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Impact of Climate Change (Global Warming) on Food-Borne Parasites

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Abstract

Parasitic food-borne zoonosis could impose heavy toll on human health and cause serious direct and indirect economic losses. A wide variety of helminthes parasites which are quite prevalent in Iran can infect human by the oral route. In the present study food-borne parasites have been discussed according to the main sources of transmission include: meat, vegetables, water and soil and reviews the parasitic infection affected the current available evidence and scenarios of climate changes in Iran. The four major climatic zones of Iran are considered. Meat-borne parasites, *cysticercus bovis* significantly decreased in Iran as a result of improve community health particularly excreta disposal in rural areas. Pork is not consumed in Iran because of the religious prohibition and human infection case with *cysticercus celluluse* and *Trichinella spiralis* is rare. And the prevalence of fish-borne parasites is not considerable because fish consumption in Iran is not high. Fascioliasis is now the most important food-borne parasites in Iran, mainly from Gilan province where placed in the zone1. Hydatidosis is endemic in Iran. Eating raw vegetable is the main cause of infection. *Dracunculus medinensis* was the most important water-borne parasites; the infection has been eradicated in Iran, which is due to consumption the most sanitary water. Although the prevalence of soil-borne parasites is very low compared to the past but it is the most common parasites in the zone1. A comprehensive study contain detailed estimations of food-borne parasites can provide useful solutions for their control and preventions.

Keywords: Food-Borne Parasites, Ecology, Epidemiology, Climate Change, Iran

1. INTRODUCTION

Food borne diseases caused by helminthes are quite prevalent all through the country. Because of the habit of living the risk of food contamination with parasites is normally high. Iran is a vast country with a population of 75 million. Weather of Iran is such countries with a semi-arid climate. Consideration of climatological data and of topography of country led to division of Iran into the four major climatic zones (Fig. 1) where it seemed likely that differences in parasite problems may be found. Iran in terms of geopolitics is located in a region of the world which is called the heart of the earth, although the term has been used for political and military goals [1]. Therefor Iran has strategically very important role in the spread of infections [2]. Climate change refers to any interpretation to be certain about the expected patterns of average weather, which Happen to the Earth or in a specific region in the long term. Climate change has a major impact on the biology of parasites and parasites distribution subsequently effects on human health and food security [3,4]. Since ancient, data have been collected on the impact of climate on human health [5]. Iran has four climate of medical climatology as follows (Fig. 1): 1) The Caspian zone, 2) The Mountain plateaux zone, 3) The Persian Gulf zone, 4) The Desert zone [2,6]. There are eight sub-continent which are not shown here. Studies have been conducted on the epidemiology of parasitic infections in Iran, although not comprehensive but have long been considered to the Prevalence and abundance of parasitic infections [6]. Skerman et al. (1967) studied the incidence and epidemiology, control and economic importance of Gastro-Intestinal parasites in the small ruminants in two climatic zones (Caspian Sea climate and Mountain climate) of Iran [6]. Based on these results, the Prevalence and abundance of Gastro-intestinal nematodiasis were different in small ruminants in the two zones (zones 1 and 2) [6]. After strategic treatment with anti-helminthes and reduce worm burden as a result, the protein content increased 2.5 kg. As well, to feed the future population is affordable [6]. In Iran, food of animal protein is produced from 75,000,000 sheep and goats, 7,000,000 native and industrial cattle and 25,000,000,000 poultry [7]. More than 150 different species of fish found in the Persian Gulf and more than 78 species of fish found in the Caspian Sea. Caspian Sea is the hosts of one of the most valuable fish stocks in the world. The Caspian Sea is the host of sturgeon, one of the valuable foods in the world, provides a source of fish for human food [8]. Lamb meat is the most popular meat in the food supply and beef in the next. Other sources of meat include goat, camel and buffalo. Milk consumption in Iran is 70-80 Kg annually. Milk is pasteurized and helminthes infective larvae have not been reported from milk [7]. The aim of this study was to investigate the epidemiology and ecology of food-borne parasites. In the present study, parasites were studied by means of transmission to humans. Also the impact of climate change on the parasites is investigated. It is noted that most food-borne parasites are zoonotic.

2. TYPES OF PARASITES

2.1. Meat-borne Parasites (Helminthes Parasites)

Taenia saginata Commonly known as the beef tapeworm, is a zoonotic tapeworm belonging to the order Cyclophyllidea and genus *Taenia*. It is an intestinal parasite of humans, causing taeniasis. Cattle are the intermediate hosts, where larval development (metacestod) occurs and named *cysticercus bovis*, it is most prevalent where cattle are raised and beef is consumed. Consuming of infected beef with *cysticercus bovis* as raw or semi-cooked products causes human taeniasis due to *Taenia saginata*. Beside of meat, infected liver or lungs may also take a role in transmission to the man under condition. Raw meat is not eaten in Iran but the barbecue is very common and desirable and the meat may be raw in the middle of it. The incidence of adult tapeworm in man cannot be figured out accurately, and is estimated about 0.5- 1 per cent in Iran [9] the rate of infection varies from one part to another. The highest was 17% recorded from Mazandaran and next 14% from Gilan

province. Now, the prevalence of taeniasis in Mazandaran is 0.5% [9]. And the most prevalence of cysticercosis in cattle is 2-3% reported from north of Iran [9]. The prevalence of Taeniasis decreased in Iran as a result of Improve community health particularly excreta disposal in rural areas. In the slaughterhouse, Carcass inspection was done carefully. And infected meat is maintained in the freezer according to Health guidelines so Meat hygiene is increased [10].

Taenia solium is the pork tapeworm belonging to cyclophyllidea cestodes in the family Taeniidae. The adult worm is found in humans and metacestode (*cysticercus cellulosae*) in pigs. It is transmitted to pigs through human faeces or contaminated food, and to humans through uncooked or undercooked pork. However, accidental infection in humans by the larval stage causes cysticercosis. The most severe form is neurocysticercosis, which affects the brain. It is most prevalent in countries where pork is eaten [11]. Pork is not consumed in Iran Because of the religious prohibition. Before the Islamic Revolution, domestic pig was reared in Iran. This pig and wild swine were used for research on *cysticercus cellulosae*, 0.3-3% of pigs and 4% of boars were infected (10) but human infection have not been reported yet.

Trichinella spiralis is a parasitic nematode that has a direct life cycle, meaning it completes all stages of development in one host. The larval forms are encapsulated as a small cystic structure within the infected host. Humans typically become infected when they eat undercooked *Trichinella* infected pork and affected the disease trichinosis. Before the Islamic Revolution, examination of pig meat using trichinoscope was routine in Tehran abattoir, but it has not been reported *Trichinella* infection in domestic pigs in Iran yet. But from 4,950 carcasses of boars examined for *Trichinella spiralis* the larva was found in 2 of them [12]. This parasite has been reported also from more than 60% of Jackals and wild cats and 16% of Brown Bear from north of Iran [13]. After the Islamic Revolution, Domestic pig breeding was stopped although Wild boar meat is consumed for Armenians. *Trichinella* infections from a group of humans have been reported recently, by consuming grilled hunting boar meat infected with *Trichin* [14].

2.2. Fish-borne Parasites

Fish consumption in Iran is not high. Average annual consumption of fish is 7 grams per day in Iran, while it is about 18Kg in the world. In Iran, Coastal residents eat more fish, they have different diets. Coastal residents consume about 13 kg of fish per year [8]. The prevalence of Fish-borne parasites in Iran is not significant.

Anisakis or herring-worm is a natural parasite of marine fish-eating mammals. Human cases occur where fish are eaten raw, larvae are found in abscesses in the wall of the intestinal tract and stomach. Larvae of *Anisakis* were found in the flesh of Persian Gulf fish [15]. The results of the recent study showed that more than 90% of the *Thannus tonggol* fish were infected [16] but human infection with anisakidae has not been reported, since eating raw fish is rare in Iran [15].

Diectophyma renale is a natural parasite of the kidney or the body cavity of carnivores and the unembryonated eggs are passed out in urine. Eating infected raw fish likely leads to dioctophymosis. Adult worms in the kidney cause renal colic and later dysfunction. A case is reported of a woman's lived in east Azerbaijan (North West of Iran) [17]. But in Iran the prevalence of Infection in stray dogs and other carnivores are considerable [18].

2.3. Vegetable-borne Parasites

***Fasciola* sp.:** Fasciolosis is a well-known parasitic disease, because of its medical and veterinary importance. It is now also an important human parasitic disease with estimated ranging from 2.4 to 17 million people infected [19]. *Fasciola hepatica* and *F. gigantica* the causative agents of fasciolosis of animals and man are reported from different regions in Iran [20,21], although the distribution of both species overlaps in many parts of the country [19,21]. Human fasciolosis is a matter of concern in provinces situated along the shore of the Caspian Sea, especially in Gilan Province. This province has experienced two waves of the fasciolosis epidemics. The first wave was begun in 1987 when an outbreak in Gilan affected more than 10,000 people. The second wave of the epidemic began within 10 years later where several thousand people were infected [22]. Reports of several hundred cases of human fasciolosis between two outbreaks and afterward show that Gilan Province has become an endemic area for human fasciolosis in Iran. At least 17,000 human infections have been reported in Gilan Province since 1989 [22]. Recently worldwide losses in animal productivity due to fasciolosis were conservatively estimated at over US\$ 3.2 billion per annum [23]. In Asia the most human cases were reported from Iran, mainly from Gilan Province [24], findings showed that fasciolosis is very prevalent among animals in Rasht and Bandar- Anzali. Considering the prepatent period of fasciolosis [12 weeks], the absence of *Fasciola* egg in calf is a natural phenomenon. But the percentage of infection in other animals and animal manure was higher than 21. 5% previously reported from ruminants of Gilan [25]. Fasciolosis may cause serious economic problem. Climate change is effective in *Fasciola*. When summer rainfall is high, Facilitate the growth of wild plants (*Menta piperita*, *Menta aquatica*, *Nasturium officinale*) but damaged farming vegetable, therefore Humans consume the wild plants, which are the sources of infection. In addition, the environment of *Lymnaea truncatula* (the intermediate host of *Fasciola hepatica*) is prepared well. The impact of this climate change on the incidence of Fasciolosis is undeniable [26].

Hydatid cyst: Hydatidosis, caused by *Echinococcus* spp. (*E. granulosus* and *E. multilocularis* in Iran) is one of the most important zoonotic diseases, throughout the most parts of the world [27]. *E. granulosus* is the causative agent of cystic hydatid disease or hydatidosis, whereas infection with *E. multilocularis* in man leads to the more aggressive form of alveolar echinococcosis. Ingesting embryonated eggs through hands, food, drinks or material contaminated with parasite eggs infects humans; the larvae reach the blood and lymphatic circulation and transport to the liver, lungs and other organs [28]. Cystic echinococcosis is considered endemic in the entire Mediterranean zone including all countries from the Middle East [29], but alveolar echinococcosis is less prevalent and has been reported only from Iran, Turkey, Iraq and Tunisia [30]. Hydatidosis is endemic in Iran and is responsible for approximately 1% of admission to surgical wards [31]. The annual incidence rate of hydatidosis in human in Iran 0.61/100,000 [31] are among documented reports. *E. multilocularis* is another agent of human hydatidosis (alveolar echinococcosis) with red fox (*Vulpes vulgaris*) and jackal (*Canis aureas*) as final hosts as well as social vole (*Microtus socialis*) as intermediate host [32] in Iran , where is recognized an endemic country for the disease [33]. Here is tendency to eat raw vegetables with food. Unfortunately, in most vegetable farms, dogs freely prowl and contaminate the vegetables. Another potential source of infection is carrot juice, which almost everywhere is sold in a mixture with ice cream. The washing system of carrots is such that the parasites' eggs are retained in washing water and most of them are not separated from the carrots [31]. A tendency to eat soil by pregnant women especially in rural areas makes the situation in benefit of infecting with hydatidosis.

The importance of environmental factors in influencing the transmission intensity and distribution of *Echinococcus* spp. is increasingly being recognized [31].

***Dicrocoelium dendriticum*:** Low human cases have been reported. But this is one of the most common infections in ruminants in Iran now; it is one of the main causes of liver destruction in the slaughters house [34]. Despite consumed the wide range of anti-helminthic drugs, Infection with this parasite remains considerable and researchers have been suspected to drug resistance in *D.dendriticum*, but it is obvious that this issue requires further study [35].

***Trichostrongylidae*:** Contamination of vegetables with Trichostrongylid eggs and eating them raw was causing haemonchosis, osthertagiasis, in the past. But now, Strategic treatment of nematodes with anti-helminthes drugs has led to completely eliminate the infection in humans and significantly reduce infection in ruminants [36].

2.4. Water-Borne Parasites

Dracunculus medinensis or Guinea worm is a nematode that causes dracunculiasis. The disease is caused by the large female nematode of *D. medinensis* and it was the most important water borne parasites. Fortunately, the disease has been eradicated in Iran. Indeed, the most sanitary water consumption is due to eradicate the infection [37].

2.5. Soil-Borne Parasites

Important parasite infections in humans are caused by eating soil. Dining on soil may be an accident, like children who Play on the ground and do not wash their hands and sometimes it is a bad habit in humans, most often in rural or pre-industrial societies among children and pregnant women which are may be related to pica. Toxocarasis is one of the most important soil-borne and emerging parasites. Most people are infected by contact with contaminated soil [37]. Forty years ago, Ascariasis infection was 83% in Khozestan province (South West Iran) and infections have also been reported in other areas with suitable climatic conditions. But now, due to improving public health, it is 1%. *Trichuris trichura* although its prevalence is very low compared to the past but it is a one of the most common parasites in Iran especially in zone 1, Fig. 1 [37].

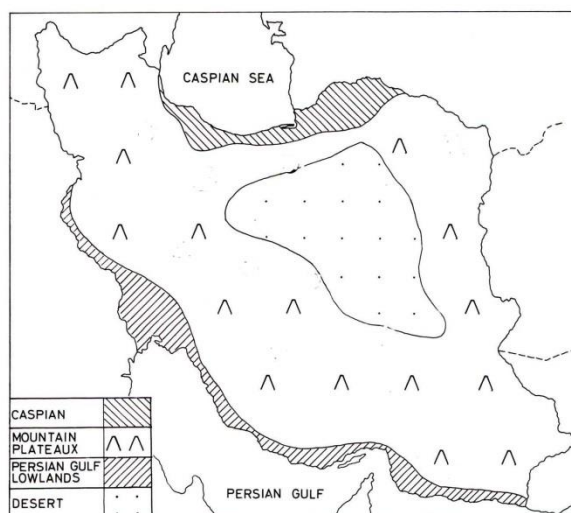
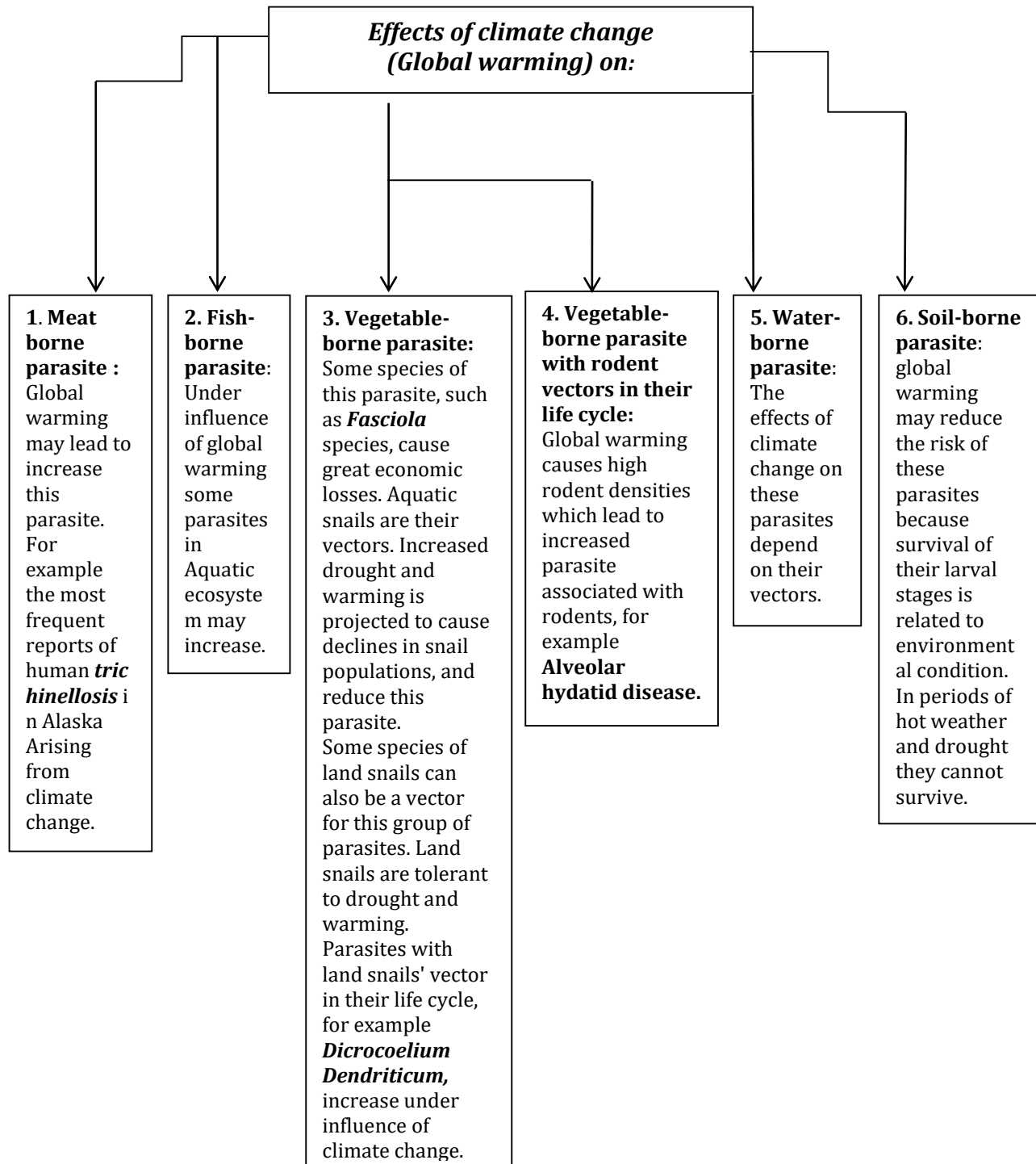


Figure 1: The major climatic zones of Iran (Skerman etal., 1967)

3. RESULTS



4. DISCUSSION

The globalization of food supply, increased international travel, increase of *population* with highly susceptible persons and changing the habits of life are important factors associated with increasing

food-borne parasites [4]. In the present study the evaluation of the food-borne helminthes classified in the four groups. Moreover, the important food borne protozoa should not be ignored such as Toxoplasmosis and Sarcocystiasis (meat-borne protozoa), Giardiasis and Cryptosporidiosis and Cyclosporiasis (water-borne protozoa). With the advent of climate change and the influence of global population expansion, food insecurity and land-use changes, questions about the potential impact of changing temperature, rainfall patterns, increasing urbanization, deforestation, grassland degradation and overgrazing on zoonotic disease transmission are being raised [5]. Since it is inadequate systems for diagnosis and monitoring the parasitic infections as well lack of supervision systems to report the detailed of the infections and the mechanisms of transmitted usually the incidence of food-borne parasites infections are underestimated. And the same is true of drug resistance [38]. It must be noted that, personal and Laboratory safety, in other word biosafety, is essential to study food-borne and zoonotic parasites and research on the most cases should be performed in the laboratory with class II and III, so Research has been limited on this parasites. Climate change is one of the main causes gain food-borne parasites [4]. Some of these changes are rooted in global warming can predict the epidemic of parasitic infections in humans and livestock population in the future. In Iran heat and dryness is more likely in the future, so the pattern of tropical diseases expands in temperature zone, and of the low-lying areas to the highlands [3]. According to the forecast, in Iran should be expected to reduce the incidence of *malaria* and increased the prevalence of *Leishmania*. In these times the density of mice rises, and increases the risk of diseases transmitted from mice [2]. Parasitic pathogens in freshwater and marine ecosystems are affected by climate change. As the temperature increases the rate of transfer of fish parasites and pathogenic factors increases and fisheries economy suffers. Emigration Iran via the border of East and South East (especially from Afghanistan country) affect the epidemiology of food-borne parasites. For example, surgical Cases of Hydatidosis are high in Afghans who are living in Iran, but Source of infection and transmission mechanism has not been studied yet. Although Gastro-intestinal helminthes-parasites have decreased in human and ruminants but must be wide-awake about emerging parasites which are resistance to heat temperature and anti- helminthes drugs [38]. With the current available evidence and scenarios for climate change in Iran, it would appear that the public health effects of climate change especially on parasitic infections that need to be intensively studied. A comprehensive study contain detailed estimations of food-borne parasites are still lacking for Iran. Study on forecasting model of spreading of food-borne parasites can provide useful solutions for their control and preventions as well provide food security for the human society.

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