



## **HEALTH IMPACTS OF FLOODS IN IRAN**

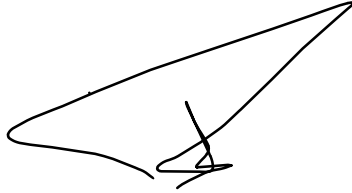
### **A LITERATURE REVIEW**

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## Declaration

Where other people's work was used, it was properly cited in the present literature review.  
The Thesis (Health impacts of floods in Iran) is my own work.

Signature

A handwritten signature in black ink, consisting of a large, sweeping loop on the left and a smaller, more complex scribble on the right.

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### **List of Abbreviations**

<b>MOH</b>	Ministry of Health
<b>ME</b>	Medical Education
<b>NCD</b>	Non-Communicable Disease
<b>CVD</b>	Cardiovascular Disease
<b>EMC</b>	Emergency Management Centre
<b>UNICEF</b>	United Nations International Children's Emergency Fund
<b>NGO</b>	Non-Governmental Organization
<b>RH</b>	Reproductive Health
<b>IFRC</b>	International Federation of Red Cross and Red Crescent Societies
<b>IRC</b>	International Red Crescent
<b>EM-DAT</b>	Emergency events database
<b>WHO</b>	World Health Organization
<b>NDMO</b>	National Disaster Meteorological Organizations
<b>UN</b>	United Nations
<b>PTSD</b>	Post Traumatic Stress Disorder
<b>VAW</b>	Violence Against Women

<b>GIS</b>	Geographic Information System
<b>TUMS</b>	Tehran University of Medical Sciences
<b>DHM</b>	Disaster Health Management
<b>RRNP</b>	Risk Reduction National Protocol
<b>NFEWS</b>	National Flood Early Warning System
<b>IRIMO</b>	Islamic Republic of Iran Meteorological Organization
<b>MDCD</b>	Meteorological Data Collection and Distribution
<b>HSI</b>	Hospital safety Index
<b>DRR</b>	Disaster Risk Reduction
<b>US</b>	United States
<b>LMIC</b>	Low Middle-Income Country
<b>HIC</b>	High Income Country

## Concepts and Definitions

**Climate change:** Any change in the climate over time, whether brought on by natural variability or as a result of human activity, is referred to climate change in the terminology of the Intergovernmental Panel on Climate Change (IPCC) (1).

**Vulnerabilities:** The degree to which a system is exposed to and unable to withstand the negative consequences of natural disasters is known as its vulnerability (1). In this study, "vulnerability" refers to the social and individual aspects that show how sensitive a system is to the effects of disasters (2,3).

**Secondary hazards:** The threat to one's health that develops after an event, such flooding, is referred to as secondary hazards. The effects of secondary hazards following floods can be felt by coming into touch with contaminated water, or in the long term for example when health services are disrupted after floods, increasing the harm to human health (4).

**Sociodemographic factors:** The term "sociodemographic" refers to a set of characteristics that define a person or a group based on their social and demographic components such as age, gender, level of education, and residency location, among others. It relates to, is associated with, or involves a mix of social and demographic characteristics (5).

**Flood:** The term "flood" refers to the situation that arises when water exceeds the boundaries of a stream, river, or other body of water, either naturally or artificially, or when it builds up through drainage over low-lying areas (6).

## **Abstract**

**Background:** Floods are the most frequent natural disaster worldwide and their impacts are multifold. Iran is prone to disasters with the majority caused by floods. This thesis examines the effects of floods on human health in Iran, while considering the influence of various sociodemographic factors on increasing the severity of health effects of floods. It then offers recommendations based on information already available about national policies, to assist disaster risk reduction plans and health policy makers in developing the effectiveness of their implementations.

**Methods:** A literature review was performed. Findings are ordered based on a combined conceptual framework demonstrating the causal pathway of floods and as a result, the direct and indirect effects of floods on health by considering vulnerable characteristics which influence on severity of health complications.

**Results and discussion:** Floods are caused by both natural and human influenced factors, such as heavy rainfall and unplanned urbanization. The findings of this thesis show that there are different short term and long-term health impacts, including drowning, injuries, communicable diseases, mental health problems and reproductive health problems, that happen directly after floods or through secondary hazards. Sociodemographic vulnerabilities, such as age, gender, education, location, source of income, lack of awareness and consequently risky behaviors, have an impact on the severity of health complications after floods. Different national policies and health system measures are in place and international cooperation has been done to support disaster risk reduction in Iran, but still the severity of the problem has not reduced because of little consideration to preventive and mitigation strategies. Recommendations are made based on existing evidence to help policymakers to enhance existing national policies. One of the key recommendations deriving from this study is raising public awareness about the flood related health risks to reduce the likelihood of engaging in risky behaviors during flood occurrence.

**Conclusion:** Different risk factors impact the severity of the health problems that floods can bring on and the health effects of floods are various. The majority of risk reduction strategies in Iran concentrate on the reaction and recovery stages and much less on prevention and mitigation in society as well as for the health system.

**Key words:** Health effects, Natural disasters, Floods, Sociodemographic vulnerabilities

**Word count: 13185 words** (without references, tables, and graphs)

## **Introduction**

One of the advanced courses during my study in the International Health program, "Climate Change and Health," caught my attention since it discussed the health effects of climate change and natural disasters. I didn't have any specialized professional expertise of how climate change and natural disasters might affect physical and mental health prior to taking this course.

Through the course, I learnt about the ways that individuals can help to lessen these changes and their effects on health. As a result, I started to care more and more about the environment because in my opinion we should first focus on maintaining the health of the planet before looking into other health issues. Without a secure house, it is impossible to consider wall colors.

Due to my interest in understanding the health effects of natural disasters, I would like to investigate the effects of floods on human health. I will also try to figure out how to reduce human-related risk factors that contribute to these disasters to increase the likelihood of preventing their health-related side effects. Additionally, this is my first effort at doing a professional study on natural disasters. The main goal of the material in my thesis is to provide information about how floods can affect health and which factors make Iranian population more vulnerable to these consequences to assist in improving national health implementations. The material of the present literature review can also raise awareness of people about health complications of floods.

According to a United Nations (UN) report, there are 163 flood events worldwide on average per year, making them the most frequent form of natural disasters (7). Compared to other regions of the world, Asia has a higher proportion of floods. Approximately 400 million people in Asia are directly exposed to floods every year, this region accounts for nearly 93% of all flood-related deaths worldwide (8).

As a developing country, Iran is one of the regions in Southwest Asia that is prone to natural disasters. In recent decades, 90% of its citizens were exposed to natural disaster problems (9). This country experienced a disastrous flood in almost all its 31 provinces in March 2019 (10), which will continue to be explained in detail further in the next paragraphs.

The purpose of this study is to explain about how Iranian floods affect people's health. Additionally, mention sociodemographic elements that have an impact on the severity of human health issues in Iran. The study attempts to formulate practical suggestions for health policy makers on how to lessen the serious adverse health effects of floods in Iran.

## 1. Background

**1.1 Geographical situation:** The Islamic Republic of Iran, which dominates the southwest of Asia and covers an area of more than 1.6 million square kilometers, is the sixteenth-largest nation in the world (11). Iran's borders with Azerbaijan, Armenia, Turkmenistan, and the Caspian Sea to its north; Pakistan and Afghanistan to its east; the Persian Gulf and the Gulf of Oman to its south; Turkey and Iraq to its west. Iran oversees a few islands in the Persian Gulf. Around one-third of its boundary is seacoast (Figure1) (11,12).

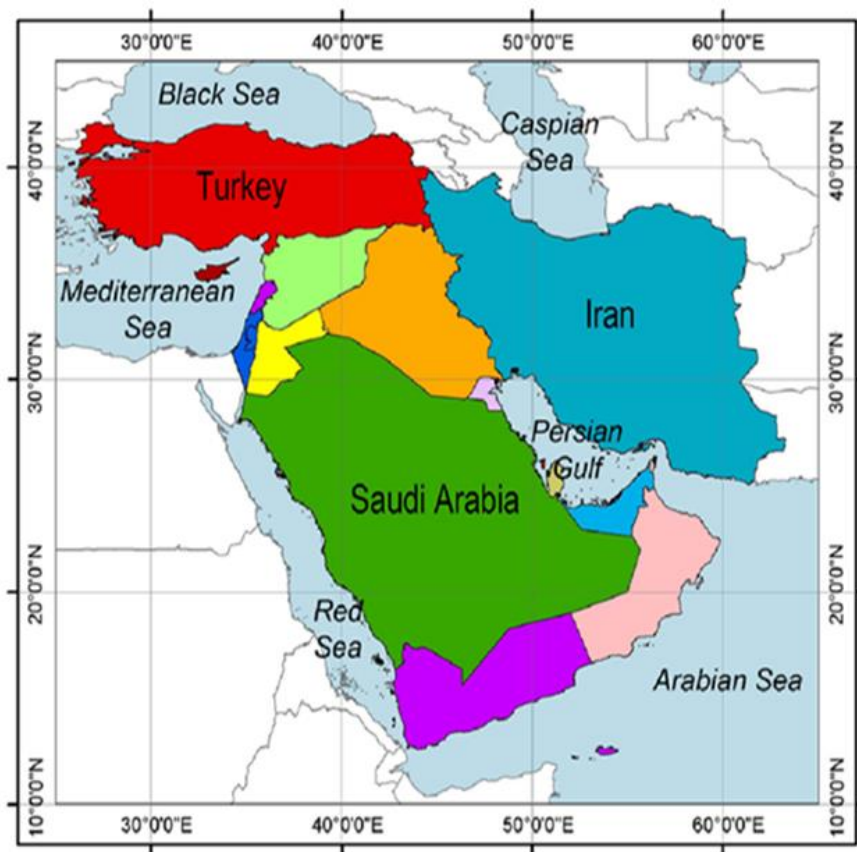


Figure1: Geographical position of Iran in the Middle East (12).

(<http://apdrc.soest.hawaii.edu/las/getUI.do>)

**1.2 Socio demographic situation:** There are 31 provinces in Iran, and each one has a governor who has been chosen. The urban population increased from 27% in 1950 to 74% in 2020, indicating growing urbanization over the last three decades (13). Iran's official state religion is Islam, which is practiced by most of its population. There are also Jewish, Buddhist, and Christian groups living over the nation (11). The following graph (Figure 2) shows the total population of Iran by age group. This figure shows that one-fourth of the population was under the age of 15, while the 30 to 39 age group have the largest population density in 2020 (14). Iran has an average life expectancy of 76 years for women and 73 years for men (11).

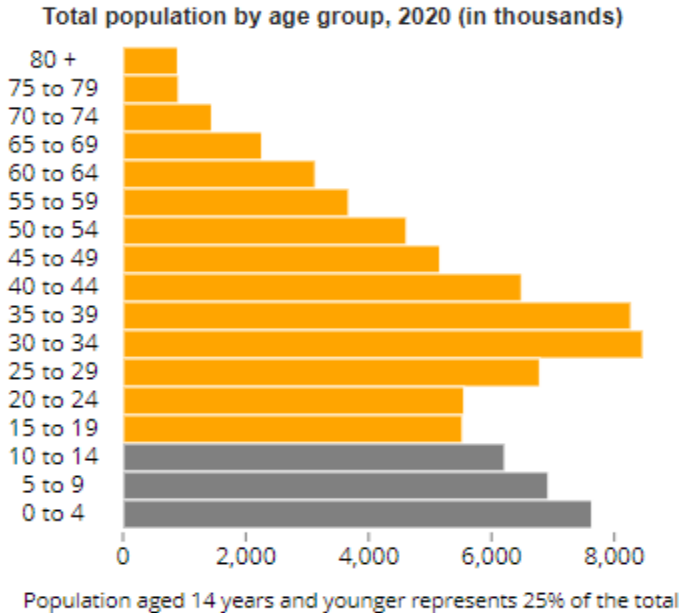


Figure 2: Total population of Iran, by different age groups in 2020 (in thousands) (14).

**1.3 Literacy:** According to the World Bank's most recent data on literacy rates, more than 80% of the people in Iran who are 15 or older can read and write. There is an almost 10% gap between men and women's rates of education and males tend to be at higher levels (Figure 3) (15).



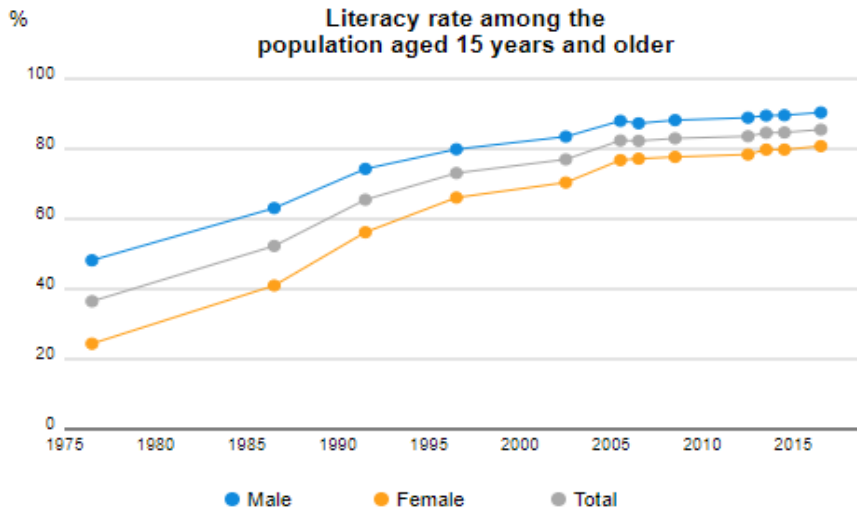


Figure 3: Literacy rate attributed to male and female and total population aged 15 years and older. (<https://data.worldbank.org/indicator/SE.ADT.LITR.FE.ZS?end=2016&locations=IR&start=1976&view=chart>) (15).

**1.4 Healthcare system:** To address Iran's health issues, the Ministry of Health (MOH) and Medical Education (ME) are in charge of developing and implementing national health policies. They delegated part of the implementation of the policy to regional medical colleges across the country. There is at least one medical university in each province. The MOH and ME consider the president of a medical university to be the top representative of health in a province. The president of the medical university is responsible for overseeing public health, medical treatment provided in government institutions, and medical education (Figure 4) (16). All three levels of health care are provided by the public sector. Due to the government's focus on primary healthcare over the past two decades, the public sector is now the main provider of primary healthcare services in the country. In Iran, the private sector has a substantial impact on the delivery of healthcare. In urban areas, the private sector mostly concentrates on secondary and tertiary healthcare services. There are numerous Non-Governmental Organizations (NGOs) engaged in health-related issues. NGOs are primarily involved in specialized domains, like those involved in cancer, diabetes, thalassemia, etc. (16).

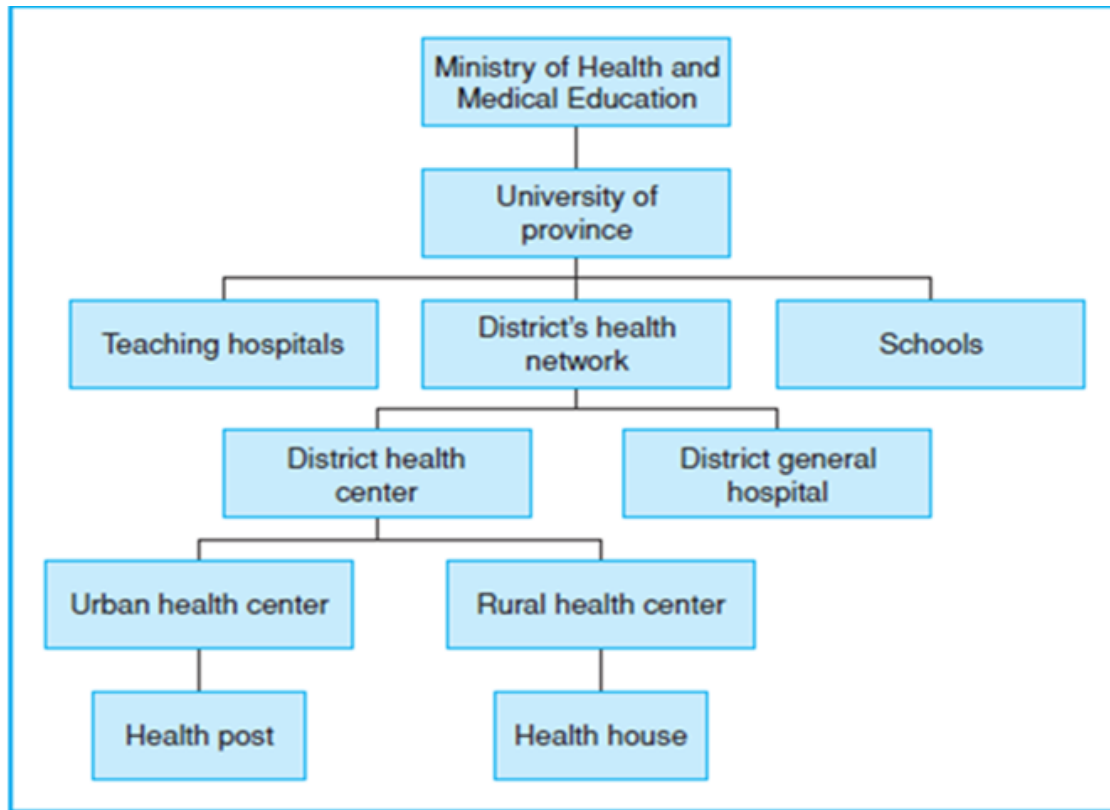


Figure 4: Health system network in Iran (16)

There are some points that needed to improve in Iran's health-care system. First, family physicians are only found in rural areas, not in urban health clinics, where the high patient-to-doctor ratio (approximately one doctor for every 4000 residents) has an impact on the quality of treatment provided to each patient in the limited time available (17). Another problem is a shortage of nurses to meet demand for care. Nursing tasks often focus on aiding doctors rather than performing a specialized role in public health (17).

In Iran, cardiovascular disease (CVD) is the leading cause of death and over half of all deaths are attributed to CVDs, according to government statistics (16). The second leading cause of mortality, particularly for young people, is accidents, which account for 18% of all fatalities. 14% of all fatalities are caused by cancer. Neonatal and respiratory disorders, which account for around 6% of all fatalities for each in Iran, are the fourth and fifth most common causes of mortality (16). While noncommunicable diseases (NCDs) such as CVDs, cancer and

injuries, account for the majority of disease burden in the country as a whole, the country also faces the problem of infectious diseases, which are often linked to neighboring countries (18,19). As an example, up to 250 samples of Crimean Congo fever occur annually, with a death rate of 25%, making it a serious health risk that was previously unknown in Iran. Smuggled chickens from nearby nations were detected as a reason, however MOH and ME were able to successfully handle these epidemics and even aid the surrounding countries (19).

**1.5 Healthcare system in crisis:** The center for organizing, coordinating, and managing health crises is the Emergency Management Centre (EMC), which is under the Deputy of Health in the MOH and ME (20). The Ministry of Interior has comprehensive control over the disaster management system in the public sector (21). Furthermore, the National Disaster Task Force (NDTF), founded in 2003, serves as an inter-organizational structure that coordinates throughout the various stages of a crisis (21). When a disaster occurs, the NDTF assumes primary responsibility for arranging relief efforts by technical ministries and humanitarian organizations (21). Following the occurrence of emergencies and disasters, hospitals are the first line to provide emergency health services (22). Furthermore, based on knowledge gained from the Rudbar-Manjil earthquake in 1990 and the Safilan school fire in 2005, The United Nations International Children's Emergency Fund (UNICEF) and NGOs were among the most active providers of mental health services, with the help of the Social Welfare Organization and the Social Welfare and Rehabilitation University in the health crisis. The health system has the main responsibility of guidelines for nutrition and Reproductive Health (RH) in emergency situations by supporting and educating health professionals (20). Since 1991, the International Federation of Red Cross and Red Crescent Societies (IFRC) has been operating in Iran, offering technical assistance in disaster management, shelter, disaster law, youth and health programs and capacity development projects. The National Disaster Management Organization (NDMO) oversees the coordination of the efforts of Ministries, local governments, national NGOs, and the IFRC. Thus, social groups across Iran's population join in and demonstrate care and concern with the victims of flood disasters by doing a variety of activities as a volunteer (19).

**1.6 Climate features and Natural disasters:** Although it varies over the national territory, the climate is primarily arid and semi-arid with elements of hilly, dry, semi-dry and coastal climates. Iran is among the nations which are most vulnerable to natural disasters because of its geographic and climatic features (23). Iran is a disaster-prone country and 31 of the 40 various types of natural disasters that can be seen across the world have been classified in Iran provinces (13,21). The frequency of major natural disasters including earthquakes, flooding, droughts, Hurricanes, sandstorm, severe weather, snow, and wildfire in different provinces of Iran during the previous century (1920-2020) are indicated in the chart below (Figure 5) (13).

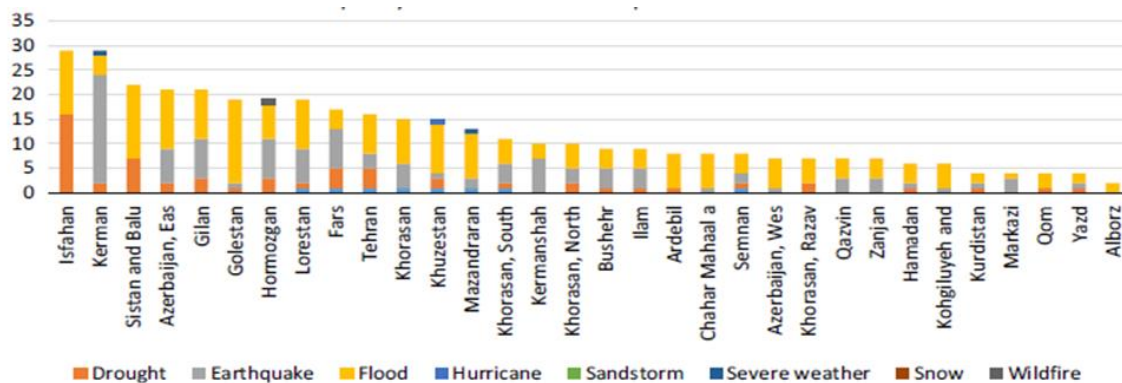


Figure 5: Frequency of disasters in Iranian provinces (1920-2020) (13).

(<https://doi.org/10.1186/s12962-020-00242-8>)

**1.7 Current flood situation in Iran:** According to a report from the European Civil Protection and Humanitarian Aid Operations, Iran recently witnessed flash floods which occurred in the middle of July (2022) (24). The floods occurred as a result of the heavy rainfall and river overflows, causing damage in approximately all provinces, notably in Tehran and Lorestan. Up to July 31st, 69 individuals were confirmed dead, thousands of animals drowned, and more than 2000 properties were destroyed. According to the Iranian Red Crescent (IRC), more than 27,000 flood victims have received humanitarian assistance across the country (24).

## 2. Different types of floods

There are three main categories of floods, River floods, flash floods and coastal floods, all of which can occur as a result of natural and human causes or a combination of both (25).

**2.1 River flood:** River flooding is caused by heavy rain, which is occasionally combined with snowmelt. These floods only happen in places where there are rivers and commence when a river overflows its natural banks and floods a nearby region (25). Floods occurred in March 2019, as a consequence of heavy rains (Figure 6) (26), in the Iran's northern and north-eastern areas, notably Golestan, Mazandaran and Khorasan were an example of river flooding (27).

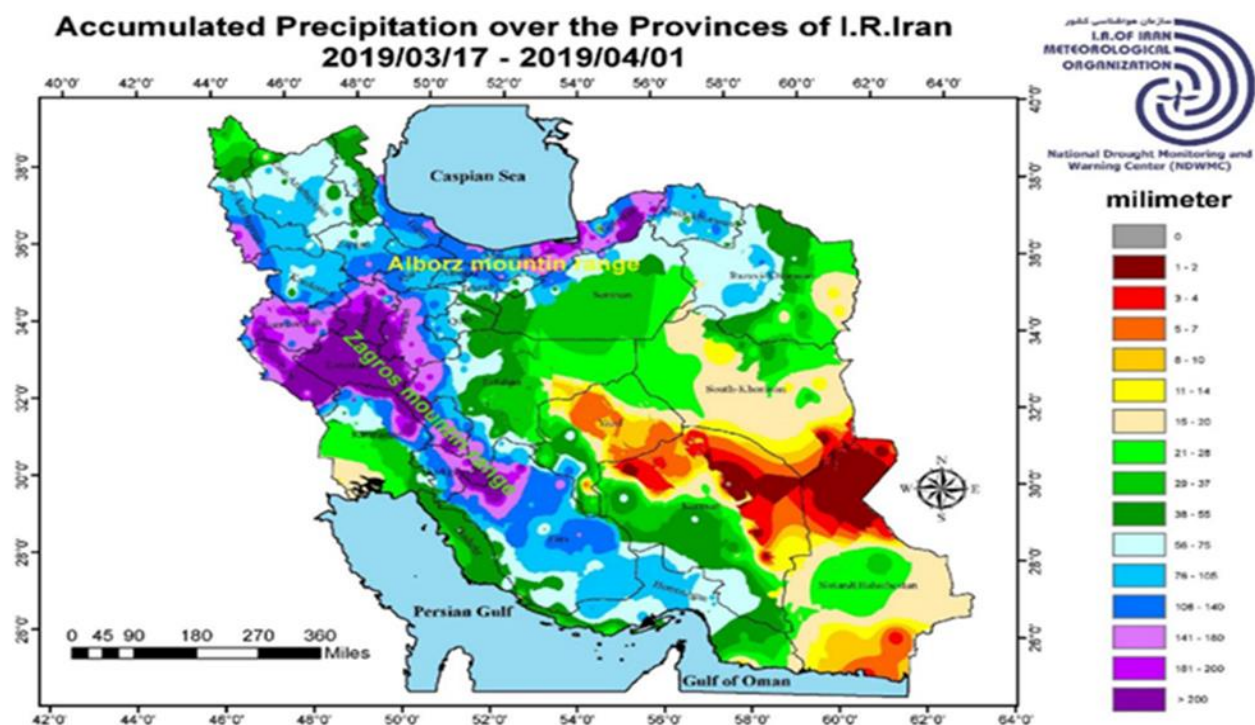


Figure 6: Observed total precipitation during March–April 2019 (figure was reported from National Drought Monitoring and Warning Centre of Iran Meteorological Organization) (26). (<https://doi.org/10.1007/s42452-020-03964-9>)

**2.2 Flash floods:** Flash floods are known to approach flow conditions at fast speeds and can carry boulders, mud, automobiles, and other obstructions in their path. They can occur rapidly, often in only a few minutes. As a result, they have a short response time and the ability to severely influence and devastate populations, in various climatic situations all over the world (25,28). In August 2001, the Mother-Soo catchment in the Caspian region of Golestan (Figure 7) saw the Caspian Sea's worst flash flooding incident, killing over 300 people (28). According to Emergency events Database (EM-DAT) reports, the number of flash floods in Iran between 2000 and 2022 was two times higher than of river floods, indicating that flash floods cause the majority of flood-related damages in Iran (24).

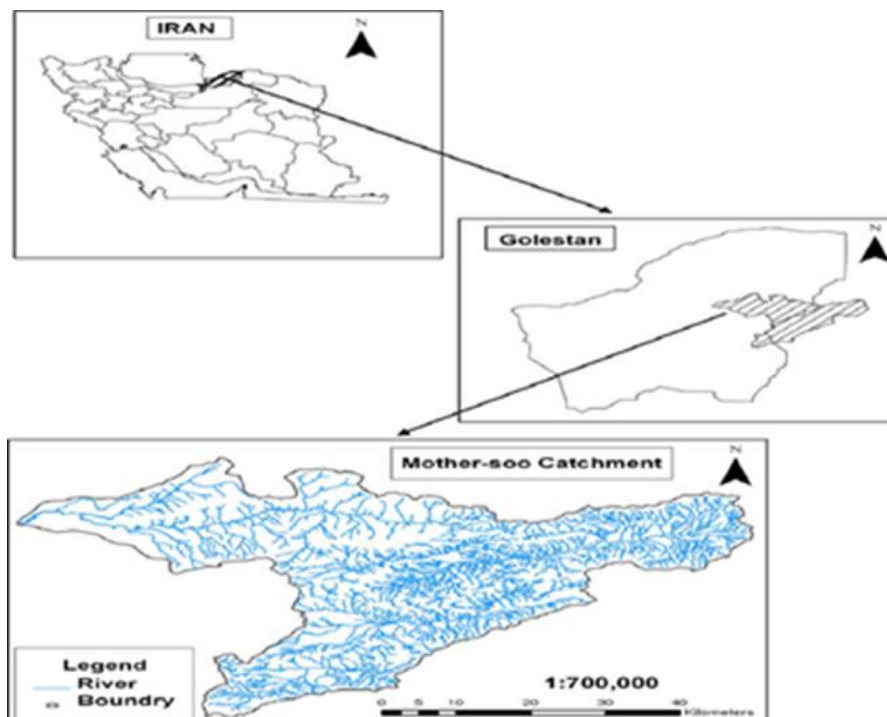


Figure 7: Location of Mother-soo catchment, Iran (28).

(<https://www.researchgate.net/publication/251417523>)

**2.3 Coastal flood:** Different climatic and non-climatic risks, such as sea level rise, storm surges, cyclones, waves, winds, tides and tsunamis may cause coastal floods which impact coastal

regions (25,29). The city of Bandar Abbas (Figure 8), which stands as the Hormozgan province's capital, is situated in a low-lying region with an elevation of less than 5 meters. As a result, waves, wind, and tropical storms from the Persian Gulf and Oman Sea may have impacts on Bandar Abbas (29). Gonu, the strongest tropical storm ever recorded in the Arabian Sea, devastated parts of the Persian Gulf and the Omani coast in 2007. It caused 23 fatalities in Iran's southern coast, especially in the province of Hormozgan. Coastal flooding in this area will always be a potential, especially as a result of the combination of the mentioned coastal dangers and sea level rise brought on by climate change (26).



Figure 8: Location of Bandar Abbas city, Iran (29).

(<https://doi.org/10.1016/j.ocecoaman.2019.105077>)

### 3. Problem statement and Justification

Flooding is one of the most damaging disaster events that can occur on the globe, resulting in widespread morbidity and mortality (30). The location, population distribution, and

characteristics of the built environment all have significant effects on how floods influence human health (31). Floods have affected 1.6 billion people globally, the biggest number of any disaster type, accounting for almost half (44%) of all disaster incidents between 2000 and 2019 in the world (7). Although floods exist everywhere, some places are more vulnerable to danger than others. Part of the reason for this difference in vulnerability is the fewer capacity to adapt socially, technologically, and financially, which makes developing countries more prone to effects of natural disasters (31).

The main public concerns of major flood-related health complications include drowning, injuries, animal bites, mental health difficulties, communicable diseases, and violence. Flooding increases the spread of infectious diseases such as water-borne, vector-borne, and rodent-borne illnesses, as well as cutaneous and respiratory infections, through secondary hazards such as water contamination (9,26,31-33). It has been estimated that more than 170,000 people on average are exposed to floods each year in Iran (27). After flooding, the occurrence rate of a variety of diseases in people whose homes have been flooded mentioned four times higher than people whose homes have not been flooded (27).

First and foremost, Iran is geographically prone to flooding, and secondly, it has shortcomings in its health system, infrastructure, and response capacity. Iran's National Health System Reaction Plan lacks the capacity to provide a comprehensive and appropriate response. Despite efforts, many of the flood-related health concerns in Iran have not been addressed (34).

Although floods are the most prevalent natural disasters in Iran, few studies have focused on the challenges that the health system faces when it must respond. In addition, there is a scarcity of literature on the health consequences of flood disasters for the entire country of Iran. An increase in understanding and awareness about the many health effects of floods would allow policy makers to anticipate and respond to this public health concern which has a significant impact on people's well-being.

This thesis aims to close this knowledge gap concerning the health impacts of floods in Iran and then learn more about the influence of various sociodemographic vulnerabilities on flood



related health effects of the Iranian population. It will therefore aid in understanding and provide opportunities to improve health policies and programs. Then, based on the results, offer recommendations to assist policy makers improve flood prevention, mitigation, and response plans to lessen the severity of the health effects of floods in Iran.

#### **4. Objectives**

There are a few objectives that this literature review aims to fulfill. Objectives are as below:

1. To explain different secondary hazards of floods which can have an impact on health outcomes
2. To describe short - and long-term health impacts of floods in Iran
3. To define different socio demographic vulnerabilities, which increase the likelihood of human health impacts, due to floods in Iran
4. To review Disaster Health Management plans and identify the challenges of the healthcare system in a flood situation in order to provide policymakers with practical recommendations to reduce the severity of the floods' health consequences in Iran

#### **5. Methods**

The present study is a literature review based on screening different kinds of literature such as interview based, systematic review and qualitative publications from Google Scholar, PubMed, and other databases and search engines. Important search terms were as below (Table 1):

<p><b>Key words</b></p>	<p>Health effects, Natural disasters, Floods, Sociodemographic vulnerabilities</p>
<p><b>Words and Phrases</b></p> <p><b>Google Scholar</b></p> <p><b>PubMed</b></p>	<p>“Climate change” AND “Natural disasters”</p> <p>“Climate change” AND “Floods”</p> <p>“Flood” AND “Iran”</p> <p>“Natural causes” AND “Flood”</p> <p>“Human made factors” OR “Anthropogenic” AND “Flood”</p> <p>“Floods” AND “Health”</p> <p>“Floods” AND “Health” AND “Iran”</p> <p>“Natural disasters” OR “Floods” AND “Health”</p> <p>“Floods” AND “Health impacts”</p> <p>“Floods” AND “Physical health impacts”</p> <p>“Floods” AND “Mental health”</p> <p>“Mortality” OR “Fatalities” AND “Flood”</p> <p>“Sociodemographic features” AND “Flood” AND “Iran”</p> <p>“Vulnerabilities” AND “Flood”</p>

Table 1: Key words and important searched terms

**5.1 Inclusion criteria:** The search was limited to articles published in English. Only articles published after 2000 were included in the review to provide up to date information. Articles which were about natural disasters in Iran were reviewed, to get information about policies of the government for risk reduction against natural disasters and specifically floods. The majority of articles that were included in this review discuss the effects of flooding on human health rather than issues which emerge from floods. Additionally, gray literature was searched via Google, with specific searches on the World Health Organization (WHO), United Nations (UN), World Bank and websites of the Iranian government. The Emergency Events Database (EM-DAT) was searched for the latest statistics about the number of people who were affected by floods. Additional articles were found through snowballing. In case there was a lack of information, regarding Iran, developing nations and global situations were discussed.

**5.2 Exclusion criteria:** After reviewing the abstracts, literature for which there were no full texts was excluded. Publications that focused mainly on climate change without including natural disasters or flooding, were removed. To focus particularly on the Iran setting, data about other nations is limited in the findings section to the extent that appropriate information about Iran is found.

**5.3 Conceptual framework:** There are a variety of factors that contribute to floods and the subsequent health effects. To analyze this health problem comprehensively, one complete framework is created by combining two distinct frameworks from one study conducted by Zhong et al. (Figure 9) (35). Zhong et al. created a framework to assess the long-term health effects of floods in a 2018 study, taking sociodemographic factors into account (35). Another framework in the mentioned study identifies secondary hazards that arise soon after floods and then highlights short- and long-term flood health consequences. The present study used a comprehensive framework created by merging the two frameworks outlined by Zhong et al. (35). To develop a complete framework that depicts the burden of flood-related health effects as well as the underlying causes and distribution of sociodemographic vulnerabilities' affects, two mentioned frameworks must be combined. The severity of flood-related health effects is influenced by how susceptible a community is to certain sociodemographic factors

(age, gender, educational attainment, economic resources, etc.). The pathway of the impacts of the sociodemographic factors can be seen clearly within the present framework. The first three objectives of this thesis are addressed using a structured framework, and the final objective, which is about health policy regarding natural disasters, particularly floods, is explained afterwards. Four main steps of Disaster Health Management (DHM) which consists of Mitigation, Preparedness, Response and Recovery explained thoroughly. Iran's health protocols in the face of natural disasters and preventative plans for reducing health impacts of floods were assessed thoroughly. Then, areas for improvement were identified and recommendations given based on the findings to assist policymakers.

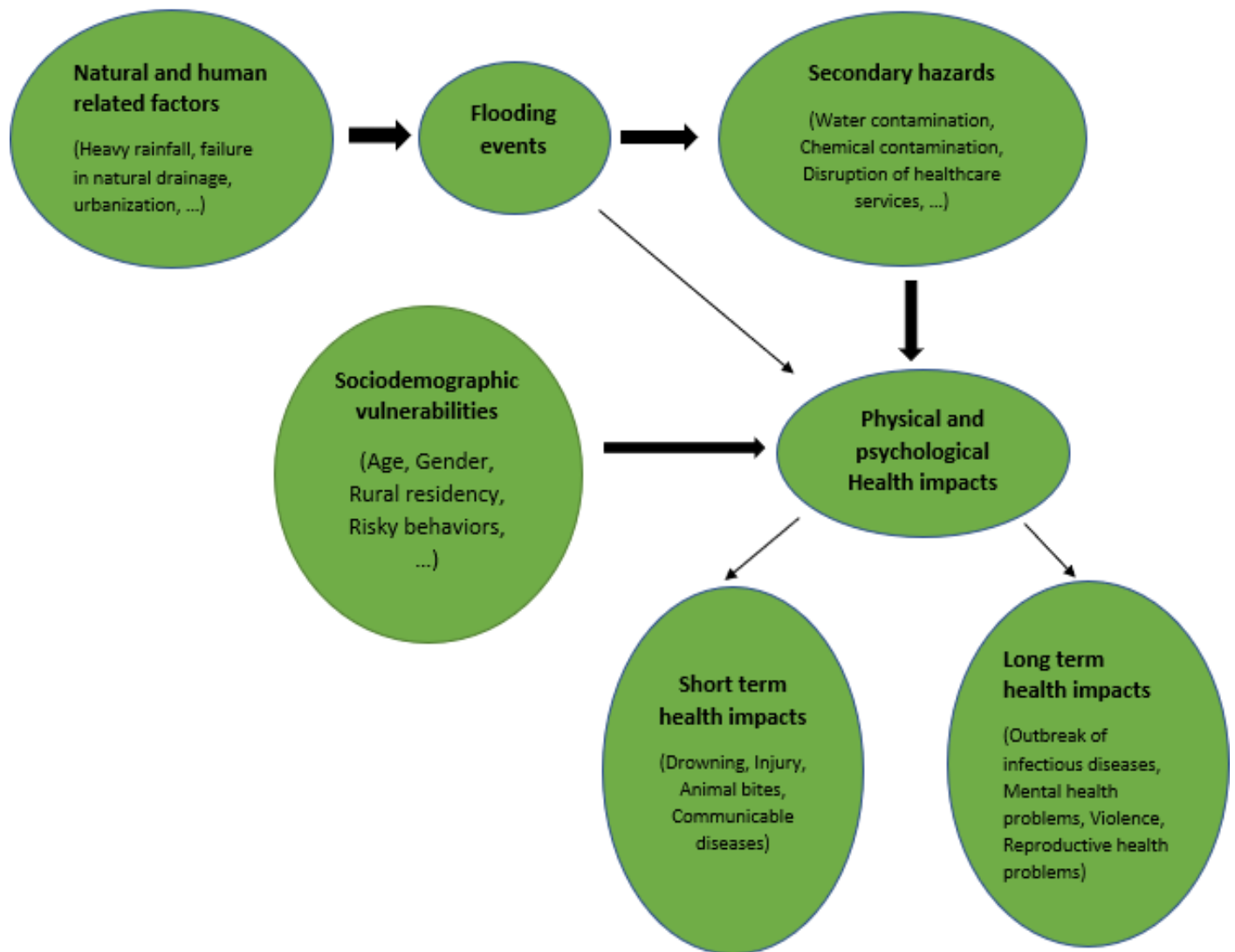


Figure 9: Conceptual framework based on two different frameworks (35)

## **6. Results**

The next paragraphs addressed the causes of flooding in Iran. Subsequently, secondary hazards that may result from floods are explained in depth. Flood-related short- and long-term health effects are described as well. The severity of flood related health consequences is influenced by various flood features and sociodemographic vulnerabilities which are outlined in the findings below.

### **6.1 Flood causes**

Effects of climate change such as extreme rainfall, snow melting, rising sea levels, global warming, as well as insufficient natural drainage, are all natural reasons for floods (25,30). Floods in different regions of Iran can occasionally cause substantial damage to life and property with as little as 9 mm of rainfall over a 50 km<sup>2</sup> watershed area (28). The major cause of flooding in Iran is intense rainfalls (13). For instance, a retrospective research of Iran's northern regions that assessed flood data from 1991 to 2013 discovered that, in addition to other climatic and manmade causes, excessive rainfall was the main reason for floods in the province of Golestan (31). Iran has extensive rainfall, particularly in the North (North of Alborz Mountains), Southwest (Zagros Mountain), South (near Persian Gulf), and South-east (The Hirmard river) (13). The average rate of precipitation from 2003 to 2021 is shown below, demonstrating that the average monthly rainfall is approximately 20 mm. The largest amount of monthly precipitation is seen in 2019, resulting in massive floods in Iran (Figure 10) (31).

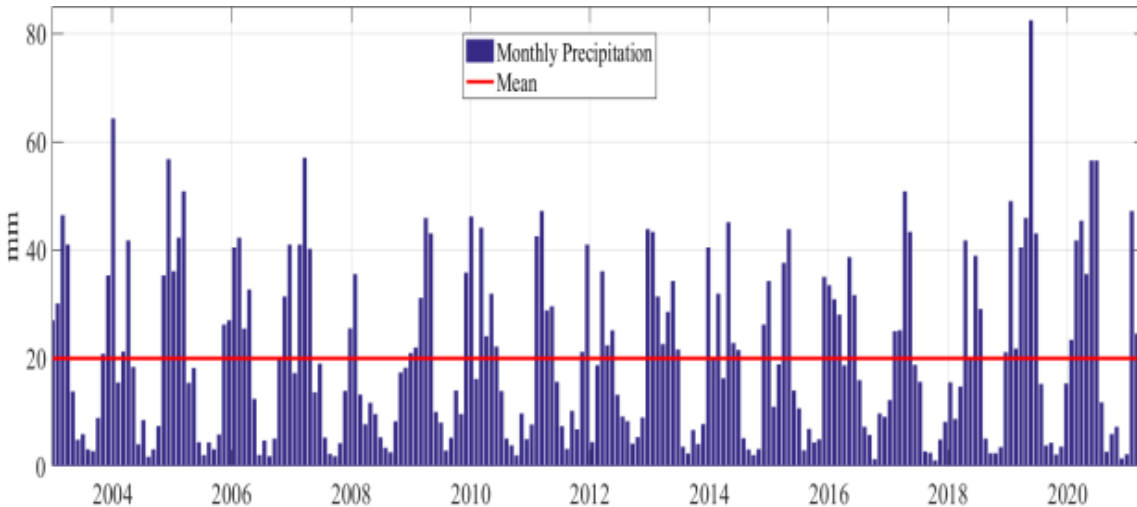


Figure 10: Precipitation in Iran from 2003 to 2021 (31)

Additionally, Floods generally happen in the spring in Iran when the snow melts due to higher temperatures, which is being exacerbated by climate change. They can however also happen at any time of year, notably in several provinces near the Caspian Sea in the summer (28).

Iran has been suffering from a continuous drought for approximately 30 years ago, partly because of climate changes (8). During this time, several ecosystems have transformed, large portions of forests have been destroyed, rivers and lakes have dried up. In places where the riverbanks formerly were before the drought, people have moved in and built homes (8). Furthermore, environmental and ecosystem degradation, deforestation and loss of biodiversity, soil and water erosion and desertification eliminate the natural environment drainage and result in higher risk of flood occurrence (6,25,36,37). In addition to heavy rainfall, which was the primary cause of the massive flood in 2019, Iran experiences disastrous flooding because of these changes, which also exacerbate health issues by avoiding natural drainage for the excessive rainwater in almost all provinces. Therefore, the lack of trees and plants caused the vulnerable land to be destroyed. This massive flood (2019) has resulted in 85 people killed, 2193 cases of injuries, and financial damage to the infrastructure in the cities and the countryside. Golestan, Khuzestan and Lorestan suffered more losses than the others. (8,10,25,27,28,36,37).

Anthropogenic causes such as rapid urbanization (almost 50% urbanization growth in last three decades), unsustainable use of water resources and inappropriate policies in water-using industries (particularly those that depend economically on agriculture) can also increase risk of flooding by destroying natural drainage infrastructures in Iran (13). Geological investigations claim that a flood tunnel in Shiraz, Iran, was filled in to make space for the construction of a new bridge and road. The previous watercourse was filled to make space for a new road, raising the slope of the basin area and altering the route to the nearby dry river. These measures exacerbate the dangers of future floods in this area (37).

## **6.2 Secondary hazards**

After flooding there are several secondary hazards which are explained below:

**6.2.1 Water contamination:** Flooding can damage sewage systems, which result in pollution of drinking water and food supplies (6). According to the study conducted by Babaei et al. about the flood that occurred in April 2017, in North-West of Iran and affected 12 cities, drinking water distribution pipelines were destroyed and drinking water sources were polluted, increasing the danger of infectious disease transmission (38). Following a flood, standing water becomes a key location for the spread of disease agents and vectors (6,33). For farmers and outdoor workers, irrigation with polluted water poses a concern. Infectious illness transmission may also result through fecal contamination of livestock and crops (6). The risk of infections such dermatitis, conjunctivitis, wound infections, and ear, nose, and throat (ENT) infections from direct contact with polluted water rises (34).

**6.2.2 Chemical contamination:** Chemicals may spread in the flow of flood water. When industrial facilities are inundated, chemicals and other toxins may be released into floods. Floods can also result in the discharge of chemicals of manufacture, which can start fires, explosions and/or release toxic gases (6). Because floodwater pressure can force generators to

break, carbon monoxide poisoning from cooking tanks, gas-powered pressure washers, and gas-powered electrical generators seems to be a typical problem during floods (6).

**6.2.3 Dead bodies:** Dead human or animal remains are a major source of viruses and microorganisms that may quickly contaminate water and soil following floods (39,40). Flood affected areas are not proper for burial of these corpses which is a significant reason for concern. Animal dead bodies can spread zoonotic illnesses, such as rabies. This only happens when they are submerged in water. If the animal body is placed on dry land, the germs cannot exist for a while. Following natural disasters such as floods, it's crucial to properly dispose of animals timely (39,40).

**6.2.4 Disruption of healthcare services and other infrastructures:** Floods can cause damage to medical facilities, forcing patients and employees to relocate, limiting access to primary health care, limiting the availability of medical resources, limiting the capability of medical workers to deliver healthcare services and causing the loss of medical records (33). For example, Floods in 2019 impacted 3800 cities and villages, causing 65,000 homes to be destroyed. According to IFRCs ([www.ifrc.org](http://www.ifrc.org)), 1200 schools as well as 70 hospitals and medical facilities were damaged, and 159 major highways and 700 bridges were among the many facilities that the flood destroyed (26,33). The disruption of houses, the lack of a decent place to stay and low hygienic conditions owing to overcrowding in shelters, can make flood victims vulnerable to physical and mental health problems, forcing many to immigrate (10). Additionally, flood affected people may see an increase in health problems, because of losing prescriptions or medical equipment or having difficulty receiving healthcare services because of flood destruction (33).

**6.2.5 Food insecurity:** Following natural disasters there is a risk of food insecurity. This is due to damage to food systems and storage as well as the destruction of people's sustainable means of survival such as agricultural lands (41,42). Ainehvand et al. pointed out in a qualitative study conducted in Iran, that poor management of organizations and unfair food distribution are the causes of food insecurity among individuals in flood affected areas as well. This is particularly the case for those who are unable to go long distances for food (41).



Flooding, either directly or through secondary hazards which explained above, has a variety of physical and psychological health consequences for humans, which are discussed in greater detail below:

### **6.3 Short term health impacts of floods**

**6.3.1 Drowning:** Drowning is the main cause of flood deaths (6). It happens for a variety of reasons, including ignoring warnings, failure to understand the dangers of risky behaviors such as stocking in automobiles, unsafe constructions of infrastructures and buildings (2,6,28). The rate of drowning from flash floods is higher than river floods. The speed and rapidity of the flash floods are the main factors, impacting the higher number of flood-related fatalities (6,28). In the massive flood that occurred in 2019, drowning was responsible for 73 of the 85 fatalities (27). The death rate from severe flooding in each region in 2019 is indicate below (Figure 11) (2). This figure comes from the case control study by Yari et al. after massive floods of 2019 (2).

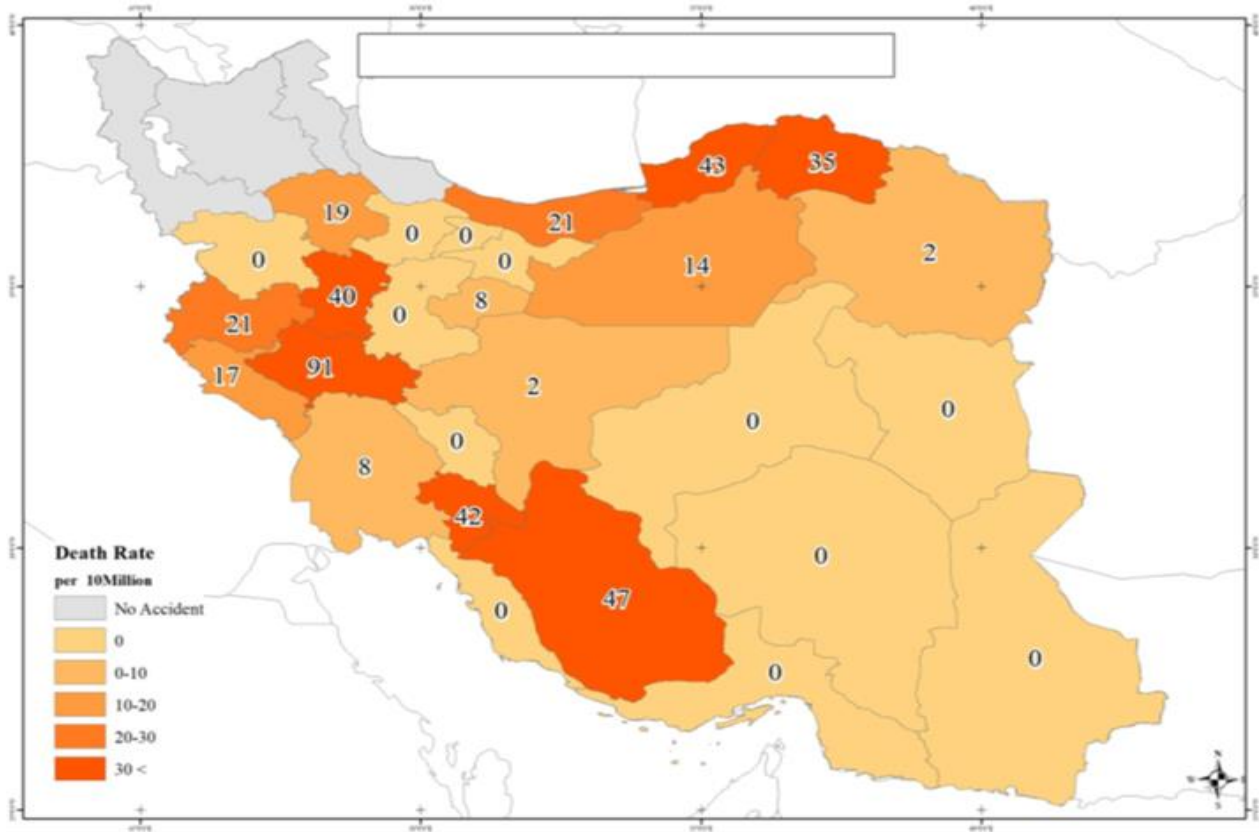


Figure 11: Flood death rate per 10,000,000 in Iran: 2019 (2).  
<https://doi.org/10.1371/journal.pone.0262005.g001>

**6.3.2 Injury:** Different types of injuries may occur during and after floods, due to a variety of circumstances (6). Possible risks to injuries following a flood include floating debris in the floodwater, collapsing structures brought on by the flood's intensity and individuals getting hurt while escaping from their homes and automobiles. Additionally, there is a risk of electrical harm from poor wiring in or around floods (6). Below you can see the rate of injuries among people of each region in Iran after 2019 massive floods (Figure 12) (2).

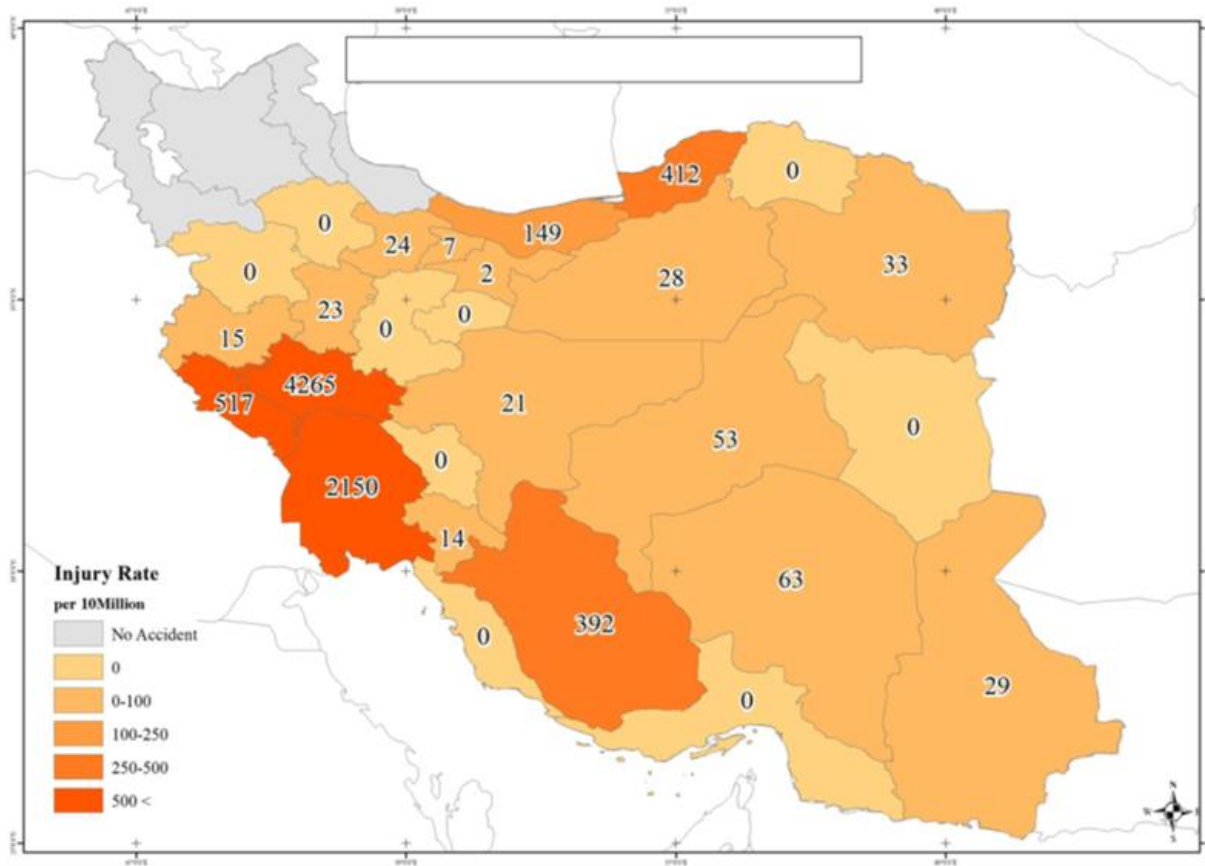


Figure 12: Flood injury rate per 10,000,000 in Iran: 2019 (2).

(<https://doi.org/10.1371/journal.pone.0262005.g002>)

**6.3.3 Animal bites:** In times of flooding, animals are routinely moved. Displacing domesticated animals, rodents, insects, snakes, and reptiles usually results in an increase in bite incidents. Diseases from ill animals might spread to people as well (6). After the 2019 flood, there were 2856 reported incidents of animal bites. According to research by Khanke et al. the majority of bites reported from Iran's north were caused by snake bites, whereas the south was affected by locust attacks (27).

**6.3.4 Communicable diseases:** Floods are a perfect breeding ground for vectors, and zoonotic reservoirs and can cause significant changes in the environment's balance (33). These conditions make the population more susceptible to spread disease. As a result, makes it easier

for infectious illnesses including water-borne, vector-borne, and rodent-borne diseases, as well as cutaneous and respiratory infections, to spread (33). Heavy rains and flooding encourage the growth of wild grasses, which in turn supports the rise of the rodent population (43).

Additionally, floods drive rodents out of their shelters into natural regions near people. When skin and mucosal membranes come into contact with soil or water that has been polluted by rodent urine, diseases can spread (43). Several rodent species including *Rattus* and *Norvegicus* were found in the provinces of Mazandaran, Gilan, and Golestan (33,44). The frequency of leptospirosis infections in humans and animals, has grown after flood in Iran, according to multiple reports from various locations, particularly in the northern provinces around the Caspian Sea (43).

Visceral leishmaniasis is rare in Iran, while cutaneous leishmaniasis is prevalent and 20,000 new cases are recorded yearly, it is however concentrated in the north-western and southern regions of Iran (45,46). Another example of infectious disease associated with floods, is rodent-borne Hemorrhagic fever with renal syndrome, which was identified in only one person in Iran after the flood (33). A significant portion of morbidity from floods is attributable to respiratory infections (6). Adenoviruses are one of several viruses, that may infect the respiratory system, and because they are common in the late winter, early spring, and early summer, they could also spread among people who have been exposed to floods, if occurred in mentioned times (44). An increase in infection in the future is predicted based on prior reports of the disease from other regions of the nation, particularly in flood-hit areas like Fars province, which was severely damaged by the most recent flood (45,46).

## **6.4 Long term health effects of floods**

**6.4.1 Outbreak of infectious diseases:** Overcrowding, interruption of waste disposal, inadequate hygiene standards, poor nutrition, and human interaction all create appropriate circumstances for increasing the frequency of infectious illnesses after floods and can trigger epidemics (36). Therefore, Shokri et al. in the study conducted in 2020 about the health of

Iranian population after the 2019 massive floods mentioned a correlation between population displacement and increasing infections (33). It happened because of a sharp rise in human exposure to pathogens and vectors in places where numerous infectious illnesses are common or where there have been indications of their prevalence. Flooding has an impact on the accessibility and availability of vital health services and may contribute to the spread of infectious diseases more widely (33). Khankeh et al. mentioned a total of 19 outbreaks occurred after the 2019 massive floods, but the proportion of affected people was less than 10 for each outbreak (27). No reports of gastrointestinal illness outbreaks following various floods in Iran have been made, however generally, epidemics of hepatitis A and E and enteroviruses may occur in flood-affected areas in the future (44). There are several strategies which resulted in low level of outbreaks after floods in Iran. For example, routine monitoring and management of the drinking water (with chlorine and boiling) as well as enhancing camp sanitation and bathroom facilities in affected areas are mentioned as preventative strategies which reduce the risk of outbreak occurrence. Furthermore, the careful handling and removal of animal remains lost in the flood and vaccination of high-risk groups are effective mitigations that adopted for eliminating the risk of infectious illnesses. Iranians' provision of humanitarian aid, usage of chemical pesticides to eradicate insects, and international organizations' assistance are mentioned as other reasons (47).

**6.4.2 Mental health problems:** The specific diagnosis of posttraumatic stress disorder (PTSD) has developed after a stressful event of an exceptionally dangerous or disastrous nature (48). This mental health problem is characterized by re-experiencing, prevention of situations connected with the stressful event, sleeplessness, lack of energy and anger, lack of concentration, and elevated wakefulness (48). Depending on how long symptoms last, there are two forms of PTSD: acute (less than three months) and chronic (symptoms persisting more than 3 months) (49). After the 2019 flood, people in Iran typically suffered during the acute period of PTSD from the loss of family members, homes, farms, facilities and so on. Furthermore, many who came for assistance returned to their home after a while. Therefore, in addition to suffering from various physical issues brought on by floods such as food shortage, unemployment, and emotional harms, many flood affected people felt forced to migrate, which

increased the risk of developing solastalgia and other psychological problems (10). The discomfort or illness known as solastalgia is brought on by the absence of one's home or other familiar surroundings, as well as the associated sense of loneliness which can be caused by natural disasters (50). The results of a cross-sectional survey done in 2014 from residents of two flooded communities in Iran indicated that every person who was exposed in any way to the flood and its terrible effects in the south-eastern Caspian area, developed PTSD to varying degrees (49). The greatest notable stress ratings were given to nightmares, fear of places and circumstances, sleep issues and aggravation (49). The mentioned research, which was done among residents of Neka and Behshahr three months after a flood in the south-eastern section of the Caspian Sea, found that the distribution of stress intensity was approximately the same for all three levels of mild, moderate and severe stress (Figure 13) (49).

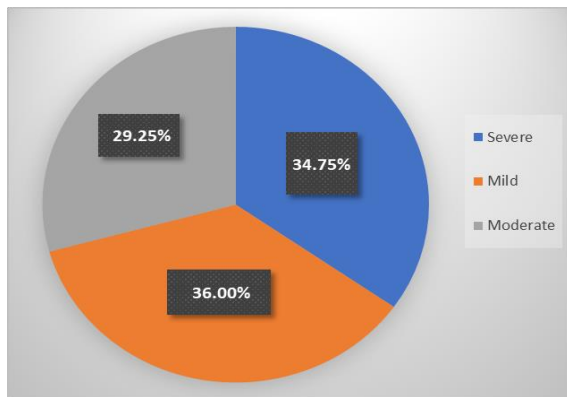


Figure 13: Stress severity level of Caspian Sea people in flooded areas after three months (49)

**6.4.3 Violence:** Violence is defined by the World Health Organization (WHO), as the deliberate use of physical force or power, whether threatened or realistic, against one's own, another person, or towards a group or community, that either results in or has a high potential to cause injury, death, psychological harm, maldevelopment or deprivation (51). Natural disasters like floods may raise the likelihood of violence in society (52). In addition, flood victims who lost their homes, family members and financial resources are more likely to experience emotional

stress and concern following flooding (10). Anxiety, aggression, and discomfort are symptoms of mental health issues that can be internalized through self-directed behavior or externalized through interpersonal aggression (49,52). Suicidal actions can be described as self-directed violence exposure (52). There is a connection between depression and suicide as well as the link between disasters and depression. Therefore, it makes sense to anticipate a relationship between disasters and suicide rates (53). The present study was unable to find any data on the suicide rate in Iran following the floods.

As an example of interpersonal violence, violence against women (VAW) can be mentioned (52). Floods may result in extensive destruction, a collapse in social security systems, and a loss of social stability. All of which can lead to the emergence of various forms of violence among the affected population in Iran, especially men (52). According to the UN definition, VAW is “Any act of gender-based violence, whether committed in public or privately, that causes or is likely to cause physical, sexual, or emotional pain or suffering to women, as well as threats of such behavior, pressure, or unjustified freedom loss” (49). Various forms of violence, including physical and psychological abuse, occurred for females in both family and community contexts, according to a 2016 qualitative study about violence against women after natural disasters, conducted in the three Iranian provinces (Bushehr, Mazandaran, and East Azerbaijan) (54). Mentioned study revealed that, the abused women suffered physical assault, and they attribute their husband's emotional suffering over financial losses as a reason for these inappropriate behaviors (54). Following the natural disasters, psychological VAW was indicated as restricting women of their independence, ridiculing them, threatening to divorce them and verbal aggression (54,55). Additionally, some men were anxious because of the decline in intimate partner sex and turned to sexual violence against their spouse. Sohrabizade et al. in the interview-based study in 2016 among female healthcare workers who had experience of working in flood affected areas in Iran revealed that, women who offered medical or social assistance to injured persons were harassed and humiliated in the flood impacted areas, which is known as community-based violence. Both afflicted males and other male relief workers in the devastated areas engaged in this type of assault against female healthcare professionals (54).

**6.4.4 Reproductive health problems:** Based on WHO definition, “Reproductive health (RH) is described as a condition of whole physical, mental, and social well-being in all aspects that contribute to the reproductive system and its activities and processes, not only the absence of sickness and infirmity” (55). RH indicates that both men and women are capable of enjoying a satisfying and healthy sexual life while be informed and have access to safe and effective family planning techniques (56). In an interview-based study, Sohrabizade et al. discussed many variables that lead to issues with reproductive health following natural disasters like floods in Iran. Interviews were conducted with a total of 22 participants, including 12 healthcare professionals and 10 key informants who had expertise and experience on RH in disasters and providing RH services in the disaster affected regions in Iran. RH difficulties develop as a result of disasters for a variety of reasons, including cultural, educational, and insufficient monitoring, as discussed below (56).

- Women like to converse with other women; however, the healthcare professionals were men. Although adult and young women's RH is more at risk in post-disaster situations in comparison to others, they are not sufficiently prepared to take this into account which is due to their low awareness of RH problems. As a result, there has been an increase in genital and urinary tract infections. Challenges to RH following disasters create an increase in unwanted births as well. This occurred based on their partner's decision as a head of family and the women had no right to deny it.

- Men avoided conversations about their RH problems because they were uninterested in doing so, which is why their RH was neglected by health authorities.

- The monitoring activities were restricted to providing prenatal care for women who resided in the flood affected areas. There were no defined and set up monitoring mechanisms to track the issues and requirements of the victims in terms of RH after the flood.



## 6.5 Vulnerabilities

There are several factors that influence the severity of flood-related health effects, such as flood features and different socio demographic variables, including age, gender, risky behaviors etc. (34,35).

### 6.5.1 Flood features

**6.5.1.1 Flood time:** In the qualitative study carried out in four cities—Ajabshir, Azarshahr, Gorgan, and Tehran—in 2017–2018, Yari et al. found that the frequency and timing of flood events have an impact on flood deaths (2). The risk of fatalities will undoubtedly increase if a flood event happens in the nighttime, however, there isn't enough research to make a conclusive statement (2). Not only the timing of flood can influence on the severity of health consequences, but also the very short interval between the commencement of the rainfall and the start of the flood is to blame for around one-third of all flood-related fatalities in the Shiraz in 2019 (28,29,31).

**6.5.1.2 Flood severity:** It indicates flooding strength in terms of deterioration, death rate, and water volume (57). Flood velocity is the ratio of the rate of rising and flowing water to the total amount of water passing through time. The amount of water released and the intensity of the rainfall both have an impact on how severe the flood is. More people are impacted by the more powerful flood. The number of individuals killed by floods has increased due to the accelerated rate of rainfall and flooding (2,34).

**6.5.1.3 Flood debris:** The kind and quantity of debris also has an impact on flood-related health impacts. Significant health problems are caused by more debris (57). For example, heavy rainfall, a large amount of debris and the obstruction of road bridges by debris were all aspects of the flood that had an impact on health according to floods that occurred in the Mother-soo watershed in August 2001 in the Golestan province (28).

## 6.5.2 Sociodemographic vulnerabilities

The impact of various sociodemographic parameters on the severity of the health consequences of the floods in Iran has been the subject of different studies. In some circumstances, the study findings differ from one another. Therefore, by highlighting the research methods and locations, the present study attempts to analyze variations.

**6.5.2.1 Age:** Different studies from Iran indicate that the elderly and children are two age groups that are more vulnerable to the negative health effects of floods (29,34). Due to their need for assistance with evacuation, requirement to access healthcare services and potential unwillingness to leave their homes, the old people are more susceptible to health complications such as injuries and drowning during floods (6). There is a link between age and the level of awareness about complications of risky behaviors in disaster time as well (57). Yari et al. mentioned that younger age groups put themselves in riskier situations for relief procedures, which is a result of a lack of awareness. As a result, depending on how much the public is aware of high-risk behaviors in a flooded area, age variable susceptibility may change (57).

**6.5.2.2 Sex and Gender:** According to studies in Iran, women are more likely to suffer severe health consequences from floods than men (29,34). Physiological differences such as pregnancy, more stressful experiences because of their responsibilities regarding children, and the physical and emotional abuse that they may have experienced from their spouse after the floods are just a few of the reasons that mentioned for female vulnerability to severe health effects of floods (34,54,57). On the other hand, gender factor depends on the role that each person plays in society and in their family (57). Therefore, it should mention that some qualities, such as being a head of family, having authority, and working hard, are convenient for men in Iranian family structures (58). These features are seen as more masculine in Iranians' culture and no one has thought of them as essential or vital for women in Iran (58). These characteristics cause males to feel more responsible for the safety of their family members in risky situations. Therefore, Yari et al. in the case control study revealed that men generally have

a higher risk of mortality from flooding in Iran (2). For instance, in the significant flood that occurred in 2019, there were twice as many male fatalities as female deaths (Table 2) (27).

	Cause of death					Gender	
	Drowning	Thunderstorm	Landslide	Mountain Landslide	Electrocution	Male	Female
Total death	73	4	2	3	3	67%	33%

Table 2: Deaths attributed to flooding in the March 2019 Floods (27)

**6.5.2.3 Risky behaviors:** Based on the qualitative study in various flood affected areas in Iran, observing the flood event near riverbanks, taking pictures during the flood instead of escaping from the location, being curious about others during flood events, participating in relief efforts and rescue without considering safety standards are examples of risky behaviors (57). Crossing flooded roads, rivers and bridges by foot is also another high-risk behavior which exacerbates the risk of drowning (57). Furthermore, although many people think that staying in their automobiles during a flood is a safe option, cars can float in water that is no deeper than only 30 cm (12 inches). People’s wrong perception caused them to miss the nearby safe zones during the Shiraz flash flood in March 2019, which led to half of all fatalities during the disaster (37). As another example, in April 2017, heavy rains in the southern areas led to flash floods in East Azerbaijan, Iran, which in some places triggered landslides. The majority of the fatalities occurred when people were driving, moving, or attempting to save their vehicles from the floodwaters (38). According to certain claims and video proof, some even passed away while viewing the flood flow from a nearby area and drowned in the water (38). This was despite the

fact that there were enough warnings issued and heavy rain and the possibility of floods were anticipated. Overall, because of the general public's lack of awareness of flood threats and the population's inadequate trust in governmental officials, it can be difficult to convince people to take the threat seriously, resulting in warnings being ignored in Iran (59). Shabani kiya et al. found that people who disregard flood warnings are twice as likely to engage in risky behaviors, such as walking through floodwaters (60). Additionally, they discovered a link between exposure to floods and high-risk actions, showing that those who had previously encountered flood occurrences had been considerably less likely to engage in high-risk activities than people who have not exposure to flood yet (60). It may be because of their experience regarding the consequences of life-threatening actions. Moreover, perceived, or actual swimming abilities increased the risk of drowning during floods. Swimming abilities, whether perceived or actual, can boost confidence and courage while facing floodwater, which increases the risk of drowning since flood water behaves considerably different from pools (2,61).

**6.5.2.4 Occupation and income resource:** Some jobs put workers at greater risk of health consequences of floods, which could even result in their death. For example, due to their employment, some people are required to go through disastrous areas such as stock breeders and shepherds (57). They must take their animals to flood-prone areas where they can be grazed which increases the risk of drowning and injuries in flood events (57). According to a study by Ahmadi et al. in the Pole Dokhtar region in Iran after the 2019 flood, some rural areas of the region, that are not solely dependent on agriculture and whose income sources include small businesses, and self-employment beside agriculture are less affected by the health effects of flood than other rural areas of the region that have agricultural jobs only (3). The reason is that there is a relationship between income and house type, residential location, and the quantities of money granted to organizations for flood protection operations in their occupancy, all of which are tied to people's economic availability (2,3).

**6.5.2.5 Education:** It has been demonstrated that low levels of education and even basic literacy level can cause major behavioral changes in terms of avoiding risk and taking precautions based on knowledge of the dangerous consequences (62). It is plausible to infer

that educated people are more aware of the dangers of risky behaviors. Education has an essential impact on the family flood adaptation ability as well (2,61). Therefore, increasing the family members' educational levels can improve their capacity to access, interpret and utilize adaptive knowledge, toward flood disaster (3). Furthermore, education and income are often highly connected. It was widely recognized that educated people had better earnings. Therefore, higher education may reduce vulnerability through higher income which result in higher standard level in house types (62).

**6.5.2.6 Rural residency:** The majority of rural smallholder farmers are negatively impacted by climate-related disasters like floods (3). This happened because they depend on naturally climate-sensitive resources for their livelihood and flooding had seriously destroyed agricultural lands (3). Moreover, the Iranian Health Ministry faces a serious issue with the lack of specialists in rural areas because of unfair distribution of physicians between cities and villages (63). As a result, people who reside in rural areas and require expert medical care sometimes have difficulty in obtaining specialty and subspecialty medical services, which become even more significant following disasters such as floods (63). Additionally, due to landslides and road damage brought on by disasters such as floods, certain rural places that are distant from the nearest city remain inaccessible which make them more vulnerable to health complications and increase the risk of death for severely injured victims (64). Lower variety of job opportunities (They mostly rely on agriculture), inadequate specialist physicians, an overreliance on rain-fed smallholder farming and the use of substandard building materials for constructions because of lower income resources all played major roles in flood susceptibility, making it more difficult for households to respond to the adverse health effects of flooding (3,65).

**6.5.2.7 Marital status:** Shabani Kiya et al. discovered a link between marital status and flood adverse effects in their interview-based study. Despite common belief, married individuals are more willing than single people to take dangerous actions such as going through a flood on foot (60). Therefore, there is a link between marital status and a higher likelihood of engaging in risky behaviors in Iran and consequently higher likelihood of drownings and injuries. The reason

may be attributed to other vulnerabilities such as age and gender related cultural aspects which were explained above (60).

**6.5.2.8 Religious beliefs:** Religious beliefs appear to be related to the severity of health effects of natural disasters such as floods (66,67). In an interview-based study with 25 participants, Sohrabzade et al. stated that some people believe that natural disasters occur because of sins committed by members of a community who are disobedient to God's commands. As a result, they do not pay attention to preventative steps prior to disasters. Additionally, when disasters occur, they do not attempt to prevent injuries since they believe that, they deserve to be wounded because it is God's reflect to their sins (66). On the other hand, a small number of participants of mentioned study held the opinion that after disasters, their strong reliance on God's assistance and spiritual religious beliefs helped them to tolerate the loss of their loved ones and cope with the post-disaster destruction (66). Therefore, it may be concluded that having a religious belief can either put one's health in danger or help one cope with issues following a disaster.

**6.5.2.9 Other factors:** Use of drugs or alcohol, the individuals' height, and weight, disability and being in prison during the floods are the other factors which can have a significant impact on how seriously floods affect human health and even result in fatalities (2,6,35,68).

## **6.6 Disaster Health Management (DHM)**

When dealing with disasters that necessitate both financial and human resources, DHM takes on the task of preventing, preparing for, responding to, and recovering from the health consequences of disasters in Iran. DHM is a systematic process that employs administrative policies, organization, operational skills, and capacities (20). The four main stages for which the DHM is responsible are Mitigation, Preparedness, Response and Recovery which are explained below:

**6.6.1 Mitigation phase:** Mitigation is the process of consistently taking steps to lessen or completely remove the dangers that disasters and their impacts pose to human health and property. The objectives of the mitigation process are to save lives, minimize financial losses, lessen risk and susceptibility, and improve building structures against the effects of disasters (69).

**6.6.2 Preparedness phase:** The development of the emergency management profession to successfully plan for, mitigate against, respond to, and recover from any threat through training and practice (69). The IRCS, according to the National Disaster Management Organization (NDMO), is the major agency for community disaster preparedness and public education (70).

**6.6.3 Response phase:** In this phase, emergency services and public assistance should be prepared to save lives and decrease the detrimental consequences of disasters on health (13). This phase occurs soon following a disaster and encompasses both immediate (relief) and long-term (reconstruction) responses (34).

The flood response in Iran is carried out by many Ministries and Organizations, including the MOH, the Water and Sewage Organization, the IRC, the Ministry of Power, and the Department of Agriculture (71). Rapid evaluation in the initial few days after a disaster is significant for establishing priorities and assessing the affected community's urgent needs (71). For example, in the flash flood which occurred in April 2016 in 23 Western and Southwestern provinces of Iran, a quick health assessment team was dispatched to the flooded districts to assess the loss and the health requirements of the affected individuals. This group included professionals from a variety of sectors, including environmental health, communicable illnesses, Emergency Operation Centers, and technical health deputies from affected areas (71). Additionally, first aid, psychosocial support and medical attention are needed for many of the flood victims. The MOH is implemented to provide emergency healthcare coverage (72). For example, within 24 hours of the 2016 flash floods of Iran, the MOH deployed the first batch of vaccination and antiseptics to the afflicted areas (71). In support of the MOH efforts during the 2019 massive floods, IRCS, which was noted as an important sector that aids in health system response functions in disaster situations, offered 24 mobile clinics that provided basic health treatment (72).

**6.6.4 Recovery phase:** The livelihood, amenities, and living situations of communities affected by disasters should be improved during the recovery phase (13). When a disaster occurs, the aim is to provide appropriate aid to assist those affected in recovering from the disaster's immediate impact (34).

## **6.7 Disaster related health risk reduction policies and plans in Iran**

The Iran National and Health System's plans for decreasing the severity of health complications of natural disasters and specifically floods as well as the organizations in charge of carrying out the procedures are described below in more detail:

**6.7.1 Risk Reduction National Protocol (RRNP):** The Iranian Ministry of Interior was given the legal responsibility to serve as the coordinator of all initiatives relating to immunization and the avoidance of loss of life and property in natural disasters in 2003 (21). The pre-disaster and post-disaster stages of the RRNP are included in the country's approach for all disaster reduction actions which described below (Table 3) (21,69).



Pre disaster	Post disaster	Responsible sectors
<p><b>Risk identification:</b> included disaster evaluation, such as disaster frequency and location, as well as vulnerability assessment.</p> <p><b>Risk assessments:</b> evaluation of disaster functions using the Geographic Information System (GIS) or mapping.</p> <p><b>Mitigation process:</b> physical actions, structural planning (for example, land use and urbanization), economic analyses, and raising knowledge about disaster risk.</p> <p><b>Risk transfer:</b> ensuring public and private facilities against disaster risk and providing funding for climate events.</p> <p><b>Preparation:</b> early warning systems, crisis response, and infrastructure such as shelters and public services</p>	<p>Emergency clean-up and quick repairs provided by humanitarian assistance</p> <p>Damage evaluations</p> <p>Mobilized Recovery resources</p> <p>Repairing and rebuilding damaged infrastructures</p> <p>Budget management, restructuring of impacted industries including agriculture, and inclusion of elements for disaster mitigation</p>	<p>Minister of Interior (chairman)</p> <p>Deputy Minister of Interior for development Affairs</p> <p>Ministry of Energy</p> <p>Ministry of Health</p> <p>Ministry of Roads and Transportation</p> <p>Ministry of Communications</p> <p>Ministry of housing and urban planning</p> <p>Ministry of Agriculture Jihad</p> <p>Chief of staff of the General Commander of Armed Forces</p> <p>Vice President and Director of the Management and Planning Organization</p> <p>Director of I.R Iran Red Crescent Society</p> <p>Director of I.R Iran Broadcasting Organization</p>

Table 3: Risk Reductions National Protocol in Iran and Implementation sectors (21,69)

**6.7.2 Disaster early warning system:** Early Warning System (EWS) is an important protocol for reducing the severity of flood-related health issues by warning people about flood occurrences in advance (73). Islamic Republic of Iran Meteorological Organization (IRIMO) and the Climatological Research Institute established and presented to the government the National Flood Early Warning System (NFEWS), which has been in use since 2000 (73). For instance, the early warning of the disastrous flood that occurred in Golestan in 2001 was issued within two days prior to incident (73). NFEWS tasks are divided into three sections which are explained below (73):

Observation: Meteorological data from radar, satellites, climatologic, and hydrological stations was collected by Meteorological Data Collection and Distribution (MDCD).

Forecast and Warning Issue: Early flood warnings have been provided to the National Committee of Disaster Reduction, the Province Forecasting Center, the Internet, the Leader's office, the President's office, and the National Parliament.

Response: Action plans are offered by connected agencies in the response section, including the Ministry of Transportation, Road Information Centers, Red Cross Organization Health Centers, and others.

**6.7.3 Educational health plans:** The Master of Public Health (MPH) with a disaster specialization has been provided by Tehran University of Medical Sciences' (TUMS) School of Public Health and Institute of Public Health Research since 2006 to provide awareness of public health implications toward natural disasters (68). Additionally, according to the Comprehensive Health Sector Road Map, TUMS contributed to the development of a DHM transition plan for the years 2012 to 2025, which included goals, strategies, and necessary steps for decreasing the flood related health impacts (68).

**6.7.4 International cooperation:** Iran was one of the first countries to sign on to monitor the Hyogo Framework for Action's local implementation. It indicates Iran's participation in integrating Disaster Risk Redaction (DRR) into national development beside the other 167 participating countries. Planning at all stages by considering preventative and mitigating

techniques, to lessen susceptibility, is a goal of this framework, which began in 2005 and ends in 2015. It aims to decrease disaster losses and create more sustainable policies for DRR (68).

## **6.8 Challenges of DHM system in response to floods in Iran**

Although Iran has made significant progress in the inter- and intra-sectoral disaster health management after various natural disasters, there are still areas that require improvement and difficulties that the health system encountered (20). According to an interview-based study conducted by Pour Hosseini et al. among 30 managers of relevant organizations with experience in dealing with various natural disaster managing in Iran during past ten years, the followings mentioned as the most pressing issues (74):

**6.8.1 Human resources management:** To reduce the effects of natural disasters on health, it is crucial to provide human resources. An analysis of previous disasters' health management shows that a large number of medical professionals, members of the public, and organizational forces volunteered to help in the affected area. Despite their good intentions, their presence created confusion in the area because of lack of coordination and failing to consider the specific needs of the region. The volunteer's lack of information and training regarding emergency situations renders them ineffectual (74).

**6.8.2 Physical resources management:** Due to a lack of supervision over how to distribute and receive donations during many previous crises, a lot of resources were wasted (74). For example, due to their near-expiration dates, lack of familiarity of received medications for national physicians, and significantly differing dosages from local medications, the majority of the drugs posted from other nations were useless (74). In addition, a study evaluating the strengths and weaknesses of the health system at an early stage following the 2019 flood disaster revealed that, despite the presence of pharmacists in flood-affected areas, there was a lack of both special medications like chemotherapy and regular medications like serums and antibiotics (75). Furthermore, the mentioned study suggested that there were additional issues

with drug distribution, including a lack of vehicles for distributing medications, a failure to check the public's demands, and a lack of coordination (75).

**6.8.3 Inter-organizational coordination:** Being unable to distinguish medical rescuers from regular citizens was mentioned as one of the potential reasons of confusion and inconsistency in crisis areas (74). The Iranian police force is responsible for keeping an eye on and monitoring the impacted areas, however, many of the medical professionals who were providing care in the disaster impacted areas lacked identity cards, which could lead to an unequal distribution of healthcare services (74). Furthermore, health services in the 2019 flood disaster face challenges including a lack of coordination regarding the dispatch of specialized physicians and medical services to flood-affected areas, parallel work of organizations, and a lack of visiting time control (75).

**6.8.4 Hospital preparedness:** The term "hospital preparedness" refers to a wide range of elements, including medical duties, Human resources, infrastructure, and Standard Operating Procedures, all of which would be regularly evaluated and improved. Therefore, the hospital must have a comprehensive strategy in place for handling the disaster well in advance of the occurrence of natural disasters (76). One of the things that could cause irreversible harm to the Iran's healthcare system is a lack of preparation for disasters, including inadequate planning and coordination, inadequate health services, and a lack of training for staff in disaster response time (77). Furthermore, the Hospital Safety Index (HSI) is a tool created by the WHO and recommended as a trustable and affordable diagnostic tool that evaluates the structural safety, non-structural safety, and functional capacity of a hospital in 145 areas such as operational plan for disasters (78). Therefore, in a study by Ardalan et al. on hospital safety evaluation based on HSI across 421 Iranian hospitals in response to the natural disasters in 2015, it was found that 43% of Iranian hospitals were disaster safe. Functional capacity, structural safety and non-structural safety were all at 41%, 42%, and 47% respectively (78). The graph below shows the HSI-based trend for hospital disaster safety in Iran between 2012 and 2015 (Figure 14) (78). Comparison of the two assessments reveals progress between

2012 and 2015, however the overall safety rate of Iranian hospitals' preparedness is less than 50%, indicating the need for more investigation to enhance hospitals' preparation in Iran (78).

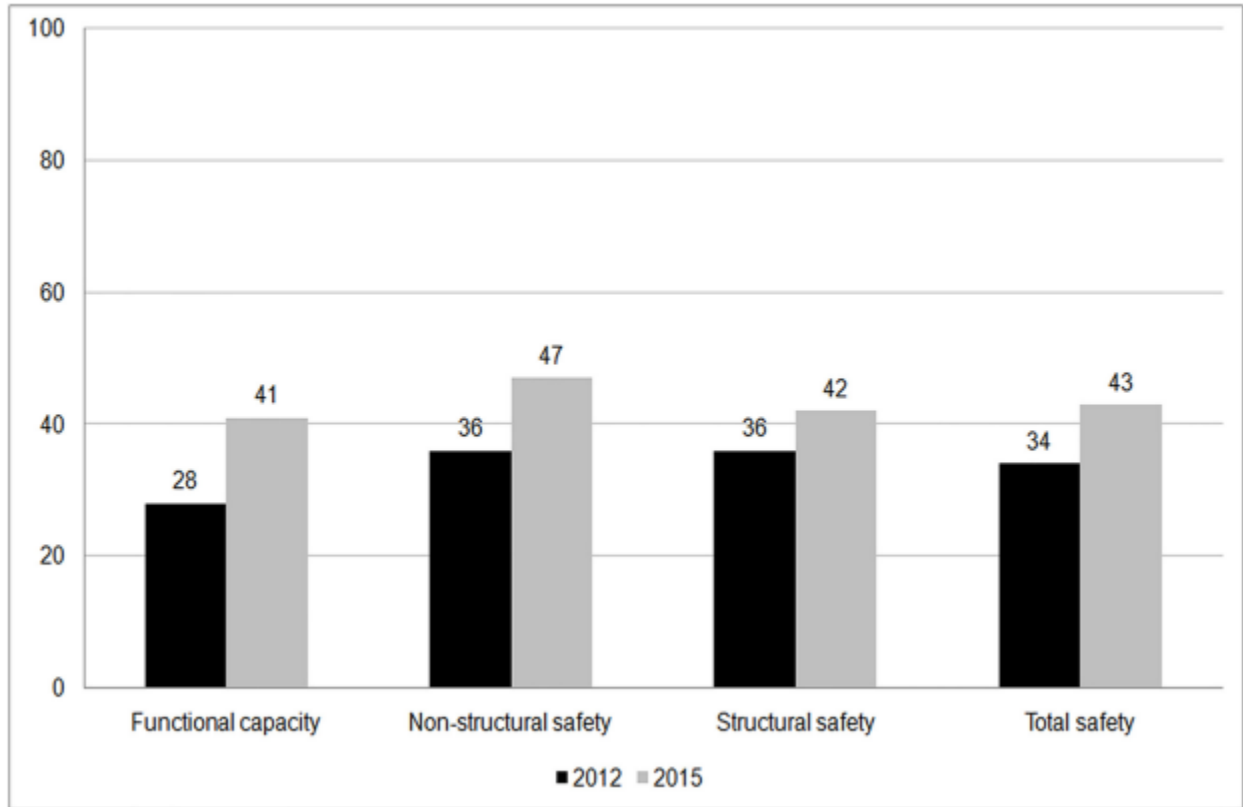


Figure 14: Trend of Hospital disaster safety in Iran from 2012 to 2015 based on HSI (78).

**6.8.5 Nutrition management:** It is extremely important to consult nutritionists for assistance, decide on specific diets for emergency situations, and have medical specialists closely monitor the locations of food and water preparation, distribution, and storage throughout the disasters (79). The scarcity of vitamin supplements for children and pregnant women was found to be one of the issues the healthcare system facing in the wake of the 2019 floods (75). Additionally, there was a shortage of food for those with chronic illnesses, such as diabetics, as well as inadequate dairy and fruit supplies. The failure to consider cultural differences among different locations while distributing the food was another significant issue with nutrition management in 2019 massive flood (75). Ainehvand et al. in the study about challenges of the national plan toward achieving food security after disasters mentioned that disrespectful behavior from

those delivering meals lead to denial from those who get them and worsen food shortages among those who receive them (41). There are different guidelines from several agencies who are responsible to distribute food for disaster-affected individuals in Iran. The differences and inconsistency in guidelines from responsible agencies such as the Ministry of Agricultural Jihad and the Health Sector of Military Organizations cited as another cause of food security challenges in flood affected areas (41).

**6.8.6 Mental health support:** A team made up of psychologists, psychiatrists, social workers, and neuroscientists should be present in the impacted area to offer psychological assistance (74). In a qualitative study based on interviews with 26 specialists in disaster management in various disasters in Iran, Rabie et al. discussed difficulties in dealing with mental health issues that the healthcare system faced (80). The primary issue with the Iranian healthcare system, according to nearly all interviewees (96.1%), is that the healthcare professionals are not familiar with the fundamentals of psychological assistance. Furthermore, 92.3% of them cited the lack of appropriate expertise in disaster areas, insufficient training of healthcare professionals, and disregarding the emotional requirements of vulnerable populations as other important issues. More than three-quarters of interviewees identified the immediate stop of psychological support following disasters as an example of Iran's mental health services' shortcomings in disaster effected areas (80).

**6.8.7 Budget management:** Typically, the Iranian Republic of Iran grants 2.5 percent of its annual budget to natural disasters (21). Below is the distribution of budget among four steps of policy making in Iran demonstrated (Figure 15) (13). As indicated in the figure below, the response phase was the most expensive for the government, accounting for about half of the disaster expenditure over the last century. The second phase in terms of disasters' costs (40% of the budget) is recovery (13). The most important stage of the DHM process is preparation (81); however, it is the third priority for spending government funds (13). The mitigation phase, which comes last in Iran's national budget allocation for dealing with natural disasters, has received just 1% of funding during the past 100 years (13). This strategy of distributing funds for

disasters results in a decreased amount of money being allocated over time for preparedness and mitigation. Therefore, the severity of the damage aftermath will increase (13).



Figure 15: Distribution of budget allocation to different disaster phases (1920-2020) (13).

## 7. Discussion

The most common natural disasters in Iran are floods, which can lead to a variety of health consequences over time, including drowning, injuries, infectious diseases, mental health problems, and so on. By analyzing various secondary hazards following floods, this thesis provides an overview of the risks that floods pose to human health in Iran. The material of this study was organized based on a conceptual framework that is a combination of two different frameworks to describe a thorough pathway of the causes and health related consequences of floods. To define how much flooding affects people's health, this thesis looked at flood-related characteristics and sociodemographic vulnerabilities. Various health systems and national plans implemented with the aim of reducing the severity of health impacts of flooding in Iran were thoroughly reviewed. It also identified the issues that need to be further explored in health programs. The findings of this study will be further discussed in this part to produce practical recommendations to fill the knowledge gaps and strengthen health policies addressing the health effects of floods in Iran.

**Natural and man-made causes of flooding:** Climate change, especially intense rainfall, and destroying natural drainage infrastructures by deforestation and unplanned land use came up as major contributors to flooding in Iran. Iranian findings about the occurrence of floods due to unplanned urbanization are in line with those of Italy and Indonesia (82). However, in France by increasing urbanization, the risk of flood decreases, and this is because standards are given priority (82). These statements suggest that the goal of reducing vulnerability to floods can be achieved if protection from natural drainage infrastructures is considered a top priority at all levels of urbanization planning.

**Secondary hazards:** After flood occurrence, infections can spread through direct contact with contaminated floodwater. Agricultural or industrial wastes, chemicals, and sewage from overflowing sewers typically contaminate floodwater. Severe flood disasters in Bangladesh and Indonesia have been linked to contaminated drinking water sources which then result in numerous infections there after floods (83). By analyzing the risks connected to exposure to pathogens in contaminated floodwaters, Veldhuis et al. noted that it is difficult to stop pathogens from spreading in floodwaters. As a result, they suggested that the only way to reduce the risk of various infections is to increase public awareness about avoiding direct contact with flood water (83). Furthermore, the remaining dead bodies of people and animals are a resource of infection following flooding as well. For example, the bodies of Hurricane Katrina victims were discovered in the aftermath of widespread flooding in the United States (US) (84). The appearance of multiple decaying corpses in open settings has raised concerns about the development of infectious disease outbreaks (84). Simple safety measures like using personal protective equipment and adhering to basic hygiene procedures can significantly lower the danger of spreading any infections connected with handling corpses (84). As another secondary hazard, food shortages can put people's lives in danger. Based on findings, the MOH has a main responsibility to oversee the food security of people in Iran after floods, but a lack of management on equitable distribution and poor intra-organizational coordination with other accountable institutions like the Ministry of Agriculture and Red Crescent Organization led to a lack of long-term interventions and ignoring the needs of the vulnerable population. Food insecurity linked to different sociodemographic vulnerabilities. For example, those with fewer



income resources and a greater reliance on agricultural products who live in rural areas are more susceptible to food insecurity than others. Crop losses influence the physical and emotional well-being of farmers and their families in High Income Countries (HICs). Farmers in Low Middle-Income countries (LMICs) will also experience the mentioned difficulties since their already insufficient baseline levels of resources will be destroyed by the floods as well (42). For example, flood-related agricultural losses have made food insecurity worse in nations like Bangladesh and Ethiopia, where the food security situation is among the worst in the world (42,85). The cause of food insecurity following Japan's earthquake in March 2011 was a lack of food supplies, emphasizing the importance of food storage during the planning phase (86). As another example, an assessment of Hurricane Katrina revealed a lack of attention to vulnerable people's needs as a challenge for reaching to food security (87), which was similar to Iran's experience after 2019 floods (41,88). The analysis of these data indicates that in addition to paying attention to pre-disaster food supplies, vulnerable populations like rural inhabitants, those with less income sources, and those who are chronically ill should also be given priority in health plans.

Disruption of health services is a key issue that worsens the health effects of flooding by limiting access to healthcare for flood relief as well. For example, in August 2010, floods in Pakistan submerged an area the size of England and damaged or destroyed 2 million properties as well as 514 medical facilities (89). Similar destructions took place in Iran after the 2019 massive floods. Therefore, there is a need for additional investigation to minimize such deadly consequences by constructing higher quality healthcare buildings.

**Short term health impacts:** Regarding health impacts immediately after floods, drowning, injury, animal bites and communicable infections emerged in the present study. Drowning is the leading cause of flood-related mortality in Iran, which was an expected result because, according to a research analyzing the causes of flood disaster mortality, nearly two-thirds of flood-related deaths worldwide were caused by drowning (90). The danger of drowning and injuries from floods in Iran are correlated with the features of the flood and the sociodemographic variables of the population, including age, gender, level of education, and type of job. Compared to other types of floods, flash floods have a higher rate of drownings and

injuries. Studies from the US confirmed the same findings, showing that flash floods in North America are causing a higher rate of deaths due to their high velocity and unexpected occurrence (91). The risk of fatalities rises since flash floods occur rapidly and there is limited probability of flood warnings as well. Additionally, flooding makes it easier for diseases that are transmitted by rodents, insects, and water, to spread. Due to alterations that flood water makes in the environment's equilibrium, this was an expected result. Communicable diseases after floods are associated with secondary flood hazards such as post-flood remaining dead bodies and poor water sanitation quality. However, it can be claimed that efficient health management in response phase such as providing clean water in flood affected areas are beneficial in lowering the risk of infections following floods in Iran (47).

**Long term health impacts:** Infectious outbreaks, mental health issues, violence, and RH difficulties are highlighted as long-term health consequences of floods in Iran. Alderman et al. discovered that flooding has been demonstrated to increase the likelihood of infection outbreaks. For example, leptospirosis cases in Mumbai and India increased up to 8-fold following the 2005 floods (42). However, the results of the present study demonstrated that Iran's outbreak rate after floods is not as high as in other LMICs. Another evidence of Iran's rate of outbreak after natural disasters is the city of Bam in Southeast of the country, which experienced an earthquake in 2003 that destroyed more than 90% of its structures (92), while 1.6% of 75,586 disaster affected people had diarrheal disorders after earthquake (93). Effective health interventions including the distribution of bottled water, trash disposal, sanitation, and the decontamination of high-risk regions can be associated with a lower rate of outbreaks following natural disasters in Iran.

Regarding longer term health effects, anger and anxiety after natural disasters may develop from various mental disorders, and manifest in aggression toward spouses or sexually abusing them (54). Studies from other countries have shown that psychological impacts have correlation with location of residency. They are greater in rural areas than in urban communities (42) which is in line with the findings of this thesis. Lower levels of education, and the constant threat of severe climate related events to their agricultural resources and livestock are mentioned as reasons of rural vulnerability to mental health problems. Direct trauma

exposure has been consistently identified as a risk factor for the development of negative psychological outcomes in both HICs and LMICs (42). Although Iran's health system was successful in eradicating infections after natural disasters, mental health interventions have some limitations. Unfamiliarity of stakeholders with the basics of psychological support, inadequate expertise in disaster areas and the sudden termination of psychological support following disasters are mentioned as points that require more investigations.

Moreover, due to limited access to health facilities, women in Iran obtain fewer prenatal care after floods. This limitation has also been documented in North Dakota, US (47). Lower RH awareness and attention among young women has been linked to an increase in urine infections in the aftermath of floods. Other challenges that make RH crucial for more investigation include failing to adhere to regional cultural preferences (for example, a lack of female physicians), being unable to supervise prenatal care on a regular basis due to disruptions in health services and inadequate equipment.

**Sociodemographic Vulnerabilities:** There is a connection between flood-related factors such as flood velocity and flood time, as well as several sociodemographic factors and the severity of flood-related health consequences. For example, age was found as a susceptible factor in the present study. Alderman et al. found out that younger people up to the age of 35 are more vulnerable to health effects of flooding in Australia (42). The association between younger age and risky behavior was established by lower perceptions of the consequences of potentially life-threatening activities and participation in relief and cleanup activities without attention to safety protocols (42). Contrary to Australia's findings, the majority of Iranian studies recognized children and the elderly as two susceptible age groups. Therefore, it is possible to claim that age vulnerability has a connection to where floods occur as well.

The present study identified women as a vulnerable population to flood health effects, which was expected outcome given that similar findings were found in other LMICs like Ethiopia, Nepal, and Bangladesh (42). On the other hand, few studies in Iran claimed men were at higher risk of death. The reason is that males are the head of families in Iran. Therefore, in risky situations, saving the lives of other family members prioritizes over their own, putting them at greater risk of fatalities in some areas. It is likely that male vulnerability in Iran is connected to

gender-related variables, whereas female susceptibility is mostly linked to physiological differences. It became obvious that the cultural aspects of Iranian families were the main reason for men higher mortality, which was distinct from the US. Men have been shown to have a higher risk of death in the US, and one key element contributing to this risk is driving during floods (42).

Overall, level of education and location of residency are the most important sociodemographic factors which impact on severity of health complications of floods. Findings of present study indicated that, higher level of education results in more awareness about complications of floods and lower risk-taking actions during flood. Taking life-threatening actions during a flood raises the possibility of getting hurt or drowning. Flood disaster fatalities in Europe and Indonesia are also mainly attributed to risky behaviors during disasters (60,94-96). The probability of engaging in risky behaviors is linked to gender and age as well. It appears that those who are younger, and male have a higher intention to engage in risky behaviors. The key point to note is that previous flood experiences made people less likely to take risks, which may be due to their awareness of the complications. Additionally, educated individuals are more likely to earn better salaries, which increases spending on safe and high-quality housing.

Furthermore, people who reside in rural areas in Iran are more vulnerable to health difficulties after floods. This result was predictable, and it wasn't only for Iran. According to studies on India, people in rural areas are more vulnerable since there are fewer financial resources for rural residents, which leads to substandard housing and a reliance on agricultural sources (97).

Only one Iranian research identified a correlation between marriage and an increased risk of experiencing flood-related health issues. It could be related to other vulnerable characteristics such as age or cultural factors. Because of the limited scope of the study, it is difficult to draw general conclusions. There was also no information available on a worldwide scale.

Moreover, few research has examined the relationship between religious beliefs and post-disaster health effect. For instance, in Bangladesh, where many believe that natural disasters are God's way of warning them for their sins, they tend to ignore preventative advice (67). On the other hand, few studies from other nations mentioned that those who are more religious may be better at problem-solving and stress management after natural disasters than those

who are less religious (98,99). Although these statements from different regions were consistent with the present study, it is not possible to make broad generalizations about Iran because only one study about this association could be found.

By examining the relationship between several sociodemographic vulnerabilities and flood-related health impacts, it is clear that there is a strong link between them and that each one has the potential to either enhance or minimize the health issues by association with the others.

**Disaster risk Management:** The four primary phases of DHM are mitigation, preparation, response, and recovery. The Sedighi et al. research, which included statistics on risk reduction strategies in Iran and other countries, stated that Australia emphasized data collection for disaster-related recovery phase while France prioritized investment in prevention (13). These international findings contrast with what occurred in Iran following natural disasters. Iran allocates the biggest portion of disaster-related spending to the response and recovery phase while allocating the least portion to mitigation and prevention. Despite the nation's involvement in a variety of regional, national, and worldwide initiatives to promote preventative and risk reduction strategies, it still seems that there are some issues that arise after floods that might be easily avoided with more attention beforehand. Lack of resources, insufficient hospital preparation as a first line of defense in disaster-related health issues, and insufficient rescue strategy based on international guidelines are areas that require additional research to improve. Furthermore, a lack of funds for teaching the public about the risks of life-threatening behaviors, as well as a lack of equipment to assist flood victims, are shortcomings in national plans that should be investigated further to decrease flood-related health issues in Iran.

## **8. Conclusion**

This thesis aimed to comprehend the short- and long-term health consequences of floods in Iran by assessing several secondary hazards following floods. Several sociodemographic characteristics and flood features were found and detailed in this study which have an impact on severity of flood-related health consequences. Evaluating existing national and health

system policies and plans in Iran provides an opportunity to identify areas that require more investigation in order to assist policymakers in improving their policies, resulting in a reduction in the health consequences of floods in Iran. Overall, floods are among the most common natural disasters on the globe. Flood disasters affected more than 10 million people in Iran during the previous decade. Following the presented conceptual framework, the floods' short- and long-term health consequences may be exposed either directly or through secondary hazards. The presence of dead bodies, chemical and water pollution, which raises the risk of infectious disease transmission mentioned as secondary hazards following floods. Secondary hazards can also have an impact on people's health by disruption of health services and food insecurity, which limits access to food and medical care. The Iranian population's vulnerability indicators are like those of other LMICs such as Indonesia and Ethiopia. In general, it is possible to conclude that living in rural areas, relying mainly on agricultural resources, and having a lower educational level, low level of knowledge of the dangers of risky behaviors, and disregarding warnings, exacerbated adverse health impacts of floods in Iran. Short-term health issues, such as drowning, injuries, animal bites, and communicable diseases, cause a wide range of human health problems. Longer-term issues, such as infectious disease outbreaks, mental health issues, violence, and RH issues, each have multifaceted consequences. The long-term consequences of floods may manifest at different times after the floods, even years later. To conclude, while policies are in place to reduce the harmful health effects of floods, there are several requirements that government and health system plans do not achieve. For example, although Iran's disaster budget mostly dedicated to flood response and recovery, developed nations commit more financial resources to mitigation and preparedness measures. Based on findings, there are several recommendations, to help risk reduction policy makers comprehend the importance of the health effects of floods in Iran and improve the existing implementations.

## 9. Recommendations

- Attention should be paid to increasing the people's knowledge about dangers of floods to their life and promoting public safety culture through national media and virtual networks. Regional events that bring people together can be a good opportunity to talk about the importance of public awareness about serious flood related health complications as well. The other beneficial way is training flood preparedness strategies to students at school and encouraging them to engage in raising their family's awareness by transferring what they learn. Training on health effects of floods should be provided not only to the general population, but also to healthcare stakeholders. They must understand the distinction between health services provided in normal circumstances and disaster-related health difficulties that require more consideration to the patients' emotional capacities.

-Healthcare professionals should consider socio-cultural aspects, especially in rural areas where treatments are frequently refused by women when delivered by male health workers, in order to encourage women to take care of and not neglect their reproductive health following floods.

- More equipment for mobile clinics in flood-affected villages, as well as vehicles such as helicopters and boats to carry patients to hospitals, should be provided. These approaches necessitate longer time frames and legislative lobbying with donors to generate financial resources.

- To lessen the negative effects on mental health, such as depression and anxiety, which may develop weeks or months after flooding, it is vital to periodically supervise the flood victims. Additionally, it will be helpful in these circumstances to involve society healthcare providers who are familiar with cultural aspects of residents especially in rural areas which are more vulnerable to flood related health impacts.

- Attention must be paid to preparedness planning and the provision of sufficient resources to be used in emergency and disaster circumstances to meet the demand for healthcare services during disasters. DHM programs must devote more funding to preparedness and mitigation

measures to implement these recommendations. To achieve this goal, MOH should persuade health budget providers by alerting them about the negative health consequences of floods, which can be reduced by increased hospital readiness.

- Protocols must be developed for regular screening of urbanization in cities, particularly in those with large populations like Shiraz and northern regions, where massive deforestation is a result of increased development. According to established standards, infrastructure resilience should be considered before other considerations in national strategies for land use and sustainable urbanization. This is a recommendation outside the health sector, but with the aim of improving the health of the population by minimizing the risk of disruptions by floodwater.

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