natural disaster, the flooded population will experience confusion and extreme behaviors that the physical presence of the control and evaluation groups of carriers and rodents in the region can greatly reduce the stress on the population and give them relative peace [12].



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At the end of 2018 and the beginning of 2019, severe and frequent floods occurred in some provinces, including Khuzestan Province, Iran, which resulted in many human and financial losses. It is essential to identify the arthropods that have become more prevalent since the beginning of the flood phenomenon and the diseases transmitted by them to adopt quick and correct solutions to deal with them.

This research aimed to recognize the common arthropods, the diseases transmitted by them, and the challenges of facing them during floods from the point of view of the experts of the health centers of Khuzestan Province.

## 2. Materials and Methods

### Participants

This research was designed and implemented using the content analysis method with a qualitative approach. The participants were selected by purposive sampling among the experts who had more experience and work experience regarding the subject under study in the flood-affected cities in Khuzestan Province. The purposive sampling of the study, which provides the most desired information, was done in the form of a snowball until data saturation.

To coordinate and explain the experts, a WhatsApp group was created in virtual space. Before asking the questions, the researcher explained the study's purpose and importance. Then the participants were asked to present all their experiences during the flood in Khuzestan Province in 2019 regarding vectors and vector-borne diseases.

The participants were given the opportunity for one month to explain the issues related to the vectors since the flood of 2019 by carefully examining reports. The text of the interviews was typed and classified into components and sub-components.

The qualitative content analysis method was used in the content analysis, which included five steps, including writing the entire interview immediately after each interview, reading the entire interview text to get a general understanding of its content, determining meaning units and primary codes, classifying similar primary codes in more comprehensive classes, and determining the content hidden in the data. In this way, the data obtained from the interview were divided into 5 main classes, each of which is divided into several sub-classes.

Accuracy criteria in the content analysis are validity, transferability, trustworthiness, and verifiability. In this way, the main concept of meaningful sentences was extracted in code form, and the classification of codes began. All codes with a common concept were placed in one category and named.

## 3. Results

This study included 15 medical entomology and vector control experts with more than 10 years of work experience in the health centers of Ahvaz, Dezful, Abadan, Mahshahr, Shushtar, Dasht Azadegan, and Karun Cities, Iran. After checking the data, the information was placed in 5 main categories. The main classes contained other sub-classes described below (Table 1).

### Arthropods causing problems during floods

The increase in the population of Culex mosquitoes and the complaints caused by them in cities, such as Dasht Azadegan, Hoizeh, West Ahvaz, and Karun Cities, Iran, was one of the problems of flooding occurred in 2019. In Abadan City, after the flood receded, the ponds and stagnant water left over from the flood in the rural areas caused the invasion of Culex mosquitoes, which invaded people's residential areas, trees, and nature, and as one of the problems that people were complaining about it. In Shushtar City, the activity of ground mosquitoes and in Dasht Azadegan City, ground mosquitoes and anopheles mosquitoes had increased, which resulted in the residents' complaints of the flooded villages and the camp residents about the bites of these mosquitoes. In almost all flood-affected areas, increased head lice were also reported. Another crucial issue was the abundance of houseflies in the flooded areas, especially in flood victims' camps.

Also, complaints of scabies increased. In Abadan and Shushtar, the population of Sarcoptes scabei with clinical symptoms and typical lesions of scabies was observed mostly in residential areas of some villages, schools, and boarding houses. In most cities, dust sites had greatly increased harassment and complaints due to increased humidity.

In Dasht Azadegan City, the cases of scorpion stings increased, but scorpion stings did not increase in the camps during the flood, and the reason for this was that the camps were set up in places with less risk of arthropod bites. In some cities, rodents and snakes increased due to the loss of habitat, which invaded people's residences and caused problems due to the flooding of ar-


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**Table 1.** Vectors and vector-borne diseases challenges at the flood disaster in Khuzestan Province in 2019

| Categories | Sub-categories |
|---|---|
| Common arthropods during floods | - Head lice<br>- Sarcoptes scabei mite<br>- Culex mosquitoes<br>- Scorpion<br>- House flies<br>- Mosquitoes<br>- Fleas<br>- Mites |
| Common vector-borne diseases during floods | - Pediculosis<br>- Scabies<br>- Scorpion<br>- Mosquito bites and itching |
| Interventions to control carriers during floods | - Teaching personal hygiene to flood victims.<br>- Training the forces stationed in the camps to identify, prevent and control carriers.<br>- Collection and sanitary disposal of garbage around the camps.<br>- General disinfection around tents and spraying around garbage.<br>- Distribution of insect repellent spray and pen.<br>- Active diagnosis of families living in camps to identify people with scabies and lice.<br>- Distribution of permethrin shampoo and dimethicone lotion among patients with pediculosis.<br>- Transporting pediculosis patients living in the camp by vehicle to the bathrooms installed outside the camp.<br>- Foliar spraying of bacillus thuringiensis (Bt) in stagnant waters to control the larval stage of mosquitoes.<br>- Keeping livestock in places far from settlement camps by military aid workers to prevent the accumulation of flies, ticks, fleas, and other pests in settlement camps.<br>- Spraying the area against day-old mosquitoes with deltamethrin poison according to the suggestion of environmental health.<br>- Installing nets on the windows.<br>- Drainage of stagnant water in accessible places. |
| Organs and establishments intervening in the control of carriers | - Jundishapur University of Medical Sciences, Ahvaz<br>- Jundishapur University of Medical Sciences, Dezful<br>- Islamic Revolution Guards Corps<br>- Red Crescent Organization<br>- Basij<br>- Governorates of cities<br>- Governorships<br>- Private pharmaceutical companies<br>- Private companies controlling domestic and foreign carriers |
| The challenges of being faced with carriers during floods | - Absence of national directives to control carriers<br>- Absence of an official protocol to prepare for dealing with vector-borne diseases during disasters<br>- The intervention of uninformed and irresponsible institutions<br>- The intervention of benefactors and public institutions<br>- Lack of facilities and equipment<br>- Lack of intra-departmental cooperation between the University Health Vice-Chancellor and also between other University Vice-Chancellors<br>- Lack of health infrastructure<br>- Unpreparedness of relevant institutions<br>- Failure to carry out improvement operations in rural areas<br>- Lack of workforce<br>- Non-acceptance of the insect-repellent pen by some people<br>- Improper accommodation for installing door and window nets:<br>- Not using educational videos and images |





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eas. Nomads and ranchers also complained about the increased flea population among livestock.

## Vector-borne diseases caused during floods

Almost all the flooding areas of Khuzestan Province, especially the camps, complained about the increase in pediculosis. According to the residents of Shadgan and Abadan, the site of Yadman buildings, 5 km from the entrance of Abadan, which was previously used for Rahian-e Noor caravans., the surroundings of this place were full of stagnant water and reeds and dirt lands inside the area, and many trees. Many villagers brought domestic animals to this place. In those conditions, most people observed pediculosis due to the lack of good hygiene and the accommodation of several people in one room. Several cases of pediculosis were also observed among the residents of the Azadegan and Shushtar camps. One of the reasons for the increase in pediculosis in people is the impossibility of checking them upon entering the camps, and it was found that most people were infected with lice before entering the camps and after entering the tents due to family relationships and the proximity of the tents and using each other's equipment, this disease had spread more among them. After active detection of the disease, it was found that the prevalence of lice infestation was lower than reported. Any head itch caused by a lack of daily bathing and cleaning was attributed to lice due to a lack of knowledge to distinguish between head lice and scalp, and many cases were rejected after examination.

In Abadan, an increased rate of leishmaniasis was observed compared to last year. In Dasht Azadegan, no significant difference was observed in the rise in leishmaniasis in flooded areas in 2019. In Dezful, due to the predictions regarding increased leishmaniasis, an operational plan was developed in this regard; as a result, after the flood, leishmaniasis decreased, which seems logical considering the type of leishmaniasis in the area, which is rural, and the connection with the colony of rodents, as well as the destruction of rodent nests after the flood. In Dezful and Abadan, scabies disease with clinical symptoms and typical lesions was observed in residential areas of some villages and schools, and boarding houses. In the cities of Abadan, Shushtar, and Dasht Azadegan, cases of scabies were diagnosed. Also, several tick bites were observed and in two or three cases, the tick was separated from the patient.

Following the bites of insects, especially Culex mosquitoes, skin rashes caused by their bites caused skin allergies, and people complained a lot.

In the groups that worked at the flood dams and their job was to fill the soil bag and place it in front of the water path, due to digging the ground, cases of scorpion stings were reported which were treated by physicians.

## Interventions to control vectors during floods

- Face-to-face and tent-to-tent personal hygiene training for camp residents regarding the methods of preventing insect bites and dealing with them by wearing long-sleeved clothes, washing clothes and sheets in hot water and drying them with sunshine, and emphasizing the use of vacuum cleaners with disposable bags to prevent the accumulation of garbage around the camp.

- Teaching ways to prevent insect and arthropod bites to forces stationed in camps, for example, popular forces and Red Crescent forces.

- Collection and sanitary disposal of garbage around the camps to reduce the population of flies and regularly check the environmental health status of the camps.

- General disinfection around the tents and spraying around the dumps with deltamethrin poison and emptying the trash cans three times a week instead of twice a week by the municipality.

- Individual distribution of repellents and insect repellents and sprays for the inner and outer walls of the tents.

- Examining the families living in the camps to identify people with scabies and lice and treating these people by distributing dimethicone lotion or dialysis along with training and re-examination in the next two days to inform about the situation and the result.

- Daily visits of experts from disease control to the camps and review of reports.

- Distribution of permethrin shampoo and dimethicone lotion among patients with pediculosis.

- Transporting pediculosis sufferers living in the camp by vehicle to the bathrooms installed outside the camp for daily washing along with the distribution of cleaning supplies and training on how to use permethrin shampoo due to the lack of bathrooms in the camps.

- Spraying Bacillus thuringiensis (Bt) in stagnant water to control the larval stage of mosquitoes.



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- Keeping cows and sheep in places far from the settlement camps by relief forces to prevent the increase in the population of flies and the spread of ticks.

- Installing nets on the windows.

- Drainage of stagnant water, if possible.

## Organs and organizations working on the control of vector-borne diseases

In some regions, various bodies and organizations, such as governorates, districts, Red Crescent, IRGC, and even some private and non-Iranian companies, have expressed their desire to control vectors and even started working in some cases. However, their activities were controlled since the groups were unaware of the relevant standards, methods, and risks. In some cases, training was provided by the Red Crescent Organization to comply with the instructions and activities of the "transport control group of the provincial health center." Regarding non-Iranian spraying companies, spraying was done after holding meetings with the provincial health center and identifying the problems and necessary points for interventions.

## Challenges of vector control programs during floods

### Absence of national guidelines for vector control

The biggest challenge facing vector-borne diseases is the lack of national guidelines for vector control in crises. To solve this problem, the provincial health center unit prepared a form to register and present reports and sent them to the camps and cities. Many private companies and organizations considered the first action in this field to be spraying, mainly in spraying and fogging equipment. This problem was well organized in Khuzestan Province, but unfortunately, in some provinces, many poisons were used in retention and spatial spraying. In Khuzestan Province, the use of integrated methods could solve the following problems:

### Absence of an official protocol to prepare for dealing with vector-borne diseases during disasters

Another issue was the lack of preparation for various operations in emergencies at the national level. In Khuzestan Province, because such an incident was anticipated, a one-day exercise was held for officials in this field in Izeh City, Iran, in 2018, and possible conditions were predicted. Finally, measures were reviewed and summarized based on the World Health Organization (WHO) source because no formal protocol existed from the center for disease control for this issue.

### The intervention of uninformed and irresponsible institutions

Another challenging point was the intervention of uninformed and irresponsible bodies and institutions in the field of control of carriers, which happened in the first weeks, and no single management was observed to organize them; until the university committee was formed, and everyone was obliged to follow the policies proposed by the University of Medical Sciences and the Health Center.

Many organizations, such as governorates, the Red Crescent, military organizations, and even some non-Iranian companies, agreed to cooperate in this field. In some cases, they also worked, but one reason was the lack of knowledge about standards, methods, and environmental and health hazards, which prevented their activities. In cases, such as the Red Crescent Organization, training was provided so that they can operate according to the instructions and consistent with the actions of the provincial health center. The number of interventions by these organizations was high in the first weeks. However, over time, these interventions decreased, and all of them started to operate under the supervision of the deputy health department and the health center of the province.

### The intervention of benefactors and public institutions

Benefactors and public institutions were very willing to cooperate in this field, which in some cases caused problems; at the same time, the provincial health center was obliged to follow the legal procedures. Therefore, by justifying these institutions and benefactors, efforts were made to make systematic cooperation under the supervision of the provincial health center.

### Lack of facilities and equipment

At the beginning of the work, a lack of facilities and equipment existed provided with the cooperation of the University of Medical Sciences, the governorate, and other organizations. Of course, some minimums were considered for this purpose. For example, to be ready for the rapid response team, the equipment and essentials needed to control the vectors to carry out intervention measures based on spraying or fogging


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were foreseen. Many provinces had not yet provided these minimums and suffered a lot.

### Lack of intra-departmental cooperation in health deputy

Since the health department has three groups, environmental health, work health, and combating diseases and disasters, inter-departmental coordination seemed to be weak at the beginning of the work. For this purpose, the instructions, duties, and scope of work of each unit should be determined, which was done with the interaction of all three groups and teams. For example, due to the abundance of flies in the camps, environmental hygiene had to spray in unfavorable weather conditions and cloudy and rainy conditions. If there were a ministerial directive for the division of duties, problems, such as the futility of labor and wasted efforts would not arise.

### Lack of health infrastructure

One of the limitations was the lack of a bathroom because the use of anti-lice drugs was reduced, and people were reluctant to use them, while dimethicone lotion should remain on their heads for three days, according to the Ministry of Health. Due to the lack of a bathroom in the camps, people with pediculosis living in the camp had to be transported by vehicle to the bathrooms installed outside the camp for daily washing. Cleaning and hygiene items were provided to them and how to use Permethrin shampoo was taught, and the patients used them under the supervision of experts.

### Unpreparedness of relevant institutions

This incident occurred in a situation where the relevant institutions were not prepared for the disaster; among them, the lack of preparation to provide a safe place for people to live.

### Failure to carry out improvement operations in rural areas to control vectors

Most complaints were related to rural areas, especially the houses on the outskirts of the villages. These houses were located in the agricultural fields and the vicinity of the livestock-keeping area, and they needed to be improved, and nothing was done for them. The most attention was paid to education and insect repellent sprays.

### Lack of human resources

In the case of scabies, this sensitivity was that a doctor must diagnose scabies. Often in highly dispersed camps, no doctor was available to confirm cases of scabies. In the case of arthropod control, many items, such as insecticidal sprays in various types existed for the environment and levels and individual use and cost a lot of money. However, these costs were inconsistent with the rest of the unit's human resources, facilities, and volume of programs. This was why those cities with more villages involved in floods did not have successful operations to control arthropods due to the lack of human and physical resources.

### Non-acceptance of insect repellants by some people

In some areas, Red Crescent distributed insect repellents among the people, but they were not welcomed by the people.

### Improper accommodation to install door and window nets

Due to the heavy traffic, it was impossible to install nets on the windows.

### Not using educational videos and images

The educational forces needed to use images and training videos in those places, which was not done.

## 4. Discussion

The main goal of this research is to explain the experiences of health experts in the field of vector-borne diseases during the flood of 2019 in Khuzestan Province using a qualitative approach. During events, such as floods and tsunamis, the habitats of insects, such as mosquitoes are damaged, and their natural larval nests are destroyed. However, as the stagnant water accumulates, new larval nests are provided for insects, especially for mosquitoes of the Culicidae family [6]. The formation of stagnant water provides suitable environments for the reproduction of Anopheles, Culex, and Aedes mosquitoes, and depending on the region, causes the occurrence and spread of diseases transmitted by mosquitoes, such as malaria, Rift Valley fever, dengue fever, West Nile fever, and Chikungunya virus [7]. This work can cause an outbreak and an explosive increase in the population of Culex mosquitoes. Although most Culex mosquitoes are not vectors of vital diseases in Iran except West Nile fever [4, 8], their


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numerous and annoying bites can cause many health problems in flooded areas. seasonally low or dry river floods and overflows can also cause a rapid increase in the population of Aedes mosquitoes [10].

The two main components in this study are the existence of arthropods and the diseases caused by them and the challenges to face and deal with them. Khobdel et al. stated that some of the provinces affected by the flood crisis in early 2019, such as Golestan, Khuzestan, North Khorasan, Shiraz, Mashhad, Sistan and Baluchistan, and Ilam Provinces, Iran, had the highest level of contamination by carriers. Also, the studies conducted in Lorestan Province show the beeswax epidemic in most cities and villages of this province, especially in the flooded City of Poldokhter in Iran [6]. Factors, such as the destruction of the natural habitats of the carrier and reservoir of the disease by humans for the expansion of cities and roads, global warming, and natural disasters, including floods, cause the epidemiological dynamics of leishmaniasis [13].

Studies show that the malaria epidemic due to flood is a well-known phenomenon in endemic areas worldwide. Due to the recent rains and floods and the increase in mosquito larval nests, the probability of malaria cases has increased in the country. This disease is also endemic in the countries of the region, especially Pakistan, Afghanistan, Saudi Arabia, and Yemen [14].

Khobdel et al. stated that the recent floods in Iran in 2019 caused an increase in the water in the wetlands and the return of water to the dried-up wetlands in central and southern Iran and their restoration, which on the one hand caused the migration of birds to these wetlands and on the other hand, due to the increase of mosquito spawning sites, it can expand the spread of West Nile fever vectors. Therefore, the probability of seeing disease cases in the provinces where this virus has been reported, such as Golestan, Gilan, Kermanshah, Isfahan, Khuzestan, Qom, Khorasan Razavi, and Tehran, is not far from expected [6].

According to the studies of Doosti et al., Aedes albopictus, one of the vital vectors of the dengue virus, has been found in Sistan and Baluchistan Province. However, the main vector of this virus is the Egyptian Aedes mosquito, which has not been reported from Iran, so far [15]. Therefore, due to Iran's precautionary conditions for this disease and climatic changes after the flood, serious attention should be paid to the possibility of this disease.

Chinikar et al.'s study show that Crimean-Congo fever has been observed in 26 provinces of Iran, and 42.5% of the population of these regions is at risk of this disease. Most cases of human disease have been reported from the provinces of Sistan and Baluchestan, Isfahan, Fars, Tehran, Khorasan, Golestan, and Khuzestan [16, 17]. Therefore, it is necessary to pay attention to the risk of spreading this disease in both critical and normal conditions. Another disease transmitted by ticks is relapsing fever. Today, this disease has been eliminated in Iran. However, due to the zoonotic nature of tick-borne relapsing fever and the possibility of an epidemic of its louse type due to various crises, the health system should be diligent to implement more care and monitoring programs, especially in endemic areas of the disease.

Doosti et al.'s studies show that the Aedes albopictus mosquito, the vector of Chikungunya fever, was observed in small numbers in Sistan and Baluchistan Province in 2016 [15]. In 2016, the largest epidemic of this disease in the Middle East was reported in Pakistan, with 30 000 cases [18]. Due to the climatic changes in the conditions of floods and extensive land connections with the country of Pakistan, it is possible for the mosquito vector to spread to the country and spread in the Sistan and Baluchistan region; therefore, not only in the time of crisis and accidents but also in the present conditions, the entomological monitoring and care system should be active in this case [19-21].

Papatasi fever is transmitted with the viral agent to humans bitten by an infected mosquito of the genus Phlebotomus [22]. According to "Tavana" studies, in the Iran-imposed war in the border areas of Kermanshah and Ilam Provinces, both Sisal and Naples serotypes caused disease epidemics [23].

During disasters, the environment around rodents, such as humans, undergoes changes, and their food sources and shelters are destroyed or damaged; therefore, in these cases, a kind of competition remains between humans and rodents to obtain food and shelter. In such cases, rodents and other animals coexisting with humans are more visible. They may migrate to human places to find food and shelter [24]. In addition to economic losses, rodents can spread and transmit many diseases (more than 35 diseases), including plague, leptospirosis or hemorrhagic jaundice, fevers caused by rat bites, salmonellosis, leishmaniasis, trypanosomiasis, and Morin's typhus to humans or other animals [25]. In addition, we must consider the economic importance caused by the damage that rodents


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cause to warehouses. Post-disaster damages and losses caused by rodents double the damages caused by disasters and multiply the problems. Considering that no specific organization is responsible for rodent control operations, we will obtain the history of rodent control operations related to before disasters from institutions, such as municipalities, agricultural departments, and ports and shipping organizations in ports, as well as health departments. In addition, we can obtain useful information from private vector control companies in the region [26, 27].

Lice that have health and medical importance are pubic, head, and body lice. Among these species, only the human body louse is a disease carrier. This louse is the carrier of typhus disease, lice epidemic, and epidemic relapsing fever disease. In addition, body lice and other lice cause a lot of harassment to people due to their bites [28]. During floods and conditions of population density in the camps, their transmission increases, and it is necessary to pay attention to the control and collective treatment of the disease.

Synanthropic flies have adapted to human society by entering human dwellings. By not observing the principles of health, humans aggravate this relationship. In addition to causing potential health and epidemiological problems, these flies cause human harassment and inconvenience to people. Since the Musca domestica (housefly) moves freely on human food, waste, and unsanitary materials, it can transmit more than 100 pathogens. Due to disruption in health systems during disasters, the population of these flies usually increases [25].

Scabies disease has been reported from different regions of Iran, but this disease is more prevalent in the northern provinces of Iran (Mazandaran, Gilan, Golestan), which have a humid climate [29]. The spread of scabies in military forces is more common than in ordinary people because most soldiers stay in sanatoriums in dense and closed spaces. This disease was widespread during the Iran-Iraq war, and after the war ended, it was still reported in many provinces [29, 30]. In unexpected incidents, scabies becomes more prevalent due to the crowding of people in temporary camps and the lack of facilities for bathing and personal hygiene.

Scorpions are the critical group of poisonous arthropods. In unexpected events, such as earthquakes and floods, these creatures may rush toward human environments due to the loss of their permanent and temporary shelters. In recent years, due to the increase in heat, especially in the country's southern regions in hot seasons, we have witnessed the invasion of scorpions in human places and increased scorpion stings [31].

Although bed bugs are not disease carriers, they cause nervous and digestive disorders in some people. In crowded areas, such as camps for the temporary accommodation of displaced persons, severe bed bug infestation may occur due to a lack of hygiene principles [32].

Another component of this research is the control methods and challenges of controlling non-communicable diseases during floods. In this direction and to prepare for disasters, a committee called the emergency committee for dealing with catastrophe should be formed and included under the supervision of a committee called the sub-committee for the control of carriers in the health department. The task of this subcommittee is to update information on the presence or absence of disease, prevalence and incidence, and distribution of vector-borne endemic diseases in the region and neighboring regions. Due to the migration of vectors from nearby areas, it is essential to investigate the disease and the presence of vectors in neighboring rooms with the target area [33]. At the appropriate time, this sub-committee is responsible for implementing carrier control operations in the region. The members of this sub-committee are generally selected from people affiliated with the Ministry of Health, the Red Crescent Organization, local policymakers (governors and regional governors), and some private companies to implement the operation. Epidemiologists, medical entomologists, and environmental health experts can be used in this sub-committee [34].

One of the first actions that the sub-committee should take is to assess the problems related to carriers and rodents, as well as to collect the basic and necessary information that is appropriate and sufficient. Local rodent and vector control staff should be consulted to determine temporary accommodation for the affected people. Also, the staff of the vector control department, along with the public health officers, can provide useful and constructive opinions in the field of making the buildings impervious to insects and rodents in the temporary accommodation buildings of displaced people. For example, with instructions for installing a net to protect people from biting insects, such as mosquitoes. One of the essential tasks after the accident is to determine the number of people and specialist staff, the amount of insecticide available, and the available equipment. Also, if there is no suitable control method in the area, it should be done quickly [35].



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The critical problem that operators of vector control operation face after natural disasters is the accurate assessment of vector and rodent issues [36].

Implementing and improving common vector control operations, care activities, and staff training reduces the possibility of vector-borne disease epidemics. In this regard, the World Health Organization (WHO) has prepared guidelines for the control of some vector-borne diseases, such as malaria, which are very useful and helpful [37, 38].

## 5. Conclusion

The network of healthcare services and the urban health system are disrupted by crises and unexpected events, such as floods. The accumulation of waste and sometimes the accumulation of stagnant water and sewage provide the conditions for the laying and reproducing of insects and rodents. On the other hand, people are not in their safe and protected homes as in the past but are exposed to insect bites in camps and temporary accommodation tents. In addition, overcrowding in the camps and lack of bathroom facilities and personal and collective hygiene cause the spread of parasitic insects and arthropods, such as lice, sarcoptic mites, and bed bugs. Familiarity with the implementation of specialized operations to prevent and control vectors in these incidents, which are very different from how they are implemented in normal conditions, can be effective. The crucial part of the vector control program in a crisis includes the preparation of vectors control instructions, the separation, and division of inter-departmental tasks in the health sector, the training of forces and experts, preparing equipment and tools for vector control, and regulating and forecasting of plans and implementation plans before unexpected accidents occur.

## Ethical Considerations

### Compliance with ethical guidelines

Ethical standards were observed in this research, including the explanation of the research objectives and privacy and confidentiality protocols. Also, the participants were assured that their information would remain confidential and fully respected. The current research was registered by the Ethics Committee of Ahwaz Jundishapur University of Medical Sciences (Code: IR.AJUMS.REC.1399.293).

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### Authors' contributions

All authors equally contributed to preparing this article.

### Conflict of interest

The authors declared no conflict of interest.

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