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THE EFFECTS OF CLIMATE CHANGE ON HUMAN HEALTH

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ABSTRACT

Today, the change of the climate in the world affects the atmosphere, the world itself and all living things on it. Among the most important environmental and economic problems of our time, climate change, which is at the forefront, has become an extremely complex and vital problem that has negative effects on every aspect of life, especially in the geographical area where we live. Humans are directly exposed to sudden changes in temperature, humidity, the effects of sea level and sudden changes in severe weather events due to climate change and are indirectly affected by changes in water quality, food quality, ecosystem, agriculture, industry, settlements and economy. Climate change not only affects ecosystems, social and economic life and land use, but also directly and/or indirectly influences human health. This also brings risks such as different kinds of illnesses and diseases, epidemic diseases that can occur suddenly and exposure to extreme hot weather waves. Deaths due to warm waves, cancers, cardiovascular diseases, respiratory and circulatory system diseases, food-water illnesses-vector illnesses, infectious diseases, mental health and social wellness issues, nutrition and vulnerable community influences are some of the health problems that arise as a result of climate change.

Key Words: Global Climate Change, Health, Health Effects

INTRODUCTION

From the beginning of the 19th century, industrialization process has speedily grown, and due to this fact, rapid changes have brought about in both positive and negative processes that changed the life of mankind. At the beginning of these processes, the most important factor to be shown as negative is the increase in environmental pollution. The health problems caused by environmental pollution, which threaten people and other living things, are the most important problems to be solved (1).
Many human activities as a result of social life cause people to be influential on the earth. Although the most harmful factor to nature is the human being, the most affected and influenced by these harmful consequences is again the human. Climate change, one of the most important components of global change, directly or indirectly activates other components and determines the impact of global change on humans. Studies about the negative effects of climate on human health are increasing day by day (2).
The climate of the world is changing and this change fairly affects the atmosphere, the Earth and all living things that live on it in a negative way. The change of the Earth's climate is not equally violent all over the world, likewise, it has not the same effects on every individual. Climate change is an extremely complex and vital concern that creates adverse effects in all areas of life; from health to agriculture especially in the geographical area where we live. Humans are directly exposed to sudden changes in temperature, humidity, sea level and sudden changes in severe weather events due to climate change and are indirectly affected by changes in water quality, food quality, ecosystem, agriculture, industry, settlements, and economy (1).
Climate change has been described by the President of the World Health Organization as the most important public health problem of the 21st century. On the other hand, scientific evidences, showing the negative effects of climate change feeling in Turkey, have increased. Human health, which is one of the factors highly influenced by climate change, is threatened especially in the Mediterranean region due to hot weather fluctuations and water stress (2).

Climate change and its effects

Climate change is defined as "the changes in the average and/or variability of the climate, regardless of its cause, over a period of several decades or more". Global climate change shows increase in the avarage surface temperatures of the Earth and changes in the climate resulting from the reinforcement of natural greenhouse effect due to rapid increase of greenhouse gas accumulation (H2O, CO2, CH4, O3, N2O, CFC-11, HFC, PFC, SF6) released by the atmosphere through human activities such as the use of fossil fuels, land use changes, deforestation and industrial activities. In addition, the United Nations Framework Convention on Climate Change (UNFCCC) defines climate change as "a change in the climate as a result of human activities directly or indirectly distorting the composition of the global atmosphere in addition to the natural climate change observed in a comparable period of time" (1).
According to the Fifth Assessment Report (AR5) of the International Climate Change Panel (ICCP), climate change has already begun: “The warming of the climate system is a definite finding, and most of the changes observed in the decades from the 1950s to the new millennium have never been seen before. The atmosphere and the oceans have warmed, the amount of snow and ice has decreased, the sea level has risen and the greenhouse gas concentrations have increased." The most advanced climate models predict a 1.5 to 4.5°C change in mean surface temperatures (high probability) in the world in a specific period; between the years of 1990-2100 (1, 2, 24).
Climate change is the leading one of the biggest problems that humanity faces in the 21st century. The climate change, which has been regarded as a problem that could lead to very serious socio-economic consequences due to the negative effects that could pose a threat to human health, ecosystems or even the sustainability of the human race, has started to be at the top of international agenda especially in recent years. It is predicted that a rise in temperature above 2°C in comparison with the period before industrialization, will cause a critical temperature increase in terms of irremediable changes on the Earth's climate and ecosystem.
Among the effects of climate change, decreases of freshwater resources, general changes in food production conditions, floods, storms, temperature fluctuations and increases in death due to drought can be mentioned (1).

The effects of climate change on health

In addition to the great facilities provided by modernization, there are many negative aspects as well. Modern life contributes positively to our health through the improvements in diagnoses and treatment methods, but on the other hand, it also endangers our health because of its negative aspects.

Many organizations such as the World Health Organization (3), the European Respiratory Society (ERS) (4), the European Allergy and Clinical Immunology Academy (EACIA) (5), the American Thoracic Society (ATS) (6) and the TGNA (7) draw attention towards the effects of climate change on health. It is predicted that the effects climate change on human health will become evident in the next 5-50 years (8).

Climate change and its effects negatively influence the fulfilment of the requirements for a healthy life. Clean air, potable water, adequate nutrition and healthy life requirements are mentioned among these requirements. The diminished accessibility or the complete absence of these requirements which ensure the provision of healthy living have a direct or indirect influence on the health of the human beings. Each year, lots of people lose their lives as a result of the reasons related to climate change; approximately 1.2 million people die because of urban air pollution, 2.2 million people because of diarrhea resulting from inadequate access to clean water sources and inadequate hygiene; 3.5 million people because of malnutrition and 60,000 people because of natural disasters (1).

Possible health effects due to climate change can be shown as outlined in Table 1 (9).

Table 1. Possible effects of global climate change on human health (9)

Weather Event	Influence on Health	Most Affected Sections
Hot waves	Thermal stress	People with respiratory disease, athletes, infants, children and the elderly
Unusual weather events; Rain, storm, hurricane, flood	Injuries, drowning	People living in lowlands, coasts, and people with low income
Drought, flood, average temperature increase	Foodborne (food and water) diseases	A large part of society
Sea level rise	Injuries, drowning, salinization of water and soil, ecological and economic deterioration	People living in coasts, and people with low income
Drought, ecosystem migration	Food and water shortages, malnutrition	People at low income levels, elders and children
Extreme weather events, drought	Mass population movements, international conflicts	All of the community
Increased ozone in ground-level, increase in the amount of airborne allergen and other contaminants	Increase in respiratory diseases (COPD, asthma, allergic rhinitis, bronchitis)	Elders, children, those with respiratory disease
Climate change in general; Extraordinary events	Mental health	Teenagers, homeless people, people working in agricultural activities, and people at low income level

The effects of climate change on human health are now becoming noticeable. The effects that have been noticed and anticipated so far are cancers, cardiovascular and respiratory illnesses, food-water illnesses, temperature-related illnesses, mental health and social wellness problems, nutrition problems in vulnerable communities. Many findings indicate that these health issues will particularly affect the poor, elderly and children, particularly in Africa and Southeast Asia (8).

Health effects of hot and cold air

Recently, hot days, hot nights and heatwaves are seen more frequently than in the past. Temperature fluctuations lead to an increase in the number of deaths in short term. The condition of air like being too cold, too hot, too humid or too dry affects human health negatively. Having exposure to extreme temperatures can cause physiological stress, illness and even death (11).

Surveys show that the number of deaths due to hot air depends on the temperature level and the health status of the exposed people (1). In addition, deaths due to hot weather are also dependent on the intensity and frequency of temperature. When the body temperature reaches 39°C degree, the body shows signs of salt and water loss and deaths may occur when the body temperature reaches 40.6°C degree (12).

Due to the increase in the frequency of heat waves depending upon global climate change, warmer summers and warmer winters are expected. Although not so many variabilities are observed within the season, the increase in average temperatures will increase the number of heat waves in summer months and reduce the cold waves observed in the winter months. For instance, the extreme heat wave observed in the UK in 1976 is thought to be related with global climate change. The hot summers, seen once in every 310 years formerly, are now seen every 5-6 years and this situation indicate that the air will warm up fairly towards the 2050s (13).

Hot air waves trigger cardiovascular, cerebrovascular and respiratory deaths. The heat wave in 2003, which reached temperatures above 35°C degree, caused more than 40,000 deaths across Europe. The elderly population, especially those with cardiovascular, cerebrovascular and respiratory diseases, are seriously affected by the increase in temperature. Again, in the summer of 2003, those aged over 65 in Italy had higher risk of respiratory illness and 34% higher risk of death on hot days. Analyzes made in England indicate that most of the deaths were in the first 2 days of the heat wave and stated that elderly people, those who have chronic illnesses (especially with atherosclerotic heart disease and renal insufficiency), mentally handicapped, bedridden, open-field workers and sportsmen are in the group under threat. Because of the climate zone in which our country is located, the possibility of experiencing hot air waves is quite high. While the South Eastern Anatolia Region is at greater risk than the Marmara Region, it is more likely that its impact will be higher in the Marmara Region because of the high population (1).

The high temperature causes an annual increase at the rate of 0.5-2% in the mortality of the elderly population in Europe. People's sensitivity to extreme temperature has recently begun to differ from the past. Some studies made in the USA show that people are more sensitive now rather than the period between the years of 1964 and 1988 (1).

As for cold weather, it continues to be problem in the northern part of the world, where air reaches very low degrees in a few hours and for long periods. Being exposed to cold air is a huge problem for the elderly and those who have poor social conditions such as outsiders, homeless people, alcoholics. In case of a problem in the electricity and heating systems of countries that have adapted to cold weather and cold air waves, an increase in death rates from cold weather is observed (1).

Between the years of 1979 and 1992, there were annual death increases ranging from 148 to 1700 in the United States depending on temperature fluctuations. It was interpreted that 1700 deaths in 1980, 556 in 1983 and 450 in 1988 occured due to the temperature waves. In North America, it is expected that deaths due to temperature fluctuations will be doubled in 2020 and increased seven times in 2050 (13).

Extreme climate events also affect mental health. For example; After the tsunami disaster in 2004, post-traumatic stress disorder was seen in 14-39% of children in the coastal area of Sri Lanka (14,15).

Drought, nutrition and food safety

Changes in the climate and severe weather events have different effects on human nutrition. The lack of regional water, salinization in agricultural areas, and the damage of crops because of floods and plant diseases affect the nutrition. Drought negatively affects the quality, quantity and therefore the quiddity of food and reduces food consumption. This situation leads to an increased mortality rate in malnutrition and diarrheal diseases (1).

Climate change is thought to be effective by changing soil quality, the incidence of plant diseases, seed and insect populations. Past 10,000 years constitute a very stable period in terms of climate. However, over the next 50 years, it is estimated that climate change will affect food production and therefore nutrition, food safety and human health at significant levels (13).

Geographical changes, product changes in agriculture, decrease in the amount of water used in the irrigation, loss of soil due to sea level rise and increase in the amount of salt in the soil will be inevitable consequences of climate change (16). It is also known that there will be a decrease in seafoods due to the change in water temperature, and in the availability of seafood depending on the increase in sea level (13).

With the emergence of new pathogens and the increased prevalence of older pathogens and with the impact of climate change, particularly depending on the temperature changes of the outer environment; the epidemiology of foodborne illness changes. Foodborne illnesses are increasing especially in the summer months (10). Warmer spring and summer months and warm winter months increase foodborne illnesses. It is estimated that up to 2050, foodborne diseases will increase by 5-20% (13).

Winds, storms and floods

Winds and storms cause the increase of microorganisms causing the release of toxic substances due to the acceleration of photosynthesis and metabolism, algae flowering and the generation of some pathogenic vibriores. Food poisoning can also be seen by consuming seafood which is contaminating with the toxins produced by these microorganisms. Especially for immune-suppressed people, consumption of oyster contaminated with parahemolyticus toxin causes deaths (12, 17, 18).

Flood events are often catastrophic and are thought to be increased as a result of climate change in the future. It has been proven that there is an increase in diarrheal diseases mostly in developing countries and even in Europe after a flood. Stagnant waters or overflows of rivers due to excessive rainfall cause flies to increase and therefore the increase of potential infectious diseases. After the floods in Italy in 1998, in the Czech Republic in 1997 and in Romania in 1996 -1997, West Nile virus fever had been an epidemic. In addition, it is observed that the risk of infection of the diseases is increased and due to direct contact with contaminated water; infection of the wounds, dermatitis, conjunctivitis, URTI and ARTI infections are also increased. Besides these effects, negative conditions such as disruption of the health services and displacement of the population may also occur (1).

Water and disease

Achieving clean water is one of the most important health issues. There are more than 2 billion people in the world who live in arid regions and suffer from malnutrition and diseases resulted from not to reach clean water. A small part of this problem that is unknown as a clear figure, can be developed out of climate change and extreme weather events. Climate change causes variances on the rain regime, surface waters, water availability and water quality (1).

Climate change is thought to affect water resources and water sanitation in particular. It is expected that there will be a significant decrease especially in drinking water resources. The incidence of diarrhea is expected to increase due to the use of river waters or unsafe water (13).

Despite improvements in treatment and care of children with diarrhea, child mortality from diarrheal diseases continues to be high, especially in underdeveloped countries and sub-Saharan Africa. Poor family children in rural areas and slum areas in urban are at greatest risk of death and illness from diarrheal illnesses. Many studies show that the transition of enteric pathogens is higher in rainy seasons (1).

When there are extreme weather events, the water support system is affected both physically and administratively. Due to the decrease in rainfall, low flow rates occur and the number of pathogens

increases. For this reason, sewerage and storm-water management is important in low-income urban communities because sewer blockage is one of the most important reasons for the spread of diseases (1).

According to the way of contagion; water-related diseases are separated as, water-borne diseases and diseases caused by insufficient hygiene. Four main points need to be taken into account when evaluating accessibility of water, quality of water and the relationship between the change in the rain regime and health. These issues;

- Relation between water access, clean water access at home and diarrheal diseases,
- The role of heavy rains in the creation of an epidemic of waterborne diseases via water network or surface waters,
- The effect of rain and temperature on microbiological and chemical contamination from surface waters, recreation and coastal waters,
- The temperature is directly affect the rate of diarrheal disease (1).

Weather quality and disease

EPA (Environmental Protection Agency, American Environmental Protection Agency) defines air pollution as" the presence of pollutants in the air in such a way to cause harm to human health or well-being, or to create other harmful environmental effects". The adverse effects of air pollution can be understood in terms of reaching a recipient environment, being in touch and exposition (1).

Air pollutants mainly caused some effects such as; impaired respiratory function, increased respiratory system diseases, facilitating disease exacerbations in people with chronic respiratory system and heart disease, increased incidence of cancer and increased incidence of premature death (19).

The increase in air pollution, the increase of the atmospheric greenhouse gases caused by industrial activities, domestic pollutants (air pollution, house dust mites, pet mites, fungal spores, etc.), extraterrestrial pollutants (air pollution, pollens, chemical inhalants agents etc.), and allergens are important parts of the environmental pollution. Inhalant allergens cause an increase in acute and chronic respiratory disease in allergic diseases such as allergic rhinitis and allergic asthma.

The extent to which the air temperatures will increase according to current levels, short-term changes in cross-border air pollution, hot waves, floods and excessive rainfall risks depending on the impact of these changes on other factors such as health-related air pollution, allergens and mold; the impact of climate change on people with respiratory disease will also vary (4).

Thinning of the ozone layer in the stratosphere causes the increase of the ultraviolet rays reaching the earth. The increase in ultraviolet rays reaching to the Earth leads to an increased incidence of infections and an increased tendancy of cancer due to the reason that this situation weakens the human immune system. The increase in ultraviolet rays also results in premature aging resulting from the formation of sunburn, decrease in photosensitivity and skin elasticity (20, 21). Soil-level ozone is usually caused by chemical reactions at high temperatures in sunlight and occur as a component of urban fumes. Exposure to high concentrations of ozone increases hospital admissions for lung infection, chronic obstructive pulmonary disease (COPD), asthma, allergic rhinitis, and other respiratory diseases and causes premature death (1).

Deoxyribonucleic acid (DNA) systems are also endangered due to the increase in ultraviolet rays. The increase in ultraviolet rays reaching the Earth also leads to DNA disorders leading to ecological effects such as decrease of photosynthesis, adverse effects of growth and multiplication of plants and death of phytoplankton (22, 23).

Evidence of health effects of particulate matter is stronger than ozone. Particulate matter seriously affects the number of deaths and illnesses. For this reason, increasing concentration also increases the negative effects on health (1). Depending on the climate change, the amount of pollen and air pollutants in the outdoor environment is expected to increase and therefore diseases such as asthma are expected to increase (13).

Beyond the health problems that environmental pollution creates related with greenhouse effect, the health problems created by global warming can be much more important. Global warming, which is mainly caused by environmental pollution, causes climate change and climate change can directly cause diseases and deaths (22, 23).

Vector, rodent welding and other infectious diseases

Climatic variations directly affect the epidemiology of vector-borne infections. Heat and moisture changes affect the feeding, maturation and survival of the vectors (9).

The indirect effect of climate change and changes in the ecosystem cause an increase and change in the living areas of the vectors and lastly cause vector-bone diseases such as Malaria, Dengue, Lyme, Chagas (Africa sleepy sickness) and Encephalitis. The change and multiplication of the virulence of disease agents causes an increase in the incidence of infections such as Tuberculosis, Syphilis and AIDS (10).

Vector-borne diseases are formed via infection of the disease agent by the sting of arthropods such as mosquitoes, sand flies, ticks and black flies. Vector-based diseases are the best studied group of studies on the relationship between climate change and diseases. Crimean-Congo Hemorrhagic fever, Hantavirus and Filovirus infections have recently been identified in Turkey and are associated with climate change. Many species of wild birds act as biological and mechanical carriers of human pathogens as well as vectors of infectious agents. Many of these birds are migratory species. Climate change has caused changes in the date of migration and dietary of many migratory birds (1).

Despite the usual common link between climate and malaria and climate change has regional and global impacts on malaria, there are still many uncertainties. Because, the complex dynamics of malaria with drug resistance and the importance of non-climatic factors such as socio-economic developments, due to the lack of detailed information at the same time; to determine infection and infection outcomes detailed historical observations of malaria and climate are not sufficiently made. Dengue is the world's most important vector-borne disease. There are many studies investigating the relationship between the climate and the appearance of the Dengue disease. On the other hand, this reported relationship does not fully reveal the complex impacts of climate change and other factors. Studies have shown that drought may also cause an increase in transmission with extreme rains and high temperature (1).

CONCLUSIONS AND RECOMMENDATIONS

As is well known, with industrialization, there have been major changes in the world's atmosphere and climate, with the intervention of people on the capacity of nature and destruction of natural resources. Although the change in the climates is a natural phenomenon that has been going on throughout history, it has not been as fast as it is today and the human influence is not so great. In recent years, a large number of weather and climate events have occurred in many parts of the world in terms of violence, influence, time, and location. This poses a serious threat to the socio-economic development of all life forms and societies around the world.

Due to the global climate change, hydro-meteorological disasters, especially drought and storms, are expected to be more effective in the future of our country. Today, it is seen that there are significant increases in the incidence, severity and duration of natural disasters both in the world and in Turkey due to the global climate change.

Diseases and deaths dependent on hot waves due to global warming have started to be seen seasonally. In addition, increasing rates of disease spreading by carriers, expansion and alteration of the reproductive areas of the carriers are another important consequence that are confronted. The increasing average of environmental temperature will affect the number of carrier organisms such as mosquitoes, its distribution and distribution rates, causing pathogens to multiply faster and increase their disease-making abilities. It would not be wrong to draw the conclusion that future diseases will be lethal compared to those living in the past, when climate change effects as these and many others like these are thought. In fact, many diseases that we recovered quickly today can cause deadly results within a few hours in tomorrow's climatic conditions. It is expected that the most affected population will be the elderly, children and people with health problems. People with low socio-economic conditions are also at serious risk. If the effects of climate change cannot be mitigated, the health of billions of people across the globe will be negatively affected.

These gases, which cause global climate change, will continue to remain in the atmosphere for a long time, even if all countries today reduce greenhouse gas emissions to a significant extent or stop altogether. This means that changes in the climate and the increasing severe disasters will continue for many years. In other words; It is no longer possible to stop global climate change thoroughly. In these

circumstances; It will be a rational solution to search ways to minimize the impact of the adverse effects of climate change, also expressed as "adaptation" studies.
In order to avoid negative health effects of climate change and to take necessary health precautions in possible situations;

We can use following recommendations;

- Strengthening the institutional infrastructure necessary for the detection, monitoring and control of the diseases seen or increased in our country through the impact of climate change and increasing the cooperation of inter-institutions and intra- institutions,
- Conducting necessary work particularly for the groups who will be most affected by the negativities of climate change,
- Better control of water and food safety with water and food management, fighting against water and foodborne diseases,
- Increasing public awareness in order for a better protection against the adverse effects of climate change on health,
- Making awareness raising activities in order to change the daily life behaviors of society,
- Taking precautions against extreme weather events (extreme rainfall, extreme hot and cold weather, air pollution) and resulting natural disasters (flood, fire etc.), establishment of early warning systems and diminishment of human health effects,
- Establishing policies and conduct studies to carry out monitoring and evaluation activities, control and reduction of health problems caused by climate change to provide solutions to intervene when necessary and help societies to cope with the adverse effects of global climate change.

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