

Review Paper

Impact of Climate Change on Public Health in Iran: A Systematic Review



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ABSTRACT

Background: Climate change has many effects on various aspects of human life, including health. Iran is highly vulnerable to climate changes, which can have a significant impact on public health. Therefore, this study aims to review the effects of climate change on public health in Iran.

Materials and Methods: This systematic study was conducted based on the preferred reporting items for systematic reviews and meta-analysis (PRISMA) protocol and three steps of search, screening, and synthesis of selected studies. To identify related studies published from 2000 to 2023, online databases (PubMed, Scopus, Web of Science, MagIran, and SID) were searched using relevant keywords. Finally, we selected 52 eligible studies. The selected studies were screened to extract key information.

Results: The direct effects of climate change included the increase in infectious, cardiovascular, and respiratory diseases, changes in women's pregnancy patterns, and the prevalence of preeclampsia, skin cancer, pterygium, congenital hypothyroidism, and mortality. Indirect effects of climate change included the changes in reproductive patterns and the spread of insect-borne and human diseases such as malaria, brucellosis, leishmaniasis, human salmonellosis, cholera, bloody diarrhea, Crimean-Congo hemorrhagic fever (CCHF), and COVID-19. Moreover, climate change had negative impact on the mental health such as increased mood swings, depression, schizophrenia and schizoaffective disorders, and bipolar disorder. The results showed that vulnerability to climate change varies depending on geographical and demographic factors.

Conclusion: Climate change has many adverse effects on the physical and mental health of Iranian people; therefore, the development and implementation of national strategies and programs to fight against them are essential. Despite studies conducted so far on the relationship between climate change and human health in Iran, there is still a need for further investigations, especially regarding the connection between climate change and people's mental health.

Keywords:

Climate change, Health, Iran

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Introduction

Climate change poses a significant challenge to humanity, affecting various aspects of human life, including public health [1, 2]. Rising temperatures lead to more frequent extreme climatic events and changes in ecosystems. Understanding the effects of climate change on human health is crucial for developing effective strategies to address these challenges [3-6]. A proper understanding of the negative effects of climate change on the environment, such as sea level rise, global warming, intensification of weather phenomena, severe droughts and forest fires, is very important as these changes also greatly affect human health and well-being [7, 8].

The latest Lancet report, which examined 43 indicators of the relationship between climate change and human health, emphasized that the impact of climate change on human health is worsening by the day [8]. The impact of climate change on human health occurs through multiple direct and indirect ways [9]. An adverse health impact is defined as the creation, promotion, facilitation and/or exacerbation of a structural or functional abnormality that has the potential to reduce quality of life, contribute to a debilitating disease or lead to premature death [10]. Human health is significantly affected by climate change, resulting in direct health problems such as heat-related death, cardiovascular and respiratory diseases [8, 11-13]. Moreover, the indirect impact of climate change include the spread of disease-carrying insects, forced migration, shortage of resources, and inadequate access to food and clean water [14]. Iran is susceptible to the effects of climate change because of its distinct geographical and climatic conditions [15, 16]. It is exposed to a range of climate-related hazards that can have a significant impact on public health [17]. Due to factors such as urbanization, demographic changes, and socioeconomic conditions, the Iranian population is at risk of health problems caused by climate change [18, 19].

Research has shown that extreme temperature is contributed to the increased death cases from cardiovascular and respiratory diseases [20]. The occurrence of trauma-related deaths tends to rise at higher temperatures and lower humidity levels [21]. Furthermore, environmental factors, such as temperature and humidity, have a significant impact on the prevalence of common communicable diseases such as malaria, leishmaniasis, and Crimean-Congo hemorrhagic fever (CCHF) in Iran [22, 23]. A comprehensive review of studies on the effects of climate change on human health is necessary to guide future actions [24]. Systematic reviews can help identify specific effects such as wildfires or occupational hazards, in specific countries, such as Iran [25, 26]. Therefore, the present study aims to systematically review the impact of climate change on the health of Iranian population. This research provides valuable insights for the development of health policies and interventions that can suggest a comprehensive and evidence-based approach to address the health challenges caused by climate change in Iran.

Materials and Methods

This is a systematic review study conducted according to the preferred reporting items for systematic reviews and meta-analysis (PRISMA) guidelines and based on a step-by-step method (Table 1): Formulating the research question, searching and evaluating the literature related to the research question, and finally conducting a comprehensive and systematic evaluation and synthesis of the information [27].

To find the articles related to the impact of climate change on human health in Iran from 2000 to December 2023, databases and academic search engines (PubMed, Scopus, Web of Science, MagIran, and SID) were searched by two researchers (SVE and AA) using keywords related to climate change and health (Table 2). All articles that accurately reported at least one impact of climate change (direct or indirect) on the health of the Iranian population and published in English or Persian were included. The editorials, notes, and letters to the editor were excluded. In addition, the studies that focused on

Table 1. Systematic review steps in this study

Steps	Actions
Searching	Searching databases using search strings
Screening	Paper selection according to the PRISMA criteria
Synthesis	Data extraction and categorization, comparison and conclusions

Table 2. Search strategy to identify articles related to climate change impact on human health in Iran

Component	Search Term
Climate change	"Climate change" OR weather OR "global warming" OR "environmental change" OR "climate disaster" OR "greenhouse effect" OR "climate variability" OR "climatic variability" OR "atmospheric pressure" OR "carbon emission" OR temperature OR humidity* OR precipitation OR rain* OR season* OR storm OR heat waves
Human health	Health OR disease* OR morbidity OR mortality OR illness* OR wellness OR infect* OR death OR injury* OR mental* OR emotion* OR "health effects" OR "public health" OR "mental health"
Iran	Iran* OR "Iranian society" OR Tehran OR Alborz OR Karaj OR Khuzestan OR Ahvaz OR Gorgan OR Golestan OR Gilan OR Rasht OR Hamadan OR Arak OR Markazi OR Isfahan OR Zanjan OR Kermanshah OR Kurdistan OR Sanandaj OR Mazandaran OR Sari OR Qazvin OR Qom OR Semnan OR Yazd OR "Sistan and Balochestan" OR Fars OR Shiraz OR Bushehr OR "East Azerbaijan" OR Tabriz OR "West Azerbaijan" OR Urmia OR Ardabil OR Ilam OR Lorestan OR "Shahrekord" OR "Chaharmahal and Bakhtiari" OR Khorasan* OR Mashhad OR Birjand OR Bojnord OR "Bandar Abbas" OR Hormozgan OR Yasouj OR "Kohgiluyeh and Boyer-Ahmad"

countries other than Iran, not related to the impact of climate change on public health outcomes, and those with insufficient data or methodology, narrative reviews, and non-systematic and systematic reviews were excluded.

To select the studies, two trained researchers first independently screened the titles and abstracts based on the inclusion criteria. These two researchers then independently reviewed the full texts of articles. A senior researcher resolved any conflicts or disagreements. From 9035 articles found by the database search, 2948 were removed due to being duplicates. After screening the full texts and removing irrelevant articles, 52 eligible studies were finally selected for the review. Figure 1 shows the flowchart of the study selection process.

The next step was to extract key information from the articles, including the first author's name, year of publication, study design, study area, measured climate change variables, measured health outcomes, and key findings. To summarize the results of the studies found, they were first categorized according to climate change impacts and health outcomes. Then, they were categorized according to the direct and indirect effects of climate change on health.

Results

Climate change, including temperature rise, precipitation changes, and monsoon flow changes, can directly and indirectly affect the physical and mental health of people. A summary of the most important findings of various studies related to the impact of climate change on public health is available in Appendix 1

Impact of climate change on physical health

Direct impact on morbidity

Climate changes can have a direct impact on the activity of human body systems. Direct impacts of climate change include the changes in pregnancy [28, 29], prevalence of preeclampsia [30], skin cancer [31, 32], and pterygium [33]. However, the results of a study in Kerman showed no clear association between the occurrence of congenital hypothyroidism and climatic factors [34]. More precipitation, higher temperatures, and less evaporation lead to fewer hospitalizations for asthma patients [35] and reduce the prevalence of exercise-induced asthma [36]. Other studies also showed a significant and direct association between the incidence of chronic rhinosinusitis [37] and severe acute respiratory syndrome (SARS) [38] and climatic factors such as temperature, precipitation and humidity. The results of Roshan et al. in Tabriz showed a direct and significant association between the increase of temperature and the admission rate of cardiovascular patients [39]. The studies conducted in Ahvaz and Sari cities also confirmed these findings [40, 41]. This indicates that there is a direct association between changes in temperature and precipitation and the increase in heart diseases in many areas of Iran. A study in Mashhad showed that humidity (positive correlation), temperature (positive correlation), wind speed (negative correlation) and particle matter (PM2.5) concentration (negative correlation) had a significant impact on the increase of the cardiovascular disease (CVD) cases [42].

Direct impact on mortality

The negative effects of heat waves on mortality were demonstrated in a study conducted in 8 Iranian cit-

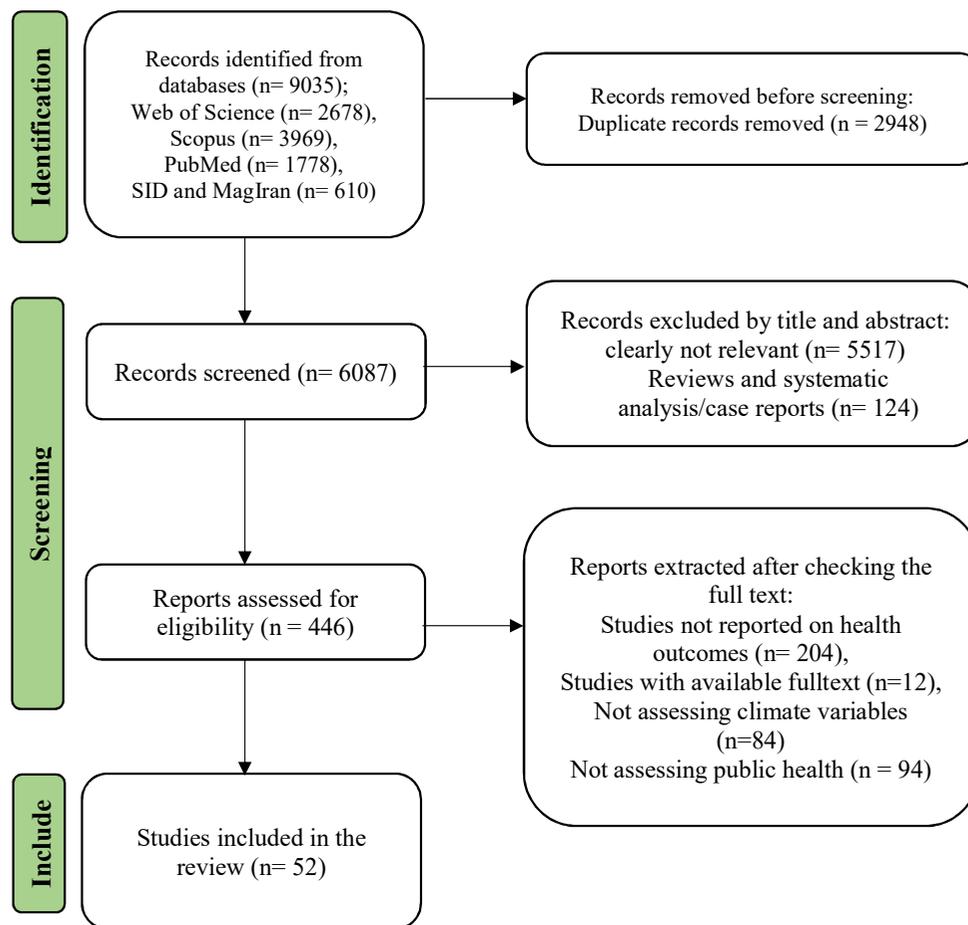


Figure 1. PRISMA flow diagram

ies [43]. Rising temperatures and heat waves can have detrimental effects on health and lead to deaths even in populations that have adapted to extreme heat [44]. The results of a study in Kerman also showed that men over age of 65 were at higher risk of death and had higher lost days of life due to temperature changes and heat waves [45]. In a study conducted by Ahmadnezhad et al. in Tehran, the results indicated an increase in mortality rate due to temperature fluctuations in the hot seasons after controlling confounding factors such as ozone and pollution [46]. On the other hand, the results of a study in Shiraz showed no significant association between temperature changes and deaths from CVDs [47]. Meanwhile, the results of a study conducted in Mashhad showed that a 1 °C increase in maximum temperature was associated with a 4.27% increase in the CVD mortality rate [48]. The results of another study in Mashhad also showed that the risk of mortality from respiratory diseases increased by 1.36 for every 10 °C decrease in temperature [49].

Indirect impact on pathogenic and infectious diseases

The indirect effects of climate change on human health can be seen in changes in the reproductive health and spread of insects such as malaria and human-associated pathogens such as cholera outbreaks [50] and dysentery [51], as well as in the spread of diseases. For example, the results of Abbasi et al. and Mohammadkhani et al. in southern Iran showed a significant relationship between the monthly density of *Anopheles stephensi* larvae and the amount of rainfall, humidity and temperature, which may lead to an increase in malaria cases [52, 53]. An increase in temperature may affect the seasonal changes of COVID-19 [54] and have a negative impact on the number of positive cases of COVID-19 [55] and the related death cases [56]. In addition, the results of a study showed that the decrease in wind speed, humidity and solar radiation led to the increase of infections caused by COVID-19 [57]. Ansari et al. also showed that climatic variables such as average temperature, rainfall, and maximum relative humidity were significantly associated

with the monthly incidence of CCHF in southeastern Iran [23]. Also, Faramarzi et al.'s study in Fars Province showed a direct and significant relationship between the incidence of malaria in humans and maximum relative humidity (+0.67) and rainfall (+0.48) [59]. In the study by Kanannejad et al., the geoclimatic factors including altitude, slope and rainfall were negatively associated with Malta fever [60]. Dadar et al. also indicated a significant negative relationship between average temperature and the incidence of brucellosis [61].

The effects of climate change, especially in tropical and subtropical regions, on Leishmaniasis had also been investigated in numerous studies. In a study in Fariman County, no significant relationship was found between climatic variables such as temperature, humidity, precipitation, and altitude and the incidence of leishmaniasis [62]. In Qom Province, a positive and relatively strong relationship was found between the incidence of cutaneous leishmaniasis (CL) and the temperature and hours of sunshine, while there was a negative correlation between the incidence of CL and soil moisture [63]. In Ardabil, a positive relationship was found between temperature and humidity and the prevalence of visceral leishmaniasis (VL) [64]. In Isfahan, Golestan, Lar, and Khuzestan cities, there was a positive relationship between the average temperature, relative humidity, and its slope with the incidence of CL and a negative relationship between the maximum wind speed, precipitation, altitude and vegetation with the incidence of CL [65-68]. In a study conducted in southwestern Iran, temperature and precipitation were the most effective climatic factors for VL [69]. On the other hand, contrary to expectations, the study by Soltan Dallal et al. on human salmonellosis, which is one of the most common causes of foodborne disease outbreaks in developing countries, found no significant relationship between average monthly temperature, rainfall, or humidity and the incidence rate of salmonellosis [70].

Impact of climate change on mental health

The impact of climate change on mental health is still not clearly understood. According to recent studies in Iran, changes in weather conditions, specifically air temperature, precipitation, clouds, and solar radiation, have adverse effects on people's mental health. These effects include mood swings, depression, increased tendency to immigrate, anger, frustration, conflicts, decreased compassion [71, 72]. The findings from the study by Mirzakhani and Poursafa revealed a higher prevalence of depression in regions of Iran with cold and rainy weather [73]. Another study in Hamadan indicated the significant positive association of dusty, rainy, snowy, foggy,

or cloudy days or days with weather conditions causing a visibility below 2 km, with hospital admissions due to causing depression, schizophrenia, and schizoaffective disorder. Moreover, air pressure had a negative impact on hospital admissions for patients with schizophrenia while admissions of bipolar patients exhibited a negative correlation with rainy days and a positive correlation with dusty and cloudy days [74].

Discussion

The purpose of this study was to systematically review the studies on the impact of climate change on the public health of Iranian people. This study delved into the direct and indirect consequences of climate change on physical and mental health. The review of studies revealed a broad range of adverse effects on various health indicators due to changes in climatic parameters [14, 24, 39]. These effects exhibited complex and non-linear patterns when interact with each other. Moreover, contradictory associations between weather effects and the health outcomes were reported.

Numerous scientific reported the direct and indirect impacts of climate change on the occurrence or severity of various diseases. Rising temperature and changes in precipitation and humidity can disrupt the physiological mechanisms which can increase the risk of contracting a wide range of diseases, including cancer, infectious and inflammatory diseases, and psychological disorders. Substantial evidence suggests that the increase in temperature and humidity can increase the risk of premature birth and preeclampsia by subjecting pregnant women to heat stress. Therefore, there is a need for prenatal care during climate change. Changes in sunlight patterns as well as prolonged and intensified exposure to ultraviolet rays due to global warming, seem to contribute to the rising incidence of skin and ocular cancers. Additionally, elevated temperature and humidity can heighten the chemical reactions in the atmosphere, leading to increased concentrations of hazardous air pollutants. This, in turn, can exacerbate conditions such as asthma, chronic respiratory disease, CVDs, and various forms of cancer [31, 32]. Hence, it is anticipated that the ongoing trajectory of climate change will result in a greater prevalence and onset of infectious diseases, respiratory diseases, CVDs, cancers, and psychological disorders in the future.

Studies have shown that the decrease in wind speed and air exchange rate due to climate change causes an increase in the concentration of suspended particles and pollutants such as ozone, carbon monoxide, nitrogen dioxide in the air. On the other hand, more stability of

the atmospheric conditions due to the decrease in wind speed brings longer periods of dust and the occurrence of phenomena such as temperature inversion, which results in an increase in the concentration of PM_{2.5} and PM₁₀ suspended particles in the air [42, 75]. The increase in the concentration of air pollutants can aggravate the symptoms and complications of respiratory diseases such as asthma, chronic obstructive pulmonary disease, and pneumonia, due to their direct effect on the lungs and the respiratory system [42]. In addition, the risk of heart attack in people with CVDs increases with the increase in air pollution.

Temperature and humidity, as two important climatic factors, play a decisive role in the population patterns and geographical distribution of some insects that carry vector-borne diseases such as malaria and leishmaniasis. For example, some mosquitos called *A. stephensi*, which is the main carrier of *Plasmodium falciparum* [the cause of malaria], has the highest growth and reproduction rates at temperatures of 20-30 °C and humidity rates of 50-80% [52, 53]. Therefore, due to the increase in temperature and humidity in some areas, there is a possibility of the increase in the population of these mosquitos and, thus, the increase in the incidence of malaria.

The proliferation and transmission of infectious disease agents (e.g. dysentery) and water-borne diseases (e.g. cholera) are closely linked to variations in temperature and humidity levels [22, 50]. The risk of Salmonella infection increases by 5-10% with every 1 °C increase in temperature [76]. Studies indicated that climate change affects precipitation patterns, sea level, and environmental factors such as surface water temperature, influencing the survival, reproduction, and transmission of waterborne pathogens that consequently endanger human health [77]. It is crucial to investigate the impact of climate change on disease transmission patterns to effectively predict and manage diseases. Numerous studies have shown that higher temperature and humidity caused by climate change can lead to increased survival and spread of viruses, bacteria, fungi, and parasites [14, 54, 57]. Additionally, the recent outbreak of the COVID-19 revealed the connection between climate variations and disease transmission, severity, and incidence [14]. Decreased wind speed and humidity level, along with increased temperature, heighten the risk of contraction and death from such diseases.

Climate change and the occurrence of disasters such as storms, floods and droughts can cause or intensify the stress and anxiety of people [71, 72]. The continuation of climate change and the uncertainty about the future can

cause a psychological stress in people, which can lead to the emergence or exacerbation of psychological disorders such as depression, anxiety, panic attacks, and even suicidal ideation in people who are more psychologically vulnerable [72, 74]. However, the severity of these psychological effects depends on the underlying psychological conditions of people, the amount of social support for them, and coping mechanisms [26]. In addition, climate change can increase the risk of alcohol and drug addictions due to exposure to stressful conditions [24]. People who are exposed to severe and long-term stress may turn to alcohol and drugs to escape from pressure. These high-risk behaviors, in turn, can cause other individual and social problems. Therefore, preventive measures for the mental health of people against the effects of climate change are of particular importance, and health officials should develop and implement educational programs to teach coping skills and provide psychological support to the at-risk people. Positive psychology and psychosocial support can also be effective in reducing mental health problems caused by climate change. Investigating solutions to increase public awareness of the dangers of climate change on health is also necessary. It is also possible to improve the knowledge, attitude, and skills of people regarding how to deal with climate change impacts through the mass media and social networks, or in educational and cultural institutions by using innovative methods such as games and animations.

Despite the existence of studies in the field of the relationship between climate change and human health, there is still a need for more and deeper research in this field for determining the exact effects of climate change on the occurrence and spread of various diseases and disorders, identifying vulnerable groups, examining the effectiveness of various preventive measures, and estimating the economic costs caused by this phenomenon. In addition, the association between some parameters of climate change, such as temperature, and some adverse outcomes, such as hospital admission due to psychiatric reasons, suicide, or exacerbation of previous mental health conditions, has received less attention [78]. In this regard, the future studies should examine the relationship between weather patterns and the incidence or severity of CVDs, respiratory diseases, neurological diseases, psychological disorders, and skin diseases. Also, investigating the impact of climate change on water-borne and food-borne diseases that are transmitted by insects is needed. In addition, it is very important to study the effects of climate change on the health of pregnant mothers and infants and identify and prevent possible complications for them. In addition, future studies can focus on determining the possible differences in the degree

of vulnerability to climate change in different groups and subgroups in society, such as low-income families, homeless people, and outdoor workers. People who are more vulnerable due to specific physical characteristics, age, gender, race, place of residence, and socio-economic conditions, should be given special attention because the amount and type of vulnerability to warm weather, cold weather, air pollution, insect-borne diseases may vary. Future studies can also investigate regional differences because the effects of climate change is not completely the same in different regions. Comparative studies on the experiences of successful countries in the field of managing health-related consequences of climate change and adapting appropriate solutions for their application in Iran can help identify and implement effective solutions based on the characteristics of each region. Accordingly, for targeted and integrated responses to the health-related consequences of climate change at the national and regional levels, there is a need for special attention, large investments, and long-term planning for preventing humanitarian and health-related crises in the future.

This systematic review had some limitations such the lack of data and statistics on the prevalence of certain diseases and different methodologies of studies. Despite these limitations, this review study offers valuable information.

Conclusion

Climate change has negative effects on Iranian people's physical and mental health. The direct effects of climate change include the increase in the incidence of infectious diseases, CVDs, respiratory diseases, changes in women's pregnancy patterns, and the prevalence of preeclampsia, skin cancer, pterygoid disease, congenital hypothyroidism, and mortality. The indirect effects of climate change include changes in the reproduction pattern and the spread of insect-borne and human diseases such as malaria, brucellosis, leishmaniasis, human salmonellosis, cholera, dysentery, CCHF, and COVID-19. The impact of climate change on mental health of people include increased mood swings, depression, schizophrenia and schizoaffective disorder, and bipolar disease. The impact of climate change on public health varies depending on geographical and demographic factors. The climate change and its consequences for the health of people will be one of the biggest challenges facing health policymakers and planners in Iran in the coming years. Therefore, it is necessary to develop and implement national strategies and plans with interdisciplinary approaches to prevent and deal with this phenomenon.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of [Ardabil University of medical sciences](#) (Code: IR.ARUMS.REC.1402.153).

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

The authors declared no conflict of interest.

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Appendix 1. General characteristics of the articles studied on climatic variables and public health in Iran, which were eligible for review

Authors and Year of Publication	Study Area	Title	Study Design	Bioclimatic Variables	Findings
Rezaee et al. 2023 [43]	Iran	Summer heat waves and their mortality risk over a 14-year period in a western region of Iran	Time series analysis	Temperature	Heat waves caused a considerable increase in mortality in all cities and in the second period. The subgroup analysis revealed that the significant impact in the second period was mainly related to females and elderlies.
Maleki et al. 2023 [54]	Iran	Seasonal variation of COVID-19 incidence and role of land surface and air temperatures: A case study in the west of Iran	Ecological and modeling study	Temperature	The result showed that temperature might change the seasonal variation of COVID-19.
Kanannejad et al. 2023 [35]	Iran, Fars Province	Geo-climatic variability and adult asthma hospitalization in Fars, Southwest Iran	Analytical descriptive study	Temperature, rainfall, humidity, evaporation, number of rainy and frosty days, slope, and land covers	Urban setting and mean annual rainy days were identified as the factors associated with increased asthma hospitalization, while mean annual temperature, mean annual temperature maximum, mean annual evaporation, and slope negatively affected asthma hospitalization. The major risk zones for adulthood acute asthma in southwest Iran were urban settings and areas with higher numbers of rainy days, lower temperatures, and evaporation at lower slopes.
Kalankesh et al. 2023 [56]	Iran, Tehran	Association meteorological factors with Covid-19 mortality in Tehran, Iran (2020-2021)	Analytical descriptive study	Temperature, humidity, wind speed and pressure	Hospitalization cases were positively associated with temperature and pressure, while being negatively associated with wind speed and humidity during the spring and autumn seasons. Conversely, mortality was associated with wind speed and pressure during winter and spring, respectively. Moreover, temperature was associated with mortality in both spring and winter.
Ghatee et al. 2023 [37]	Iran	Geo-climatic risk factors for chronic rhinosinusitis in southwest Iran	Analytical descriptive study	Temperature, humidity, rainfall, evaporation, wind, elevation, slope and land	There were significant correlation among chronic rhinosinusitis occurrence and climatic factors including mean annual temperature, mean annual rainfall, and mean annual humidity.
Aghababaeian et al. 2023 [44]	Iran, Dezful	Mortality risk related to heatwaves in Dezful City, southwest of Iran	Ecological and modeling study	Temperature	The results showed that heat waves could have detrimental effects on health, even in populations accustomed to the extreme heat. Heatwaves raised the risk of death from cardiovascular causes and lowered the risk from respiratory causes.
Saraei et al. 2023 [58]	Iran	Relationship of meteorological variable and cerebrovascular events: An ecological time series study	Time series analysis	Temperature, humidity	The results showed that hot and cold temperatures are associated with stroke admission, and low humidity increases the risk of intracranial hemorrhage.

Authors and Year of Publication	Study Area	Title	Study Design	Bioclimatic Variables	Findings
Roshan et al. 2022 [39]	Iran, Tabriz	Predicting climate change impact on hospitalizations of cardiovascular patients in Tabriz	Analytical descriptive study	Temperature	Global warming can cause an increase in the number of CVD patients per year.
Dastoorpoor et al. 2022 [40]	Iran, Ahvaz	Physiological equivalent temperature index and cardiovascular hospital admissions in Ahvaz, southwest of Iran	Analytical descriptive study	Temperature	Both cold and heat stress are involved in hospital admissions for CVDs
Khodadadi et al. 2022 [28]	Iran, Ahvaz	Universal thermal climate index (UTCI) and adverse pregnancy outcomes in Ahvaz, Iran	Analytical descriptive study	Temperature	The results showed that the low values of UTCI (11.6 °C, in lags 0-6, 0-13) caused significant increase in the risk of preterm labor. However, hot thermal stress (high UTCI) significantly increased the risk of stillbirth in lag 0-13.
Bahrami et al. 2022 [38]	Iran, Ahvaz	Climate change and respiratory diseases: Relationship between SARS and climatic parameters and impact of climate change on the geographical distribution of SARS in Iran	Retrospective cohort study	All climate variables	There was a significant relationship between SARS and the climatic variables based on the type of climate and gender. The risk of SARS increased in women and men with the increase of daily rainfall.
Jamshidnezhad et al. 2022 [55]	Iran,	The role of ambient parameters on transmission rates of the COVID-19 outbreak: A machine learning model	Machine learning-based analysis	Temperature	With increasing outdoor temperature, the use of air conditioning systems to set a comfort zone temperature was unavoidable. Thus, the number of positive cases of COVID-19 increased.
Javanbakht et al. 2021 [63]	Iran, Qom	Identification of climatic and environmental factors associated with incidence of CL in central Iran using satellite imagery	Analytical descriptive study	Land Surface Temperature (LST) and soil moisture	The results showed that the correlation with the three-month time delay was positive and relatively strong between the CL incidence and LST and sunny hours; nevertheless, there were negative correlations between the CL incidence and the soil moisture and NDVI
Dastorani et al. 2021 [32]	Iran, Ardabil	Monitoring and analyzing of the relationship between climatic elements and skin cancer in 2012-2014	Descriptive correlational study	Frost, sunny hours, minimum mean humidity, maximum absolute temperature	There was the highest correlation (more than 95%) between skin cancer in three cities of Parsabad, Khalkhal, and Ardabil and the climatic parameter related to minimum absolute temperature. However, in Khalkhal station, sunny hours had the highest correlation and the lowest correlation with glacial climate parameter in all four cities. The factors of sunny hours and maximum temperature had an effect on the incidence of skin cancer, and the minimum absolute temperature exacerbated skin cancer
Mazloomi Mahmoodabad et al. [62]	Iran, Fari-man, 2021	Study of ecological factors associated with leishmaniosis in Fariman Township during 2006-2018	Analytical descriptive study	Temperature, humidity, precipitation	There was no significant relationship between climatic variables (temperature, humidity, precipitation), climatic factor of height with leishmaniosis.

Authors and Year of Publication	Study Area	Title	Study Design	Bioclimatic Variables	Findings
Hamta et al. 2021 [64]	Iran, Meshkinshah, Ardabil	The Granger causality analysis of the impact of climatic factors on VL in northwestern Iran in 1995–2019	Longitudinal study	Temperature, humidity, rainfall, the number of frost and warm days in the year	The results of analysis showed that some climatic variables including daily mean temperature, absolute minimum temperature, maximum and minimum temperature and maximum humidity were the main factors affecting the prevalence of VL in northwestern Iran.
Salahi & Nohega 2021 [31]	Iran, Ardabil	Analysis of the relationship between climatic elements and skin cancer in Ardabil Province	Analytical descriptive study using climatic models	Frost, sunshine hours, mean humidity, temperature	The results showed that the correlation between climate variables and skin cancer in the studied stations was relatively significant and the incidence of skin cancer in the warmer half of the year was more than the cold half of the year.
Sharif Nia et al. 2021 [41]	Iran, Mazandaran	A time-series prediction model of acute myocardial infarction in northern of Iran: The risk of climate change and religious mourning	Time series analysis	Temperature, sunshine, and rain	Results demonstrated that sunshine hours and the average temperature had a significant effect on the risk of acute myocardial infarction
Abbasi, 2021 [71]	Western Iran	The effect of climate change on depression in urban areas of western Iran	Time series analysis	All climate variables	Rapid climate changes in western Iran including rising air temperature, changes in precipitation, its regime, changes cloudiness and the amount of sunlight have a negative effect on health. The results showed that type of increasing or decreasing trend, as well as different climatic elements in various seasons did not have the same effect on the rate of depression in the studied areas.
Abbasi et al. 2020 [52]	Southern Iran	The impact of climatic variables on the population dynamics of the main malaria vector, <i>A. stephensi</i> Liston (Diptera: Culicidae), in southern Iran	Analytical descriptive study using climatic models	Temperature, rainfall and humidity	A significant relationship was found between monthly density of adult and larvae of <i>A. stephensi</i> and precipitation, max temperature and mean temperature, both with simple and multiple generalized estimating equations analysis
Sajjadi et al. 2020 [16]	Iran	Impact of climate change on health in different climate of Iran	Retrospective cohort study	Maximum temperature, minimum temperature, daily rainfall	The average monthly maximum temperature and rainy days had the highest correlation with the incidence of dysentery in men and women. Also, there was a significant correlation between climate and dysentery in children and older adults over 65 years of age
Manocheh-reneya et al. 2020 [42]	Iran, Mashhad	A time series approach to estimate the association between health effects, climate factors and air pollution, Mashhad, Iran	Time series study	Temperature, pressure, relative humidity, wind speed, and rainfall	The monthly survey of mortality rate due to CVDs exhibited significant correlation with pressure (positive correlation), temperature (negative correlation), and rainfall (negative correlation). There was a significant difference between the numbers of patients experiencing CVDs in different seasons with the highest number (n=3778) recorded in autumn

Authors and Year of Publication	Study Area	Title	Study Design	Bioclimatic Variables	Findings
Soltan Dallal et al. 2020 [70]	Iran, Yazd	Associations between climatic parameters and the human salmonellosis in Yazd Province, Iran	Long-term temporal trend study	Temperature, rainfall and humidity	No significant associations were found between the average monthly temperature, rainfall or humidity and the incidence rate of salmonellosis.
Ahmadi et al. 2020 [57]	Iran, Yazd	Investigation of effective climatology parameters on COVID-19 outbreak in Iran	Analytical descriptive study	Average temperature, average precipitation, humidity, wind speed, and average solar radiation	Regions with low values of wind speed, humidity, and solar radiation exposure, had a high rate of infection
Dadar et al. 2020 [61]	Iran	A primary investigation of the relation between the incidence of brucellosis and climatic factors in Iran	Analytical descriptive study	All climate variables	The results revealed a negative significant association between mean ambient air temperature and brucellosis incidence. Also, a positive significant association was found between number of frosty days and brucellosis incidence
Bahrami et al. 2020 [51]	Iran	The relationship between dysentery and climatic parameters in Iran	retrospective cohort study	All climate variables	The findings suggested that the average monthly maximum temperature and the number of rainy days are significantly correlated with the risk of dysentery in both genders; for instance, increases were observed in the risk of dysentery in women and men in the arid-cold climate with an increase in rainfall, and also in women and men in the semi-arid cold climate with an increase in the average monthly maximum temperature.
Aboubakri et al. 2019 [45]	Iran, Kerman	The impact of heat waves on mortality and years of life lost in a dry region of Iran (Kerman) during 2005–2017	Analytical descriptive study using climatic models	Temperature	The results showed that men over 65 years of age were the most vulnerable group and had the highest mortality and lost days of life related to temperature changes and heat waves.
Kavianpoor et al. 2019 [72]	Iran, Mazandaran	Climate change impact on quality-of-life indicators of pastoralists (case study: Rangelands of Haraz River Basin, Mazandaran Province, Iran)	Analytical descriptive study	All climate variables	Pastoralists' perceptions of climate change impact on the quality of life indicators differed significantly in terms of increased migration, anger, frustration, conflicts with other pastoralists, decreased sympathy, reduced sense of responsibility, reduced participation in the range management actions, reduced effective participation in the improvement measures, increased distance between livestock pen and water resources, reduced food intake regardless of health and management of livestock diseases, and loss of social cohesion.
Mohammadkhani et al. 2019 [53]	Iran, Sistan and Baluchestan	The Relation Between Climatic Factors and Malaria Incidence in Sistan and Baluchestan, Iran	Analytical descriptive study	Temperature, humidity, and rainfall	The incidence of malaria had a significant positive correlation with the average, minimum, and maximum monthly temperatures and a negative correlation with rainfall and low humidity (<60%).

Authors and Year of Publication	Study Area	Title	Study Design	Bioclimatic Variables	Findings
Faramarzi et al. 2019 [59]	Iran, Fars	Potential effects of climatic parameters on human brucellosis in Fars Province, Iran, during 2009-2015	Analytical descriptive study	Temperature, humidity, and evaporation	There was significant indirect correlation between the incidence of human brucellosis (with a time lag of up to 5 months) and climatic parameters (minimum temperature: -0.72 and evaporation: -0.73). Moreover, there was a significant direct correlation between the incidence of human brucellosis and the maximum relative humidity (+0.67) and rainfall (+0.48).
Kanannejad et al. 2019 [60]	Southwest Iran	Effect of human, livestock population, climatic and environmental factors on the distribution of brucellosis in southwest Iran	Analytical descriptive study	Slope, elevation, land cover, mean annual rainfall, and temperature	Geo-climatic factors of elevation, slope and rainfall were negatively associated with brucellosis
Dadbakhsh et al. 2018 [47]	Iran, Shiraz	The relation between mortality from CVDs and temperature in Shiraz, Iran, 2006-2012	Ecological study	Temperature	There was no significant relationship between temperature and CVD-related deaths, which is probably due to its moderate climate, and the fact that no major heat or cold wave occurred during the study
Tapak et al. 2018 [74]	Iran, Hamadan	Investigating the effect of climatic parameters on mental disorder admissions	Analytical descriptive study	Monthly number of dusty/rainy/snowy/foggy days, cloudiness (Okta), horizontal visibility, and barometric pressure (millibar)	The number of dusty/rainy/snowy/foggy days, cloudiness, and the number of days with vision less than 2 km had a significant positive relationship with admissions due to schizophrenia. Barometric pressure had a negative effect on admissions for schizophrenia. The number of dusty/rainy/snowy/foggy days and cloudiness had a significant effect on admissions for schizoaffective disorders. Admissions for bipolar disorder were negatively associated with rainy days and positively associated with dusty days and cloudiness. The number of rainy/dusty/snowy days and cloudiness had a positive significant effect on admissions for major depressive disorder
Ramezankhani et al. 2018 [65]	Iran, Isfahan	Climate and environmental factors affecting the incidence of CL in Isfahan, Iran	Analytical descriptive study using climatic models	Temperature, relative humidity, slope, wind speed, rainfall and altitude	There was a positive relationship between mean temperature, relative humidity, and slope of area with disease incidence; however, negative association was demonstrated between maximum wind speed, rainfall, altitude, and vegetation cover with CL incidence
Azimi et al. 2017 [66]	Iran, Khuzestan	Impact of climate change on the occurrence of CL in Khuzestan Province, southwestern Iran	Analytical descriptive	Temperature, humidity, rainfall, sunshine hours, evaporation and wind	The number of rainy days, maximum and minimum temperatures and relative humidity were significant predictors of CL incidence.
Baaghdeh & Mayvaneh, 2017 [48]	Iran, Mashhad	Climate Change and simulation of CVD mortality: A case study of Mashhad, Iran	Analytical descriptive study using climatic models	Temperature	The results showed that by increasing temperature and the number of hot days, the CVD-related mortality increased which is likely to be intensified in the future decades.

Authors and Year of Publication	Study Area	Title	Study Design	Bioclimatic Variables	Findings
Ataei & Heidari, 2017 [79]	Iran, Ahvaz	Investigating the effect of climate change and dust on respiratory diseases (case study: Ahvaz City)	Time series analysis	Rainfall and temperature	With 55% increase in temperature and 82% in dust and 90% in precipitation, the rate of respiratory disease increased by 85% in January compared to September. In the years when it was infectious, the incidence of respiratory disease was lower, while in dry years when the air temperature increased, the incidence of respiratory disease increased.
Khanjani et al. 2017 [34]	Iran, Kerman	The role of season and climate in the incidence of congenital hypothyroidism in Kerman Province, Southeastern Iran	Analytical descriptive study	All climate variables	There was a significant but weak correlation between some climatic factors and the incidence of congenital hypothyroidism in some regions of Kerman. The congenital hypothyroidism incidence was higher in October (Autumn) and lower in June (Summer).
Fallah Ghalhari et al. 2016 [49]	Iran, Mashhad	Effect of air temperature and universal thermal climate index on respiratory diseases mortality in Mashhad, Iran	Analytical-descriptive study using climatic models	Temperature, wind speed and relative humidity	The study of the mortality risk ratio in all thermal stress thresholds showed that cold stress and a 10 °C reduction, increased mortality risk ratio by 1.36%
Marefati et al. 2016 [34]	Iran, Kerman, Gorgan	The effect of climatic conditions on exercise-induced bronchoconstriction in students aged 10–12 years	Analytical descriptive study	All climate variables	The results showed that prevalence of both asthma and exercise-induced asthma in Kerman with dry and cool climate was higher than in Gorgan with humid climate
Shirzadi et al. 2015 [67]	Iran, Golestan	Dynamic Relations Of Zoonotic CL and climatic factors in Golestan Province, Iran	Analytical-descriptive study using climatic models	Temperature, relative humidity, evaporation, total rainfall, and number of freezing and rainy days	The results of analysis indicated that minimum temperature, mean humidity, and rainfall had significant effect on zoonotic CL incidence.
Entezari et al. 2014 [68]	Iran, Larestan	Relationship between climatic factors and the prevalence of CL in Larestan City	Analytical descriptive study	Rainfall, temperature, relative humidity and sunshine hours	Climatic parameters of rainfall and relative humidity had inverse correlation with the prevalence of CL. However, temperature and sunshine hours showed a direct relationship with the prevalence of CL.
Nasiri et al. 2014 [30]	Northeast of Iran	Association of meteorological factors and seasonality with preeclampsia: A 5-year study in northeast of Iran	Retrospective analysis	Humidity and temperature	Seasonal (monthly) variations of the weather (humidity and temperature) had a significant effect on preeclampsia prevalence.
Ansari et al. 2014 [23]	Southeast of Iran	CCHF and its relationship with climate factors in southeast Iran: A 13-year experience	Time series study	All climate variables	Climate variables including mean temperature, accumulated rainfall, and maximum relative humidity were significantly correlated with monthly incidence of CCHF (P<0.05).
Shabani et al. 2014 [29]	North of Iran	A comparative study about the influences of climatic factors on fertility rate among the healthy and infertile women in the north of Iran	Analytical correlational study	Rainfall, temperature and air pressure	Results indicated that climatic factors such as temperature, air pressure, and rainfall had a significant relationship with healthy women' fertility rate, this relationship was not found in infertile women.

Authors and Year of Publication	Study Area	Title	Study Design	Bioclimatic Variables	Findings
Mirzakhani & Poursafa, 2013 [73]	Iran	The association between depression and climatic conditions in Iran	Analytical descriptive study using climatic models	All climate variables	The results demonstrated that depression was more prevalent in the parts of the country with cold and rainy weather
Ghatee et al. 2013 [69]	Southwestern Iran	Spatial correlations of population and ecological factors with distribution of VL cases in southwestern Iran	Analytical descriptive study	Rainfall, temperature, elevation, slope and landcover	Temperature was the most effective variable followed by rainfall and altitude
Ahmadnezhad et al. 2013 [46]	Iran, Tehran	Excess mortality during heat waves, Tehran Iran: An ecological timeseries study	Ecological study based on time-series model	Temperature	The result showed excess mortality resulted from hot temperatures which exacerbated with air pollutants in Tehran in the context of climate change. Forward displacement mortality and lagged mortalities were also seen, but the results were not conclusive about the displacement pattern of mortalities.
Validad et al. 2013 [33]	Iran, Mashhad, Zahedan	The relationship of climate factors and pterygium disease; comparative study of the cities of Mashhad and Zahedan, Iran	Descriptive-analytical study	Sunshine hours, dusty days, wind speed, ultraviolet and total sunshine index, maximum and minimum temperature, and humidity	In Zahedan, dusty days, sunshine hours, wind speed indicator, and ultraviolet and total sunshine indexes had the highest effect on the prevalence of pterygium. In Mashhad, wind speed, dusty days, and ultraviolet index were the most effective factors
Shabani & Ezzatian, 2012 [80]	Iran, Isfahan	Relationship between diseases with climatic elements and atmospheric pollutants in Isfahan Province	Descriptive-analytical study	Temperature, pressure and humidity	The results showed a significant correlation between climatic variables such as temperature, pressure and humidity and the prevalence of cardiovascular and pulmonary diseases, and ocular and skin cancers
Tavana, 2006 [50]	Iran	Is Cholera outbreak related to climate factors? Report of seven-year study from 21 st March 1998 to 21 st March 2004 in Iran	Time series analysis	Temperature, humidity and rainfall	Cholera outbreaks could be related with many climate factors. With decreasing or increasing from minimum or maximum range of temperature, the outbreak was dropped sharply and the humidity of 50% prepared the best condition for the outbreak. However, the rainfall above 294 mm in the rain seasons and high temperature above 49.6 °C in hot seasons were the major factors related to cholera outbreak.